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Docket No.: S&ZFH030508

Michael Burns
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Date: December 4, 2003

Mail Stop Patent Application
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Sir:

Enclosed herewith are the necessary papers for filing the following application for Letters Patent:

Applicant : DETLEF MARPE ET AL.

Title : METHOD AND ARRANGEMENT FOR ARITHMETIC ENCODING AND DECODING BINARY STATES AND A CORRESPONDING COMPUTER PROGRAM AND A CORRESPONDING COMPUTER-READABLE STORAGE MEDIUM

4 sheets of drawings.
The payment in the amount of $928.00 covering the filing fee.
PCT Cover Sheet WO 03/094355 A2

This application is being filed without a signed oath or declaration under the provisions of 37 CFR 1.53(f). Applicants await notification of the date by which the oath or declaration and the surcharge are due, pursuant to this rule.

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The Patent and Trademark Office is hereby given authority to charge Deposit Account No. 12-1099 of Lerner and Greenberg, P.A. for any fees due or deficiencies of payments made for any purpose during the pendency of the above-identified application.

Respectfully submitted,

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S&ZFH030508

Method and Arrangement for Arithmetic Encoding and Decoding Binary States and a Corresponding Computer Program and a Corresponding Computer-readable Storage Medium

Cross-Reference to Related Application:

This application is a continuation of copending International Application No. PCT/EP03/04654, filed May 2, 2003, which designated the United States and was not published in English.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to a method and an arrangement for arithmetically encoding and decoding binary states and to a corresponding computer program and a corresponding computer-readable storage medium which may in particular be used in digital data compression.

2. Description of the Related Art:

The present invention describes a new efficient method for binary arithmetic coding. There is a demand for binary arithmetic coding in most different application areas of digital data compression; here, in particular applications in the fields of digital image compression are of special interest. In numerous standards for image coding, like e.g. JPEG, JPEG-2000, JPEG-LS and JPIG, methods for a binary arithmetic coding were defined. Newer standardization activities make also the future use of such coding technologies obvious in the field of video coding (CABAC in H. 264/AVC) [1].

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The advantages of arithmetic coding (AC) in contrast to the Huffman coding [2] which has up to now been used in practice, may basically be characterized by three features:

1. By using the arithmetic coding, by simple adaptation mechanisms a dynamic adaptation to the present source statistic may be obtained (adaptivity).

2. Arithmetic coding allows the allocation of a non-integer number of bits per symbol to be coded and is therefore suitable to achieve coding results which illustrate an approximation of the entropy as the theoretically given lower bound (entropy approximation) [3].

3. Using suitable context models statistical bindings between symbols for a further data reduction may be used with arithmetic coding (intersymbol redundancy) [4].

As a disadvantage of an application of the arithmetic coding, generally the increased calculation effort compared to Huffman coding is regarded.

The concept of the arithmetic coding goes back to the basic documentation for information theory by Shannon [5]. First conceptional construction methods were firstly published by Elias [6]. A first LIFO (last-in-first-out) variant of the arithmetic coding was designed by Rissanen [7] and later modified [8] [9] [10] by different authors to the FIFO implementations (first-in-first-out).

All of those documents have the basic principle of recursive partial interval decomposition in common. Corresponding to the given probabilities P("0") and P("1") of two results {"0", "1"} of a binary alphabet a primarily given interval, e.g. the interval [0, 1), is recursively decomposed into partial intervals depending on the

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occurrence of individual events. Here, the size of the resulting partial interval as the product of the individual probabilities of the occurring events is proportional to the probability of the sequence of individual events. As every event S_i adds a contribution of $H(S_i) = -\log(P(S_i))$ of the theoretical information content $H(S_i)$ of S_i to the overall rate by the probability $P(S_i)$, a relation between the number N_{Bit} of bits for illustrating the partial interval and the entropy of the sequence of individual events results, which is given by the right side of the following equation:

$$N_{Bit} = -\log \prod_i P(Si) = -\sum_i \log P(Si)$$

The basic principle, however, first of all requires a (theoretically) unlimited accuracy in the illustration of the resulting partial interval and apart from that it has the disadvantage that only after the coding of the last result may the bits for a representation of the resulting partial interval be output. For practical application purposes it was therefore decisive to develop mechanisms for an incremental output of bits with a simultaneous representation with numbers of a predetermined fixed accuracy. These were first introduced in the documents [3] [7] [11].

In Fig. 1, the basic operations for a binary arithmetic coding are indicated. In the illustrated implementation the current partial interval is represented by the two values L and R, wherein L indicates the offset point and R the size (width) of the partial interval, wherein both quantities are respectively illustrated using b-bit integers. The coding of a bit $\in \{0, 1\}$ is thereby basically performed in five substeps: In the first step using the probability estimation the value of the less probable symbol is determined. For this symbol, also referred to as LPS (least probable symbol), in contrast to the MPS (most probable symbol), the probability estimation P_{LPS} is used in the

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second step for calculating the width R_{LPS} of the corresponding partial interval. Depending on the value of the bit to be coded L and R are updated in the third step. In the forth step the probability estimation is updated depending on the value of the just coded bit and finally the code interval R is subjected to a so-called renormalization in the last step, i.e. R is for example rescaled so that the condition $R \in [2^{b-2}, 2^{b-1}]$ is fulfilled. Here, one bit is output with every scaling operation. For further details please refer to [10].

The main disadvantage of an implementation, as outlined above, now lies in the fact that the calculation of the interval width R_{LPS} requires a multiplication for every symbol to be coded. Generally, multiplication operations, in particular when they are realized in hardware, are cost- and time-intensive. In several research documents methods were examined to replace this multiplication operation by a suitable approximation [11] [12] [13] [14]. Hereby, the methods published with reference to this topic may generally be separated into three categories.

The first group of proposals for a multiplication-free, binary arithmetic coding is based on the approach to approximate the estimated probabilities P_{LPS} so that the multiplication in the second step of Fig. 1 may be replaced by one (or several) shift and addition operation(s) [11] [14]. For this, in the simplest case the probabilities P_{LPS} are approximated by values in the form of 2^{-q} with the integer $q > 0$.

In the second category of approximative methods it is proposed to approximate the value range of R by discrete values in the form $(1/2 - r)$, wherein $r \in \{0\} \cup \{2^{-k} \mid k > 0, k \text{ integer}\}$ is selected [15] [16].

The third category of methods is only known from the fact that here any arithmetic operations are replaced by table

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accesses. To this group of methods on the one hand the Q-coder used in the JPEG standard and related methods, such as the QM- and MQ-coder [12], and on the other hand the quasi-arithmetic coder [13] belong. While the latter method performs a drastic limitation of the number b of bits used for the representation of R in order to obtain acceptably dimensioned tables, in the Q-coder the renormalization of R is implemented so that R may at least approximately be approximated by 1. This way the multiplication for determining R_{LPS} is prevented. Additionally, the probability estimation using a table in the form of a finite state machine is operated. For further details please see [12].

SUMMARY OF THE INVENTION

It is the object of the present invention to provide a method and an arrangement for an arithmetic encoding and decoding of binary states and a corresponding computer program and a corresponding computer-readable storage medium which eliminate the mentioned disadvantages and in particular (a) do not require a multiplication, (b) allow a probability estimation without calculation effort and (c) simultaneously guarantee a maximum coding efficiency over a wide range of typically occurring symbol probabilities.

In accordance with a first aspect, the present invention provides a method for an arithmetic encoding and decoding of binary states, wherein in a first step a presetable value range for the specification of the interval width R is separated in K representative interval widths $\{Q_1, \ldots, Q_K\}$, a presetable value range for the specification of the probabilities is separated in N representative probability states $\{P_1, \ldots, P_N\}$ and allocation regulations are given, which allocate one Q_K $(1 \le k \le K)$ to every interval width R and one P_n $(1 \le n \le N)$ to every probability, and that in a second step the encoding or decoding of the binary states take place by performing the calculation of the new interval width to be derived in the encoding or decoding

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process, respectively, using a representative interval width Q_K ($1 \le k \le K$) and a representative probability state P_n ($1 \le n \le N$) by arithmetic operations other than multiplication and division, wherein the representative interval width Q_K is determined by the basic basis interval of the width R and the representative probability state P_n is determined by the probability estimation underlying the symbol to be encoded or to be decoded according to the given allocation regulations.

In accordance with a second aspect, the present invention provides an arrangement having at least one processor and/or chip, which is/are implemented such that a method for an arithmetic encoding and decoding of binary states is may be performed, wherein in a first step a presetable value range for the specification of the interval width R is separated in K representative interval widths $\{Q_1, \ldots, Q_K\}$, a presetable value range for the specification of the probabilities is separated in N representative probability states $\{P_1, \ldots, P_N\}$ and allocation regulations are given, which allocate one Q_K ($1 \le k \le K$) to every interval width R and one P_n ($1 \le n \le N$) to every probability, and wherein in a second step the encoding or decoding of the binary states take place by performing the calculation of the new interval width to be derived in the encoding or decoding process, respectively, using a representative interval width Q_K ($1 \le k \le K$) and a representative probability state P_n ($1 \le n \le N$) by arithmetic operations other than multiplication and division, wherein the representative interval width Q_K is determined by the basic basis interval of the width R and the representative probability state P_n is determined by the probability estimation underlying the symbol to be encoded or to be decoded according to the given allocation regulations.

In accordance with a third aspect, the present invention provides a computer program which enables a computer after it has been loaded into the storage of the computer to

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perform a method for an arithmetic encoding and decoding of binary states, wherein in a first step a presetable value range for the specification of the interval width R is separated in K representative interval widths $\{Q_1, \ldots, Q_K\}$, a presetable value range for the specification of the probabilities is separated in N representative probability states $\{P_1, \ldots, P_N\}$ and allocation regulations are given, which allocate one Q_K $(1 \leq k \leq K)$ to every interval width R and one P_n $(1 \leq n \leq N)$ to every probability, and wherein in a second step the encoding or decoding of the binary states take place by performing the calculation of the new interval width to be derived in the encoding or decoding process, respectively, using a representative interval width Q_K $(1 \leq k \leq K)$ and a representative probability state P_n $(1 \leq n \leq N)$ by arithmetic operations other than multiplication and division, wherein the representative interval width Q_K is determined by the basic basis interval of the width R and the representative probability state P_n is determined by the probability estimation underlying the symbol to be encoded or to be decoded according to the given allocation regulations.

In accordance with a fourth aspect, the present invention provides A computer-readable storage medium on which a computer program is stored which enables a computer after it has been loaded into the storage of the computer to perform a method for an arithmetic encoding and decoding of binary states, wherein in a first step a presetable value range for the specification of the interval width R is separated in K representative interval widths $\{Q_1, \ldots, Q_K\}$, a presetable value range for the specification of the probabilities is separated in N representative probability states $\{P_1, \ldots, P_N\}$ and allocation regulations are given, which allocate one Q_K $(1 \leq k \leq K)$ to every interval width R and one P_n $(1 \leq n \leq N)$ to every probability, and wherein in a second step the encoding or decoding of the binary states take place by performing the calculation of the new interval width to be derived in the encoding or decoding

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process, respectively, using a representative interval width Q_K ($1 \leq k \leq K$) and a representative probability state P_n ($1 \leq n \leq N$) by arithmetic operations other than multiplication and division, wherein the representative interval width Q_K is determined by the basic basis interval of the width R and the representative probability state P_n is determined by the probability estimation underlying the symbol to be encoded or to be decoded according to the given allocation regulations.

One method for an arithmetic encoding and decoding of binary states is advantageously performed so that in a first step a presetable value range for the specification of the interval width R is separated in K representative interval widths $\{Q_1, \ldots, Q_K\}$, a presetable value range for the specification of the probabilities is separated in N representative probability states $\{P_1, \ldots, P_N\}$ and allocation regulations are given, which allocate one Q_K ($1 \leq k \leq K$) to every interval width R and one P_n ($1 \leq n \leq N$) to every probability, and that in a second step the encoding or decoding of the binary states take place by performing the calculation of the new interval width to be derived in the encoding or decoding process, respectively, using a representative interval width Q_K ($1 \leq k \leq K$) and a representative probability state P_n ($1 \leq n \leq N$) by arithmetic operations other than multiplication and division, wherein the representative interval width Q_K is determined by the basic basis interval of the width R and the representative probability state P_n is determined by the probability estimation underlying the symbol to be encoded or to be decoded according to the given allocation regulations.

Another preferred implementation of the invention is characterized by the fact that based on the interval currently to be evaluated with a width R for determining the associated interval width Q_K an index q_index is determined by a shift and bit masking operation applied to the computer-internal/binary representation of R.

It is also advantageous when based on the interval currently to be evaluated with a width R for determining the associated interval width Q_K an index q_index is determined by a shift operation applied to the computer-internal/binary representation of R and a downstream access to a table Qtab, wherein the table Qtab contains the indices of interval widths which correspond to the values of R which were pre-quantized by the shift operation.

It is in particular advantageous when the probability estimation underlying the symbol to be encoded or decoded is associated to a probability state P_n using an index p_state.

It is also an advantage when the determination of the interval width R_{LPS} corresponding to the LPS is performed by an access to the table Rtab, wherein the table Rtab contains the values corresponding to all K quantized values of R and to the N different probability states of the interval width R_{LPS} as product values (Q_K * P_n). The calculation effort is reduced in particular when the determination of the interval width R_{LPS} corresponding to the LPS is performed by an access to the table Rtab, wherein for evaluating the table the quantization index q_index and the index of the probability state p_state are used.

It is further provided that in the inventive method for the N different representative probability states transition rules are given, wherein the transition rules indicate which new state is used based on the currently encoded or decoded symbol for the next symbol to be encoded or decoded. It is hereby of an advantage when a table Next_State_LPS is created which contains the index m of the new probability state P_m when a least probable symbol (LPS)

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occurs in addition to the index n of the currently given probability state P_n, and/or when a table Next_State_MPS is created which contains the index m of the new probability state P_m when a most probable symbol (MPS) occurs in addition to the index n of the currently given probability state P_n.

An optimization of the method for a table-aided binary arithmetic encoding and decoding is achieved in particular by the fact that the values of the interval width R_{LPS} corresponding to all K interval widths and to all N different probability states are filed as product values (Q_K * P_n) in a table Rtab.

A further optimization is achieved when the number K of the quantization values and/or the number N of the representative states are selected depending on the preset accuracy of the coding and/or depending on the available storage room.

One special implementation of the encoding in the inventive method includes the following steps:

1. Determination of the LPS
2. Quantization of R:
   q_index = Qtab[R>>q]
3. Determination of R_{LPS} and R:
   R_{LPS} = Rtab [q_index, p_state]
   R = R − R_{LPS}
4. Calculation of the new partial interval:

```
if (bit : LPS) then
        L ← L + R
        R ← R_LPS
        p_state ← Next_State_LPS [p_state]
        if (p_state = 0) then valMPS ← 1 - valMPS
else
        p_state ← Next_State_MPS [p_state]
```

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5. Renormalization of L and R, writing bits, wherein

q_index describes the index of a quantization value read out of Qtab,

p_state describes the current state,

R_{LPS} describes the interval width corresponding to the LPS and

valMPS describes the bit corresponding to the MPS.

The decoding in a special implementation of the inventive method includes the following steps:

1. Determination of the LPS
2. Quantization of R:

   q_index = Qtab[R>>q]
3. Determination of R_{LPS} and R:

   R_{LPS} = Rtab [q_index, p_state]

   R = R – R_{LPS}
4. Determination of bit depending on the position of the partial interval:

```
if (V ≥ R) then
  bit ← LPS
  V ← V - R
  R ← R_LPS
      if (p_state = 0) valMPS ← 1 - valMPS
      p_state ← Next_State_LPS [p_state]
else
      bit ← MPS
      p_state ← Next_State_MPS [p_state]
```

5. Renormalization of R, reading out one bit and updating V, wherein

q_index describes the index of a quantization value read out of Qtab,

p_state describes the current state,

R_{LPS} describes the interval width corresponding to the LPS,

valMPS describes the bit corresponding to the MPS, and

V describes a value from the interior of the

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current partial interval.

In another special implementation of the inventive method it is provided that in encoding and/or decoding the calculation of the quantization index q_index is performed in the second substep after the calculation regulation:

q_**index** = (R >> q) & Qmask

wherein Qmask illustrates a bit mask suitably selected depending on K.

If a uniform probability distribution is present a further optimization of the method for a table-aided binary arithmetic encoding and decoding may be achieved by the fact that in the encoding according to claim 12 the substeps 1 to 4 are performed according to the following calculation regulation:

R ← R >> 1
if (bit = 1) **then**
L ← L + R

or

that the substeps 1 to 4 of the encoding according to claim 12 are performed according to the following calculation regulation:

L ← L << 1
if (bit = 1) **then**
L ← L + R

and wherein in the last alternative the renormalization (substep 5 according to claim 12) is performed with doubled decision threshold values and no doubling of L and R is performed, and

that in the decoding according to claim 13 the substeps 1 to 4 are performed according to the following calculation regulation:

R ← R >>1
if (V ≥ R) **then**
bit ← 1

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```
        V ← V - R
    else
        bit ← 0,
```

or

the substeps 1 to 5 of the decoding according to claim 13 are performed according to the following calculation regulation:

1. Reading out one bit and updating V
2. Determination of bit according to the position of the partial interval:

```
    if (V ≥ R) then
            bit ← 1
            V ← V - R
    else
            bit ← 0.
```

It further turns out to be advantageous when the initialization of the probability models is performed depending on a quantization parameter SliceQP and preset model parameters m and n, wherein SliceQP describes the quantization parameter preset at the beginning of a slice and m and n describe the model parameters.

It is also advantageous when the initialization of the probability models includes the following steps:

```
1. preState = min(max(1, ((m * SliceQP) >>4)+n), 2*N)
2. if (preState <=N) then
            p_state = N+1 - preState
            valMPS = 0
   else
            p_state = preState - N
            valMPS = 1,
```

wherein valMPS describes the bit corresponding to the MPS, SliceQP describes the quantization parameter preset at the beginning of a slice and m and n describe the model parameters.

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One arrangement for an arithmetic encoding and decoding of binary states includes at least one processor which is/are implemented such that a method for an arithmetic encoding and decoding may be performed, wherein in a first step a presetable value range for the specification of the interval width R is separated in K representative interval widths $\{Q_1, \ldots, Q_K\}$, a presetable value range for the specification of the probabilities is separated in N representative probability states $\{P_1, \ldots, P_N\}$ and allocation regulations are given, which allocate one Q_K ($1 \leq k \leq K$) to every interval width R and one P_n ($1 \leq n \leq N$) to every probability, and wherein in a second step the encoding or decoding of the binary states take place by performing the calculation of the new interval width to be derived in the encoding or decoding process, respectively, using a representative interval width Q_K ($1 \leq k \leq K$) and a representative probability state P_n ($1 \leq n \leq N$) by arithmetic operations other than multiplication and division, wherein the representative interval width Q_K is determined by the basic basis interval of the width R and the representative probability state P_n is determined by the probability estimation underlying the symbol to be encoded or to be decoded according to the given allocation regulations..

One computer program for an arithmetic encoding and decoding of binary states allows a computer, after it has been loaded into the storage of the computer, to perform an method for an arithmetic encoding and decoding, wherein in a first step a presetable value range for the specification of the interval width R is separated in K representative interval widths $\{Q_1, \ldots, Q_K\}$, a presetable value range for the specification of the probabilities is separated in N representative probability states $\{P_1, \ldots, P_N\}$ and allocation regulations are given, which allocate one Q_K ($1 \leq k \leq K$) to every interval width R and one P_n ($1 \leq n \leq N$) to every probability, and wherein in a second step the encoding or decoding of the binary states take place by

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performing the calculation of the new interval width to be derived in the encoding or decoding process, respectively, using a representative interval width Q_K ($1 \leq k \leq K$) and a representative probability state P_n ($1 \leq n \leq N$) by arithmetic operations other than multiplication and division, wherein the representative interval width Q_K is determined by the basic basis interval of the width R and the representative probability state P_n is determined by the probability estimation underlying for the symbol to be encoded or to be decoded according to the given allocation regulations.

For example, such computer programs may be provided (against a certain fee or for free, freely accessible or password-protected) which may be downloaded into a data or communication network. The thus provided computer programs may then be made useable by a method in which a computer program according to claim 22 is downloaded from a network for data transmission, like for example from the internet to a data processing means connected to the network.

For performing a method for an arithmetic encoding and decoding of binary states preferably a computer-readable storage medium is used on which a program is stored which allows a computer, after it has been loaded into the storage of the computer, to perform a method for an arithmetic encoding or decoding, wherein in a first step a presetable value range for the specification of the interval width R is separated in K representative interval widths $\{Q_1, \ldots, Q_K\}$, a presetable value range for the specification of the probabilities is separated in N representative probability states $\{P_1, \ldots, P_N\}$ and allocation regulations are given, which allocate one Q_K ($1 \leq k \leq K$) to every interval width R and one P_n ($1 \leq n \leq N$) to every probability, and wherein in a second step the encoding or decoding of the binary states take place by performing the calculation of the new interval width to be derived in the encoding or decoding process, respectively,

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using a representative interval width Q_K ($1 \leq k \leq K$) and a representative probability state P_n ($1 \leq n \leq N$) by arithmetic operations other than multiplication and division, wherein the representative interval width Q_K is determined by the basic basis interval of the width R and the representative probability state P_n is determined by the probability estimation underlying as the basis for the symbol to be encoded or to be decoded according to the given allocation regulations.

The new method is distinguished by the combination of three features. First of all, similar to the Q-coder the probability estimation is performed using a finite state machine (FSM), wherein the generation of the N representative states of the FSM is performed offline. The corresponding transition rules are thereby filed in the form of tables.

A second characteristic feature of the invention is a prequantization of the interval width R to a number of K predefined quantization values. This allows, with a suitable dimensioning of K an N, the generation of a table which contains all K x N combinations of precalculated product values R x P_{LPS} for a multiplication-free determination of R_{LPS}.

For the use of the presented invention in an environment in which different context models are used among which also such with (almost) uniform probability distribution are located, as an additional (optional) element a separated branch is provided within the coding machine in which assuming an equal distribution the determination of the variables L and R and the renormalization regarding the calculation effort is again substantially reduced.

As a whole the invention in particular provides the advantage that it allows a good compromise between a high coding efficiency on the one hand and a low calculating effort on the other hand.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects and features of the present invention will become clear from the following description taken in conjunction with the accompanying drawings, in which:

Fig. 1 shows an illustration of the basic operations for a binary arithmetic coding;

Fig. 2 shows a modified scheme for a table-aided arithmetic encoding;

Fig. 3 shows the principle of the table-aided arithmetic decoding;

Fig. 4 shows the principle of encoding or decoding, respectively, binary data having a uniform distribution;

Fig. 5 shows an alternative realization of encoding or decoding, respectively, for binary data with a uniform distribution; and

Fig. 6 shows the initialization of the probability models depending on a quantization parameter SliceQP and preset model parameters m and n.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

First of all, however, the theoretical background is to be explained in more detail:

Table-aided probability estimation

As it was already mentioned above, the effect of the arithmetic coding relies on an estimation of the occurrence probability of the symbols to be coded which is to be as good as possible. In order to enable an adaptation to nonstationary source statistics, this estimation needs to be updated in the course of the coding process. Generally, usually methods are used for this which operate using scaled frequency counters of the coded results [17]. If C_{LPS} and C_{MPS} designates counters for the occurrence frequencies of LPS and MPS, then using these counters the estimation

$$P_{LPS} = \frac{C_{LPS}}{C_{LPS} + C_{MPS}} \quad (1)$$

may be performed and then the operation outlined in Fig. 1 of the interval separation may be carried out. For practical purposes the division required in equation (1) is disadvantageous. It is often convenient and required, however, to perform a rescaling of the counter readings when a predetermined threshold value C_{max} of the overall counter $C_{Total} = C_{MPS} + C_{LPS}$ is exceeded. (In this context it is to be noted that with a b-bit representation of L and R the smallest probability which may be indicated correctly is 2^{-b+2}, so that for preventing that this lower limit is fallen short of, if necessary a rescaling of the counter readings is required.) With a suitable selection of C_{max} the reciprocal values of C_{Total} may be tabulated, so that the division required in equation (1) may be replaced by a table access and by a multiplication and shift operation. In order to prevent also these arithmetic operations, however, in the present invention a completely table-aided method is used for the probability estimation.

For this purpose in a training phase representative probability states $\{P_K \mid 0 \le k < N_{max}\}$ are preselected, wherein the selection of the states is on the one hand dependent on the statistics of the data to be coded and on the other hand on the side conditions of the default maximum number N_{max} of states. Additionally, transition rules are defined which indicate which new state is to be used for the next symbol to be coded based on the currently coded symbol. These transition rules are provided in the form of two tables: {Next_State_LPS$_k$ | $0 \leq k < N_{max}$} and {Next_State_MPS$_k$ | $0 \leq k < N_{max}$}, wherein the tables provide the index m of the new probability state P_m when an LPS or MPS occurs, respectively, for the index n of the currently given probability state. It is to be noted here, that for a probability estimation in the arithmetic encoder or decoder, respectively, as it is proposed herein, no explicit tabulation of the probability states is required. Rather, the states are only implicitly addressed using their respective indices, as it is described in the following section. In addition to the transition rules it needs to be specified at which probability states the value of the LPS and MPS needs to be exchanged. Generally, there will only be one such excellent state which may be identified using its index p_state.

Table-aided interval separation

Fig. 2 shows the modified scheme for a table-aided arithmetic coding, as it is proposed herein. After the determination of the LPS, first of all the given interval width R is mapped to a quantized value Q using a tabulated mapping Qtab and a suitable shift operation (by q bit). Alternatively, the quantization may in special cases also be performed without the use of a tabulated mapping Qtab only with the help of a combination of shift and masking operations. Generally, here a relatively coarse quantization to K = 2 … 8 representative values is performed. Also here, similar to the case of the probability estimation, no explicit determination of Q is performed; rather, only an index q_index is transferred to Q. This index is now used together with the index p_state for a characterization of the current probability state for the determination of the interval width R_{LPS}. For this, now the corresponding entry of the table Rtab is used. There, the $K \cdot N_{max}$ product values R x P_{LPS}, that correspond to all K quantized values of R and the N_{max} different from the probability states, are entered as integer values with an

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accuracy of generally b-2 bits. For practical implementations a possibility is given here to weigh up between the storage requirements for the table size and the arithmetic accuracy which finally also determines the efficiency of the coding. Both target variables are determined by the granularity of the representation of R and P_{LPS}.

In the forth step of Fig. 2 it is shown, how the updating of the probability state p_state is performed depending on the above coded event bit. Here, the transition tables Next_State_LPS and Next_State_MPS are used which were already mentioned above in the section "table-aided probability estimation". These operations correspond to the updating process indicated in Fig. 1 in step 4 which is not explained in more detail.

Fig. 3 shows the corresponding flow chart of the table-aided arithmetic decoding. For characterizing the current partial interval in the decoder the interval width R and a value V is used. The latter is present within the partial interval and is refined successively with every read-out bit. As it may be seen from Fig. 3, the operations for the probability estimation and the determination of the interval width R are performed according to those of the encoder.

Coding with uniform probability distribution

In applications in which e.g. signed values are to be coded whose probability distribution is arranged symmetrically around zero, for coding the sign information generally an equal distribution may be assumed. As this information is one the one hand to be embedded in the arithmetic bit stream, while it is on the other hand not sensible to use a relatively compact apparatus of the table-aided probability estimation and interval separation for the case of a probability of $p \approx 0.5$, it is for this special case proposed to optionally use a special encoder/decoder procedure which may be illustrated as follows.

In this special case the interval width of the new partial interval may be determined in the encoder by a simple shift operation corresponding to a bisection of the width of the original interval R. Depending on the value of the bit to be coded, the upper or lower half of R, respectively, is then selected as a new partial interval (see Fig. 4). The subsequent renormalization and output of bits is performed as in the above case of the table-aided solution.

In the corresponding decoder the required operations are reduced to determining the bit to be decoded using the value of V relatively to the current interval width R by a simple comparison operation. In the case that the decoded bit is set, V is to be reduced by the amount of R. As it is illustrated in Fig. 4, the decoding is ended by the renormalization and updating of V using the bit to be read in next.

An alternative realization of the coding of events with a uniform probability distribution is illustrated in Fig. 5. In this exemplary implementation the current interval width R is not modified. Instead, V is first doubled by a shift operation in the encoder. Depending on the value of the bit to be coded, then, similar to the above example, the upper or lower half, respectively, of R is selected as a new partial interval (see Fig. 5). The subsequent renormalization and output of bits is performed as in the above case of the table-aided solution with the difference that the doubling of R and L is not performed and that the corresponding comparison operations are performed with doubled threshold values.

In the corresponding decoder of the alternative realization first of all a bit is read out and V is updated. The second step is performed in the same way as step 1 in Fig. 4, i.e.

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the bit to be decoded is determined using the value of V relative to the current interval width R by a simple comparison operation, and in the case in which the decoded bit is set, V is to be reduced by the amount of R (see Fig. 5).

Addressing and initializing the probability models

Every probability model, as it is used in the proposed invention, is indicated using two parameters: 1) The index p_state that characterizes the probability state of the LPS, and 2) the value valMPS of the MPS. Each of these two variables needs to be initialized at the beginning of the encoding or decoding, respectively, of a completed coding unit (in applications of video coding about one slice). The initialization values may thereby be derived from control information, like e.g. the quantization parameter (of a slice), as it is illustrated as an example in Fig. 6.

Forward-controlled initialization process

A further possibility of adaptation of the starting distributions of the models is provided by the following method. In order to guarantee a better adaptation of the initializations of the models, in the encoder a selection of predetermined starting values of the models may be provided. These models may be combined into groups of starting distributions and may be addressed using indices, so that in the encoder the adaptive selection of a group of starting values is performed and is transmitted to the decoder in the form of an index as page information. This method is referred to as a forward-controlled initialization process.

While this invention has been described in terms of several preferred embodiments, there are alterations, permutations, and equivalents which fall within the scope of this invention. It should also be noted that there are many

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alternative ways of implementing the methods and compositions of the present invention. It is therefore intended that the following appended claims be interpreted as including all such alterations, permutations, and equivalents as fall within the true spirit and scope of the present invention.

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Claims

1. A method for an arithmetic encoding and decoding of binary states,

characterized in that

in a first step a presetable value range for the specification of the interval width R is separated in K representative interval widths $\{Q_1, \ldots, Q_K\}$, a presetable value range for the specification of the probabilities is separated in N representative probability states $\{P_1, \ldots, P_N\}$ and allocation regulations are given, which allocate one Q_K $(1 \leq k \leq K)$ to every interval width R and one P_n $(1 \leq n \leq N)$ to every probability, and that in a second step the encoding or decoding of the binary states take place by performing the calculation of the new interval width to be derived in the encoding or decoding process, respectively, using a representative interval width Q_K $(1 \leq k \leq K)$ and a representative probability state P_n $(1 \leq n \leq N)$ by arithmetic operations other than multiplication and division, wherein the representative interval width Q_K is determined by the basic basis interval of the width R and the representative probability state P_n is determined by the probability estimation underlying the symbol to be encoded or to be decoded according to the given allocation regulations.

2. The method according to claim 1,

characterized in that

based on the interval currently to be evaluated having a width R, for determining the associated interval width Q_K, an index q_index is determined by a shift and bit masking operation applied to the computer-internal/binary representation of R.

3. The method according to claim 1,

characterized in that

based on the interval currently to be evaluated with a width R, for the determination of the associated interval width Q_K, an index q_index is determined by a shift operation applied to the computer-internal/-binary representation of R and a downstream access to a table Qtab, wherein the table Qtab contains the indices of interval widths corresponding to values of R prequantized by a shift operation.

4. The method according to claim 1,

characterized in that

the probability estimation underlying the symbol to be encoded or to be decoded is associated with a probability state P_n with the help of an index p_state.

5. The method according to claim 1,

characterized in that

the values of the interval width R_{LPS} corresponding to all K interval widths and to all N different probability states are entered into a table Rtab as product values (Q_K * P_n).

6. The method according to claim 1,

characterized in that

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the determination of the interval width R_{LPS} corresponding to the LPS is performed by an access to a table Rtab, wherein the table Rtab contains the values of the interval width R_{LPS} corresponding to all K quantized values of R and to the N different probability states as product values (Q_K * P_n).

7. The method according to claim 1,

characterized in that

the determination of the interval width R_{LPS} corresponding to the LPS is performed by an access to the table Rtab, wherein, for an evaluation of the table, the quantization index q_index and the index of the probability state p_state are used.

8. The method according to claim 1,

characterized in that

for the N different representative probability states transition rules are preset, wherein the transition rules indicate which new state is used for the next symbol to be encoded or to be decoded based on the currently encoded or decoded symbol.

9. The method according to claim 8,

characterized in that

a table Next_State_LPS is created which contains the index m of the new probability state P_m for the index n of the currently given probability state P_n at the occurrence of a least probable symbol (LPS).

10. The method according to claim 8,

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characterized in that

a table Next_State_MPS is created which contains the index m of the new probability state P_m for the index n of the currently given probability state P_n at the occurrence of a most probable symbol (MPS).

11. The method according to claim 1,

characterized in that

the number K of quantization values and/or the number N of the representative states are selected depending on the preset accuracy of the coding and/or depending on the available storage room.

12. The method according to claim 1,

characterized in that

the table-aided encoding includes the following steps:

6. Determination of the LPS
7. Quantization of R:
   q_index = Qtab[R>>q]
8. Determination of R_{LPS} and R:
   R_{LPS} = Rtab [q_index, p_state]
   R = R − R_{LPS}
9. Calculation of the new partial interval:
   if (bit = LPS) **then**
      L ← L + R
      R ← R_{LPS}
      p_state ← Next_State_LPS [p_state]
      if (p_state = 0) then valMPS ← 1 − valMPS
   else
      p_state ← Next_State_MPS [p_state]
10. Renormalization of L and R, writing bits, wherein
   q_index describes the index of a quantization value read out of Qtab,

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p_state describes the current state,
R_{LPS} describes the interval width corresponding to the LPS and
valMPS describes the bit corresponding to the MPS.

13. The method according to claim 1,

characterized in that

a table-aided decoding includes the following steps:

1. Determination of the LPS
2. Quantization of R:
   q_index = Qtab[R>>q]
3. Determination of R_{LPS} and R:
   R_{LPS} = Rtab [q_index, p_state]
   R = R - R_{LPS}
4. Determination of bit depending on the position of the partial interval:

```
if (V ≥ R) then
    bit ← LPS
    V ← V - R
    R ← R_LPS
    if (p_state = 0) then valMPS ← 1 - valMPS
    p_state ← Next_State_LPS [p_state]
else
    bit ← MPS
    p_state ← Next_State_MPS [p_state]
```

5. Renormalization of R, reading out one bit and updating V, wherein

q_index describes the index of a quantization value read out of Qtab,
p_state describes the current state,
R_{LPS} describes the interval width corresponding to the LPS,
valMPS describes the bit corresponding to the MPS, and

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V describes a value from the interior of the current partial interval.

14. The method according to claim 1,

characterized in that

in encoding and/or decoding the calculation of the quantization index q_index is performed in the second substep according to claim 12 and/or 13 according to the calculation regulation:

q_**index** = (R >> q) & Qmask

wherein Qmask illustrates a bit mask suitably selected depending on K.

15. The method according to claim1,

characterized in that

when a uniform probability distribution is present

in the encoding according to claim 12 the substeps 1 to 4 are performed according to the following calculation regulation:

R ← R >> 1
if (bit = 1) **then**
    L ← L + R

or

that the substeps 1 to 4 of the encoding according to claim 12 are performed according to the following calculation regulation:

L ← L << 1
if (bit = 1) **then**
    L ← L + R

and wherein in the last alternative the renormalization (substep 5 according to claim 12) is performed with doubled decision threshold values and no doubling of L and R is performed, and

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that in the decoding according to claim 13 the substeps 1 to 4 are performed according to the following calculation regulation:

R ← R >>1

if (V ≥ R) **then**

    bit ← 1

    V ← V − R

else

    bit ← 0,

or

the substeps 1 to 5 of the decoding according to claim 13 are performed according to the following calculation regulation:

3. Reading out one bit and updating V
4. Determination of bit according to the position of the partial interval:

if (V ≥ R) **then**

    bit ← 1

    V ← V − R

else

    bit ← 0.

16. The method according to claim 1,

characterized in that

the initialization of the probability models is performed depending on a quantization parameter SliceQP and preset model parameters m and n, wherein SliceQP describes the quantization parameter preset at the beginning of a slice and m and n describe the model parameters.

17. The method according to claim 1,

characterized in that

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the initialization of the probability models includes the following steps:

1. preState = min(max(1, ((m * SliceQP) >>4)+n), 2*N)
2. **if** (preState <=N) **then**
   p_state = N+1 - preState
   valMPS = 0
   else
   p_state = preState - N
   valMPS = 1,

wherein valMPS describes the bit corresponding to the MPS, SliceQP describes the quantization parameter preset at the beginning of a slice and m and n describe the model parameters.

18. The method according to claim 1,

characterized in that

the probability estimation of the states is performed using a finite state machine (FSM).

19. The method according to claim 1,

characterized in that

the generation of the representative states is performed offline.

20. The method according to claim 1,

characterized in that

the selection of the states depends on the statistics of the data to be coded and/or on the number of states.

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21. An arrangement having at least one processor and/or chip, which is/are implemented such that a method for an arithmetic encoding and decoding of binary states is may be performed, wherein

in a first step a presetable value range for the specification of the interval width R is separated in K representative interval widths $\{Q_1, \ldots, Q_K\}$, a presetable value range for the specification of the probabilities is separated in N representative probability states $\{P_1, \ldots, P_N\}$ and allocation regulations are given, which allocate one Q_K $(1 \leq k \leq K)$ to every interval width R and one P_n $(1 \leq n \leq N)$ to every probability, and wherein in a second step the encoding or decoding of the binary states take place by performing the calculation of the new interval width to be derived in the encoding or decoding process, respectively, using a representative interval width Q_K $(1 \leq k \leq K)$ and a representative probability state P_n $(1 \leq n \leq N)$ by arithmetic operations other than multiplication and division, wherein the representative interval width Q_K is determined by the basic basis interval of the width R and the representative probability state P_n is determined by the probability estimation underlying the symbol to be encoded or to be decoded according to the given allocation regulations.

22. A computer program which enables a computer after it has been loaded into the storage of the computer to perform a method for an arithmetic encoding and decoding of binary states, wherein

in a first step a presetable value range for the specification of the interval width R is separated in K representative interval widths $\{Q_1, \ldots, Q_K\}$, a presetable value range for the specification of the probabilities is separated in N representative

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probability states $\{P_1, \ldots, P_N\}$ and allocation regulations are given, which allocate one Q_K ($1 \leq k \leq K$) to every interval width R and one P_n ($1 \leq n \leq N$) to every probability, and wherein in a second step the encoding or decoding of the binary states take place by performing the calculation of the new interval width to be derived in the encoding or decoding process, respectively, using a representative interval width Q_K ($1 \leq k \leq K$) and a representative probability state P_n ($1 \leq n \leq N$) by arithmetic operations other than multiplication and division, wherein the representative interval width Q_K is determined by the basic basis interval of the width R and the representative probability state P_n is determined by the probability estimation underlying the symbol to be encoded or to be decoded according to the given allocation regulations.

23. A computer-readable storage medium on which a computer program is stored which enables a computer after it has been loaded into the storage of the computer to perform a method for an arithmetic encoding and decoding of binary states, wherein

in a first step a presetable value range for the specification of the interval width R is separated in K representative interval widths $\{Q_1, \ldots, Q_K\}$, a presetable value range for the specification of the probabilities is separated in N representative probability states $\{P_1, \ldots, P_N\}$ and allocation regulations are given, which allocate one Q_K ($1 \leq k \leq K$) to every interval width R and one P_n ($1 \leq n \leq N$) to every probability, and wherein in a second step the encoding or decoding of the binary states take place by performing the calculation of the new interval width to be derived in the encoding or decoding process, respectively, using a representative interval width Q_K ($1 \leq k \leq K$) and a representative probability state P_n ($1 \leq n \leq N$) by arithmetic operations other than multiplication and division, wherein the representative interval width Q_K is determined by the basic basis interval of the width R and the representative probability state P_n is determined by the probability estimation underlying the symbol to be encoded or to be decoded according to the given allocation regulations.

24. The computer program according to claim 22, which is downloaded from an electronic data network, like for example from the internet, onto a data processing means which is connected to the data network.

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Method and Arrangement for Arithmetic Encoding and Decoding Binary States and a Corresponding Computer Program and a Corresponding Computer-readable Storage Medium

ABSTRACT

The invention describes a method and an arrangement for an arithmetic encoding and decoding of binary states and a corresponding computer program and a corresponding computer-readable storage medium, which may in particular be used in digital data compression.

To this end it is proposed to for example perform a table-aided binary arithmetic encoding and decoding using two or several tables.

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1. Determination of the LPS
2. Calculation of the Variables R_{LPS} and R_{MPS} :

```
RLPS = R x PLPS
RMPS = R - RLPS
```

3. Calculation of the new partial interval:

```
if (bit = LPS) then
        L ← L + RMPS
        R ← RLPS
else
        R ← RMPS
```

4. Updating the probability estimation P_{LPS}
5. Outputting the bits and renormalizing R

FIG. 1

1. Determination of the LPS
2. Quantization of R:

```
q_index = Qtab[R>>q]
```

3. Determination of R_{LPS} and R_{MPS} :

```
RLPS = Rtab[q_index,p_state]
RMPS = R - RLPS
```

4. Calculation of the new partial interval:

```
if (bit = LPS) then
        L ← L + RMPS
        R ← RLPS
        p_state ← Next_State_LPS[p_state]
else
        R ← RMPS
        p_state ← Next_State_MPS[p_state]
```

FIG. 2

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1. Determination of the LPS
2. Quantization of R:

```
q_index = Qtab[R>>q]
```

3. Determination of R_{LPS} and R_{MPS}:

```
R_LPS = Rtab[q_index,p_state]
R_MPS = R - R_LPS
```

4. Determination of bit, depending on the position of the partial interval:

```
if (V ≥ R_MPS) then
        bit ← LPS
        V ← V - R_MPS
        R ← R_LPS
        p_state ← Next_State_LPS[p_state]
else
        bit ← MPS
        R ← R_MPS
        p_state ← Next_State_MPS[p_state]
```

5. Renormalization of R, reading out a bit and updating V

FIG. 3

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Encoder:

1. Calculating the new partial interval:

```
R ← R >> 1
if (bit = 1) then
        L ← L + R
```

2. Outputting bits and renormalizing R

Decoder:

1. Determination of bit, depending on the position of the partial interval:

```
if (V ≥ R) then
        bit ← 1
        V ← V - R
else
        bit ← 0
```

2. Reading out a bit, renormalizing R and updating V

FIG. 4

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Encoder:

1. Calculating the new partial interval:

```
L ← L << 1
if (bit = 1) then
      L ← L + R
```

2. Outputting a bit and renormalizing using doubled determination threshold values (without doubling R and L)

Decoder:

1. Reading out a bit and updating V
2. Determination of bit depending on the position of the partial interval:

```
if (V ≥ R) then
      bit ← 1
      V ← V - R
else
```

FIG. 5

```
1. preState = min(max( 1,((m * SliceQP )>>4)+n),126)
2. if (preState <= 63) then
         p_state = 63 - preState
         valMPS = 0
   else
         p_state = preState - 64
         valMPS = 1
```

FIG. 6

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Zur Erklärung der Zweibuchstaben-Codes und der anderen Abkürzungen wird auf die Erklärungen ("Guidance Notes on Codes and Abbreviations") am Anfang jeder regulären Ausgabe der PCT-Gazette verwiesen.

(54) **Title:** METHOD AND ARRANGEMENT FOR ARITHMETICALLY ENCODING AND DECODING BINARY STATES, CORRESPONDING COMPUTER PROGRAM, AND CORRESPONDING COMPUTER-READABLE STORAGE MEDIUM

(54) **Bezeichnung:** VERFAHREN UND ANORDNUNG ZUR ARITHMETISCHEN ENKODIERUNG UND DEKODIERUNG VON BINÄREN ZUSTÄNDEN SOWIE EIN ENTSPRECHENDES COMPUTERPROGRAMM UND EIN ENTSPRECHENDES COMPUTERLESBARES SPEICHERMEDIUM

```
1. Bestimmung des LPS
2. Quantisierung von R:
   q_index = Qtab[R>>q]
3. Bestimmung von R_LPS und R_MPS:
   R_LPS = Rtab[q_index,p_state]
   R_MPS = R - R_LPS
4. Berechnung des neuen Teilintervalls:
   if (bit = LPS) then
         L ← L + R_MPS
         R ← R_LPS
         p_state ← Next_State_LPS[p_state]
   else
         R ← R_MPS
         p_state ← Next_State_MPS[p_state]
```

1. DETERMINE THE LPS
2. QUANTIZE R: ...
3. DETERMINE RLPS AND RMPS: ...
4. CALCULATE THE NEW PARTIAL INTERVAL: ...

[Fortsetzung auf der nächsten Seite]

WO 03/094355 A2

PATENT APPLICATION FEE DETERMINATION RECORD Effective October 1, 2003	Application or Docket Number 10 727891

CLAIMS AS FILED - PART I

	(Column 1)	(Column 2)
TOTAL CLAIMS	24	
FOR	NUMBER FILED	NUMBER EXTRA
TOTAL CHARGEABLE CLAIMS	24 minus 20=	* 4
INDEPENDENT CLAIMS	4 minus 3 =	* 1
MULTIPLE DEPENDENT CLAIM PRESENT		☐

* If the difference in column 1 is less than zero, enter "0" in column 2

SMALL ENTITY TYPE ☐ OR OTHER THAN SMALL ENTITY

RATE	FEE		RATE	FEE
BASIC FEE	385.00	OR	BASIC FEE	770.00
X$ 9=		OR	X$18=	18
X43=		OR	X86=	86
+145=		OR	+290=	
TOTAL		OR	TOTAL	928

CLAIMS AS AMENDED - PART II

AMENDMENT A

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

SMALL ENTITY OR OTHER THAN SMALL ENTITY

RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
X$ 9=		OR	X$18=	
X43=		OR	X86=	
+145=		OR	+290=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

AMENDMENT B

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
X$ 9=		OR	X$18=	
X43=		OR	X86=	
+145=		OR	+290=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

AMENDMENT C

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
X$ 9=		OR	X$18=	
X43=		OR	X86=	
+145=		OR	+290=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20."
***If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3."
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

FORM PTO-875 (Rev 10/03) Patent and Trademark Office, U.S. DEPARTMENT OF COMMERCE

PATENT APPLICATION SERIAL NO. ____________________

U.S. DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE
FEE RECORD SHEET

12/08/2003 FFANAEIA 00000073 10727801

01 FC:1001	770.00 OP
02 FC:1201	86.00 OP
03 FC:1202	72.00 OP

PTO-1556
(5/87)

*U.S. Government Printing Office: 2002 — 489-267/69033

OIPE JC48 JAN 12 2004 PATENT & TRADEMARK OFFICE

Docket No.: S&ZFH030508

I hereby certify that this correspondence is being deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450

By:____________________ Date: January 7, 2004

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applic. No.	:	10/727,801
Applicant	:	Detlev Marpe et al.
Filed	:	December 4, 2003
Art Unit	:	to be assigned
Examiner	:	to be assigned
Docket No.	:	S&ZFH030508
Customer No.:		24131

LETTER

Mail Stop: Missing Parts
Hon. Commissioner for Patents,
Alexandria, VA 22313-1450

Sir:

The above-mentioned new patent application was filed on December 4, 2003 without a signed oath or declaration, under the provision of 37 C.F.R. 1.53(f).

In accordance with the above-mentioned rule, enclosed herewith is the original signed declaration.

The undersigned hereby states that the application filed in the Patent and Trademark Office is the application which the inventor(s) executed by signing the declaration. MPEP 602 (8th ed., Aug. 2001).

The fee required for the late filing of an oath or declaration in the amount of $130.00 is also enclosed.

Respectfully submitted,

GREGORY L. MAYBACK
REG. NO. 40,716

/mjb
Date: January 7, 2004

Lerner and Greenberg, P.A.
Post Office Box 2480
Hollywood, FL 33022-2480
Tel: (954) 925-1100
Fax: (954) 925-1101

01/14/2004 WASFAW1 00000133 10727801
01 FC:1051 130.00 OP

Unified Patents, Ex. 1002

OIPE JC48
JAN 1 2 2004
PATENT & TRADEMARK OFFICE

Docket No.: S&ZFH030508

COMBINED DECLARATION AND POWER OF ATTORNEY
IN ORIGINAL APPLICATION

As a below named inventor, I hereby declare that: my residence, post office address and citizenship are as stated below next to my name; that I verily believe that I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

METHOD AND ARRANGEMENT FOR ARITHMETIC ENCODING AND DECODING BINARY STATES AND A CORRESPONDING COMPUTER PROGRAM AND A CORRESPONDING COMPUTER-READABLE STORAGE MEDIUM

described and claimed in the specification bearing that title, that I understand the content of the specification, that I do not know and do not believe the same was ever known or used in the United States of America before my or our invention thereof, or patented or described in any printed publication in any country before my or our invention thereof or more than one year prior to this application, that the same was not in public use or on sale in the United States of America more than one year prior to this application, that the invention has not been patented or made the subject of an inventor's certificate issued before the date of this application in any country foreign to the United States of America on an application filed by me or my legal representatives or assigns more than twelve months prior to this application, that I acknowledge the duty to disclose to the Office all information known to me to be material to patentability as defined in 37 CFR § 1.56, and that no application for patent or inventor's certificate of this invention has been filed earlier than the following in any country foreign to the United States prior to this application by me or my legal representatives or assigns:

German Application 102 20 962.6, filed May 2, 2002, the International Priority of which is claimed under 35 U.S.C. § 119; and International Application PCT/EP03/04654, filed May 2, 2003, the Priority of which is claimed under 35 U.S.C. § 120.

I hereby appoint practitioners associated with the Customer Number:

24131

Address all correspondence and telephone calls to:

LERNER AND GREENBERG, P.A.
POST OFFICE BOX 2480
HOLLYWOOD, FLORIDA 33022-2480
Tel: (954) 925-1100
Fax: (954) 925-1101

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

FULL NAME OF FIRST JOINT INVENTOR: DETLEF MARPE

D. Marpe — December 24, 2003

Inventor's Signature — Date

Residence: BERLIN, GERMANY

Country of Citizenship: GERMANY

Post Office Address: SÜDWESTKORSO 70
D-12161 BERLIN
GERMANY

FULL NAME OF SECOND JOINT INVENTOR: THOMAS WIEGAND

T. Wiegand — December 24, 2003

Inventor's Signature — Date

Residence: BERLIN, GERMANY

Country of Citizenship: GERMANY

Post Office Address: NÜRNBERGER STRASSE 18
D-10789 BERLIN
GERMANY

Unified Patents, Ex. 1002

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371 (c) DATE	FIRST NAMED APPLICANT	ATTORNEY DOCKET NUMBER
10/727,801	12/04/2003	Detlef Marpe	S&ZFH030508

CONFIRMATION NO. 6855

LERNER AND GREENBERG, P.A.
POST OFFICE BOX 2480
HOLLYWOOD, FL 33022-2480

FORMALITIES LETTER

OC000000012043356

Date Mailed: 03/08/2004

NOTICE TO FILE MISSING PARTS OF NONPROVISIONAL APPLICATION

FILED UNDER 37 CFR 1.53(b)

Filing Date Granted

Items Required To Avoid Abandonment:

An application number and filing date have been accorded to this application. The item(s) indicated below, however, are missing. Applicant is given **TWO MONTHS** from the date of this Notice within which to file all required items and pay any fees required below to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

- The oath or declaration is unsigned.

Replies should be mailed to: Mail Stop Missing Parts
Commissioner for Patents
P.O. Box 1450
Alexandria VA 22313-1450

A copy of this notice <u>MUST</u> be returned with the reply.

Meaza. W

Customer Service Center
Initial Patent Examination Division (703) 308-1202

PART 3 - OFFICE COPY

Unified Patents, Ex. 1002

CLAIMS ONLY

Application Number	Filing Date
10/727801	
Applicant(s)	

* May be used for additional claims or amendments

CLAIMS	AS FILED		AFTER FIRST AMENDMENT		AFTER SECOND AMENDMENT	
	Indep	Depend	Indep	Depend	Indep	Depend
1	/					
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Total Depend						
Total Claims						

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Total Indep						
Total Depend						
Total Claims						

Unified Patents, Ex. 1002

Refine Search

Search Results -

Terms	Documents
L18 and L11	1

Database:

US Pre-Grant Publication Full-Text Database
US Patents Full-Text Database
US OCR Full-Text Database
EPO Abstracts Database
JPO Abstracts Database
Derwent World Patents Index
IBM Technical Disclosure Bulletins

Search: L19

Refine Search

Recall Text Clear Interrupt

Search History

DATE: Thursday, September 09, 2004 Printable Copy Create Case

Set Name side by side	Query	Hit Count	Set Name result set
	DB=PGPB,USPT,USOC,EPAB,JPAB,DWPI,TDBD; PLUR=YES; OP=OR		
L19	L18 and l11	1	L19
L18	341/106.ccls.	689	L18
L17	L14 and l11	2	L17
L16	L14 and l11	2	L16
L15	L14 and l11 and 341/106.ccls.	0	L15
L14	341/107.ccls.	245	L14
L13	L12 and l11	10	L13
L12	341/$.ccls.	36425	L12
L11	L9 and l8 and l7 and l6 and l5 and l4 and l3 and l2 and l1	224	L11
L10	L9 same l8 same l7 same l6 same l5 same l4 same l3 same l2 same l1	1	L10
L9	decod$3	400128	L9
L8	encod$3	486432	L8
L7	arithmetic$	192078	L7
L6	caculat$3 or comput$	1682144	L6
L5	stat$	5642610	L5
L4	binary	299416	L4
L3	allocat$	209199	L3
L2	preset$	421284	L2

L1	probabilit$	177329	L1

END OF SEARCH HISTORY

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/727,801	12/04/2003	Detlef Marpe	S&ZFH030508	6855

24131 7590 09/14/2004

LERNER AND GREENBERG, PA
P O BOX 2480
HOLLYWOOD, FL 33022-2480

EXAMINER	
JEANGLAUDE, JEAN BRUNER	

ART UNIT	PAPER NUMBER
2819	

DATE MAILED: 09/14/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

PTO-90C (Rev. 10/03)

Office Action Summary	Application No.	Applicant(s)
	10/727,801	MARPE ET AL.
	Examiner	Art Unit
	Jean B Jeanglaude	2819

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 2 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *04 December 2003*.

2a)☐ This action is **FINAL**. 2b)☐ This action is non-final.

3)☒ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-24* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☒ Claim(s) *1-24* is/are allowed.

6)☐ Claim(s) _____ is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☒ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *04 December 2003* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☒ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

Specification

It is suggested to submit the cited references on pages 24 and 25 on an Information disclosure statement 1449.

Abstract

1. Applicant is reminded of the proper language and format for an abstract of the disclosure. The abstract should be in narrative form and generally limited to a single paragraph on a separate sheet within the range of 50 to 150 words. It is important that the abstract not exceed 150 words in length since the space provided for the abstract on the computer tape used by the printer is limited. The form and legal phraseology often used in patent claims, such as "means" and "said," should be avoided. The abstract should describe the disclosure sufficiently to assist readers in deciding whether there is a need for consulting the full patent text for details. The language should be clear and concise and should not repeat information given in the title. It should avoid using phrases which can be implied, such as, "The disclosure concerns," "The disclosure defined by this invention," "The disclosure describes," etc.

It is suggested not to use the word "the invention" in the abstract. Also, the abstract must be in a single paragraph. Appropriate correction is required.

Claim Objection

2. Claims 12, 13, 15, 17 are objected to because of the following informalities: it is suggested not to use numerical numbers such as 1), 2), 3) etc in the steps of a process as disclosed in the claims rather use alphabetic letters such as a), b), c) etc. to indicate

the steps. This will create confusion as the claims are already numbered. Appropriate correction is required.

3. Also, it is suggested to write “claim1” in claim 15 as – claim 1 -.

4. Moreover, steps 3, 4 are numbered in claim 15 while steps 1, and 2 are not numbered. Appropriate correction is required.

Allowable Subject Matter

5. Claims 1 – 24 are allowable.

6. Reasons for allowing the aforementioned claims will be provided in the next office action.

Conclusion

7. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

8. Mitchell et al. (US Patent Number 4,891,643) discloses an arithmetic coding data compression/Decompression by selectively employed, diverse arithmetic coding encoders and decoders.

9. Berger et al. (US patent Number 5,973,626) discloses a byte-based prefix encoding.

10. Kimura et al. (US patent Number 6,075,471) discloses an adaptive coding method.

11. This application is in condition for allowance except for the formal matters mentioned above.

Prosecution on the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

A shortened statutory period for reply to this action is set to expire **TWO MONTHS** from the mailing date of this letter.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Jean B Jeanglaude whose telephone number is 571-272-1804. The examiner can normally be reached on Monday - Friday 7:30 A. M. - 5:00 P.M..

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Michael Tokar can be reached on 571-272-1812. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Jean Bruner Jeanglaude
Primary Examiner
September 9, 2004

Unified Patents, Ex. 1002

Notice of References Cited	Application/Control No. 10/727,801	Applicant(s)/Patent Under Reexamination MARPE ET AL.	
	Examiner Jean B Jeanglaude	Art Unit 2819	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-4,891,643	01-1990	Mitchell et al.	341/107
*	B	US-5,973,626	10-1999	Berger et al.	341/65
*	C	US-6,075,471	06-2000	Kimura et al.	341/107
	D	US-			
	E	US-			
	F	US-			
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Index of Claims

Application No.	Applicant(s)
10/727,801	MARPE ET AL.
Examiner	**Art Unit**
Jean B Jeanglaude	2819

√	Rejected	–	(Through numeral) Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

Claim: Final	Claim: Original	Date: 09-09-04	Claim: Final	Claim: Original	Date	Claim: Final	Claim: Original	Date
	1	=		51			101	
	2	=		52			102	
	3	=		53			103	
	4	=		54			104	
	5	=		55			105	
	6	=		56			106	
	7	=		57			107	
	8	=		58			108	
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	11	=		61			111	
	12	=		62			112	
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	15	=		65			115	
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	17	=		67			117	
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	50			100			150	

U.S. Patent and Trademark Office

Part of Paper No. 09092004

Search Notes	Application No. 10/727,801	Applicant(s) MARPE ET AL.
	Examiner Jean B Jeanglaude	Art Unit 2819

SEARCHED

Class	Subclass	Date	Examiner
341	106	9/9/2004	JBJG
341	107	9/9/2004	JBJG
341	50	9/9/2004	JBJG
341	65	9/9/2004	JBJG

INTERFERENCE SEARCHED

Class	Subclass	Date	Examiner

SEARCH NOTES (INCLUDING SEARCH STRATEGY)

	DATE	EXMR
WEST	9/9/2004	JBJG

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

BIBDATASHEET

Bib Data Sheet

CONFIRMATION NO. 6855

SERIAL NUMBER	FILING DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
10/727,801	12/04/2003 RULE	341	2819	S&ZFH030508

APPLICANTS

Detlef Marpe, Berlin, GERMANY;

Thomas Wiegand, Berlin, GERMANY;

** CONTINUING DATA ************************** Yes JBJ

This application is a CON of PCT/EP03/04654 05/02/2003

** FOREIGN APPLICATIONS ******************** Yes JBJ

GERMANY 102 20 962.6 05/02/2002

IF REQUIRED, FOREIGN FILING LICENSE GRANTED
** 03/03/2004

	STATE OR COUNTRY	SHEETS DRAWING	TOTAL CLAIMS	INDEPENDENT CLAIMS
Foreign Priority claimed ☑ yes ☐ no 35 USC 119 (a-d) conditions met ☐ yes ☑ no ☐ Met after Allowance Verified and Acknowledged [signature] Examiner's Signature ____ Initials	GERMANY	4	24	4

ADDRESS
24131
LERNER AND GREENBERG, PA
P O BOX 2480
HOLLYWOOD , FL
33022-2480

TITLE
Method and arrangement for arithmetic encoding and decoding binary states and a corresponding computer program and a corresponding computer-readable storage medium

FILING FEE RECEIVED		
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applic. No.	:	10/727,801	Confirmation No: 6855
Applicant	:	Detlef Marpe, et al.	
Filed	:	December 4, 2003	
Art Unit	:	2819	
Title	:	Method and Arrangement for Arithmetic Encoding and Decoding Binary States and a Corresponding Computer Program and a Corresponding Computer-Readable Storage Medium	
Docket No.	:	S&ZFH030508	
Customer No.	:	24131	

INFORMATION DISCLOSURE STATEMENT UNDER 37 C.F.R. 1.97(C)(2)

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

In accordance with 37 C.F.R. 1.98 copies of the following patents and/or publications are submitted herewith:

Ref 1.01: **Title:** Draft ITU-T Recommendation and Final Draft International Standard Joint Video Specification (ITU-T Rec. H.264I ISO/IEC 14496-10 AVC). **From:** Joint Video Team (JVT) of ISO/IEC MPEG & ITU-T VCEG (ISO/IEC JTC1/SC29/WG11 and ITU-T SG16 Q.6). **Pages: 1-250.**

Ref 1.02: **Title:** Overview of the H.264/AVC Video Coding Standard. **Author:** Thomas Wiegand, Gary J. Sullivan, Senior Member, IEEE, Gisele Bjontegaard, and Ajay Luthra, Senior Member, IEEE. **Pages: 560-576.**

Ref 1.03: **Title:** Information Technology-Generic Coding Moving Pictures and Associated Audio Information: Video. **From:** International Standard 13818-2 Recommendation ITU-T H.26. **Pages: 1-224.**

10/08/2004 AWONDAF1 00000001 10727801

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Ref 1.04: **Title:** Draft Text of Recommendation H.263 Version 2 ("H.263+") for Decision. **From:** International Telecommunication Union. **Pages: 1-143.**

Ref 1.05: **Title:** Information Technology-Coding of Audio Visual Objects-Part 2: Visual. **From:** International Organization for Standardization Organization International Normalization ISO/IEC JTC1/SC29/WG 11 Coding of Moving Picture and Audio. **Pages:** 1- 526.

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In accordance with 37 C.F.R. 1.97(e) the undersigned herewith states that each item of information contained in the information disclosure statement was first cited in a communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement.

If no translation of pertinent portions of any foreign language patents or publications mentioned above is included with the aforementioned copies of those applications, patents and/or publications, it is because no existing translation is readily available to the applicant. As per the Notice in 1273 OG 55 (August 5, 2003) no copies of any above-mentioned U.S. patents and U.S. patent application publications are submitted for any application filed after June 30, 2003.

In accordance with 37 C.F.R. 1.97 (c) (2), consideration of this Information Disclosure Statement is requested.

Enclosed is the fee in the amount of $180.00.

It is believed that the enclosed prior art is less pertinent than the prior art previously submitted and cited by the Examiner. Kindly place the references in the Patent Office file wrapper.

Respectfully submitted,

Alfred K. Dassler

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Date: October 4, 2004

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FORM PTO-1449 (SUBSTITUTE) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE INFORMATION DISCLOSURE STATEMENT BY APPLICANT (37 CFR 1.98(b))	Attorney Docket No.: S&ZFH030508 Applic. No. 10/727,801 Applicant: Detlef Marpe, et al. Filing Date: December 4, 2003 Group Art Unit: 2819

		OTHER DOCUMENTS (Including Author, Title, Date, Pertinent Pages, etc.)
		Ref 1.01: **Title:** Draft ITU-T Recommendation and Final Draft International Standard Joint Video Specification (ITU-T Rec. H.264I ISO/IEC 14496-10 AVC). **From:** Joint Video Team (JVT) of ISO/IEC MPEG & ITU-T VCEG (ISO/IEC JTC1/SC29/WG11 and ITU-T SG16 Q.6). **Pages: 1-250.**
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EXAMINER	DATE CONSIDERED

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FORM PTO-1449 (SUBSTITUTE) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE INFORMATION DISCLOSURE STATEMENT BY APPLICANT (37 CFR 1.98(b))	Attorney Docket No.: S&ZFH030508 Applic. No. 10/727,801 Applicant Detlef Marpe, et al. Filing Date Group Art Unit

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	December 4, 2003 2819

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applic. No.	:	10/727,801 Confirmation No. 6855
Applicant	:	Detlev Marpe, et al.
Filed	:	December 4, 2003
Title	:	Method and Arrangement for Arithmetic Encoding and Decoding Binary States and a Corresponding Computer Program and a Corresponding Computer-readable Storage Medium
Group Art Unit	:	2819
Examiner	:	Jean Bruner Jeanglaude
Docket No.	:	S&ZFH030508
Customer No.	:	24131

A M E N D M E N T

Mail Stop Amendment
Hon. Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

S i r :

Responsive to the Office Action dated September 14, 2004,

kindly amend the above-identified application as follows:

Amendments to the Specification begin on page 3 of this paper.

12/22/2004 WADDELR1 00000012 10727801

01 FC:1251 120.00 OP
02 FC:1202 2050.00 OP
03 FC:1201 1600.00 OP

Amendments to the Drawings begin on page 4 of this paper and include both an attached replacement sheet and an annotated sheet showing changes.

Amendments to the Claims begin on page 5 of this paper.

Remarks/Arguments begin on page 29 of this paper.

Amendments to the Specification:

Please replace the Abstract, on page 37, lines 1 - 16, with the following :

-~~Method and Arrangement for Arithmetic Encoding and Decoding Binary States and a Corresponding Computer Program and a Corresponding Computer-readable Storage Medium~~

ABSTRACT

A method and arrangement for arithmetic encoding/decoding is described, wherein the probability estimation is performed by a finite state machine FSM, wherein the generation of N representative states of the FSM is performed offline. Corresponding transition rules are filed in the form of tables. In addition, a pre-quantization of the interval width R to a number of K pre-defined quantization values is carried out. With suitable dimensioning of K and N, this allows the generation of a table containing all K x N combinations of pre-calculated product values R x P_{LPS} for a multiplication-free determination of R_{LPS}. Overall, the result is a good compromise between high coding efficiency and low calculation effort. ~~The invention describes a method and an arrangement for an arithmetic encoding and decoding of binary states and a corresponding computer program and a corresponding computer-readable storage medium, which may in particular be used in digital data compression.~~

~~To this end it is proposed to for example perform a table-aided binary arithmetic encoding and decoding using two or several tables.~~ --

Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1. (original) A method for an arithmetic encoding and decoding of binary states,

characterized in that

in a first step a presetable value range for the specification of the interval width R is separated in K representative interval widths $\{Q_1, \ldots, Q_K\}$, a presetable value range for the specification of the probabilities is separated in N representative probability states $\{P_1, \ldots, P_N\}$ and allocation regulations are given, which allocate one Q_K ($1 \leq k \leq K$) to every interval width R and one P_n ($1 \leq n \leq N$) to every probability, and that in a second step the encoding or decoding of the binary states take place by performing the calculation of the new interval width to be derived in the encoding or decoding process, respectively, using a representative interval width Q_K ($1 \leq k \leq K$) and a representative probability state P_n ($1 \leq n \leq N$) by arithmetic operations other than multiplication and division, wherein the representative interval width Q_K is determined by the basic basis interval of the width R and the representative probability state P_n is determined by the probability estimation underlying the symbol to be encoded or to be decoded according to the given allocation regulations.

2. (original) The method according to claim 1,

characterized in that

based on the interval currently to be evaluated having a width R, for determining the associated interval width Q_K, an index q_index is determined by a shift and bit masking operation applied to the computer-internal/binary representation of R.

3. (original) The method according to claim 1,

characterized in that

based on the interval currently to be evaluated with a width R, for the determination of the associated interval width Q_K, an index q_index is determined by a shift operation applied to the computer-internal/-binary representation of R and a downstream access to a table Qtab, wherein the table Qtab contains the indices of interval widths corresponding to values of R prequantized by a shift operation.

4. (original) The method according to claim 1,

characterized in that

the probability estimation underlying the symbol to be encoded or to be decoded is associated with a probability state P_n with the help of an index p_state.

5. (original) The method according to claim 1,

characterized in that

the values of the interval width R_{LPS} corresponding to all K interval widths and to all N different probability states are entered into a table Rtab as product values (Q_K * P_n).

6. (original) The method according to claim 1,

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characterized in that

the determination of the interval width R_{LPS} corresponding to the LPS is performed by an access to a table Rtab, wherein the table Rtab contains the values of the interval width R_{LPS} corresponding to all K quantized values of R and to the N different probability states as product values $(Q_K * P_n)$.

7. (original) The method according to claim 1,

characterized in that

the determination of the interval width R_{LPS} corresponding to the LPS is performed by an access to the table Rtab, wherein, for an evaluation of the table, the quantization index q_index and the index of the probability state p_state are used.

8. (original) The method according to claim 1,

characterized in that

for the N different representative probability states transition rules are preset, wherein the transition rules indicate which new state is used for the next symbol to be encoded or to be decoded based on the currently encoded or decoded symbol.

9. (original) The method according to claim 8,

characterized in that

a table Next_State_LPS is created which contains the index m of the new probability state P_m for the index n of the currently given probability state P_n at the occurrence of a least probable symbol (LPS).

10. (original) The method according to claim 8,

characterized in that

a table Next_State_MPS is created which contains the index m of the new probability state P_m for the index n of the currently given probability state P_n at the occurrence of a most probable symbol (MPS).

11. (original) The method according to claim 1,

characterized in that

the number K of quantization values and/or the number N of the representative states are selected depending on the preset accuracy of the coding and/or depending on the available storage room.

12. (currently amended) The method according to claim 1,

characterized in that

the table-aided encoding includes the following steps:

~~6.~~f) Determination of the LPS

~~7.~~g) Quantization of R:

q_index = Qtab[R>>q]

~~8.~~h) Determination of R_{LPS} and R:

R_{LPS} = Rtab [q_index, p_state]

R = R − R_{LPS}

~~9.~~i) Calculation of the new partial interval:

```
if (bit = LPS) then
        L ← L + R
        R ← R_LPS
        if (p_state = 0) then valMPS ← 1 - valMPS
        p_state ← Next_State_LPS [p_state]
else
        p_state ← Next_State_MPS [p_state]
```

~~10.~~j) Renormalization of L and R, writing bits, wherein

q_index	describes the index of a quantization value read out of Qtab,
p_state	describes the current state,
R_{LPS}	describes the interval width corresponding to the LPS and
valMPS	describes the bit corresponding to the MPS.

13. (currently amended) The method according to claim 1,

characterized in that

a table-aided decoding includes the following steps:

~~1.~~a) Determination of the LPS

~~2.~~b) Quantization of R:

q_index = Qtab[R>>q]

~~3.~~c) Determination of R_{LPS} and R:

R_{LPS} **= Rtab [q_index, p_state]**

R = R - R_{LPS}

~~4.~~d) Determination of bit depending on the position of the partial interval:

```
if (V ≥ R) then
     bit ← LPS
     V ← V - R
     R ← R_LPS
     if (p_state = 0) then valMPS ← 1 - valMPS
     p_state ← Next_State_LPS [p_state]
else
     bit ← MPS
     p_state ← Next_State_MPS [p_state]
```

~~5.~~e) Renormalization of R, reading out one bit and updating V, wherein

q_index	describes the index of a quantization value read out of Qtab,
p_state	describes the current state,
R_{LPS}	describes the interval width corresponding to the LPS,

valMPS describes the bit corresponding to the MPS, and

V describes a value from the interior of the current partial interval.

14. (original) The method according to claim 1,

characterized in that

in encoding and/or decoding the calculation of the quantization index q_index is performed in the second substep according to claim 12 and/or 13 according to the calculation regulation:

q_**index** = (R >> q) & Qmask

wherein Qmask illustrates a bit mask suitably selected depending on K.

15. (currently amended) The method according to claim_1,

characterized in that

when a uniform probability distribution is present

in the encoding according to claim 12 the substeps [[1]] f to [[4]] i are performed according to the following calculation regulation:

R ← R >> 1

if (bit = 1) **then**

L ← L + R

or

that the substeps [[1]] f to [[4]] i of the encoding according to claim 12 are performed according to the following calculation regulation:

L ← L << 1

if (bit = 1) **then**

```
    L ← L + R
```

and wherein in the last alternative the renormalization (substep [[~~5~~]] j according to claim 12) is performed with doubled decision threshold values and no doubling of L and R is performed, and

that in the decoding according to claim 13 the substeps [[~~1~~]] a to [[~~4~~]] d are performed according to the following calculation regulation:

```
R ← R >>1
if (V ≥ R) then
    bit ← 1
    V ← V - R
else
    bit ← 0,
```

or

the substeps [[~~1~~]] a to [[~~5~~]] e of the decoding according to claim 13 are performed according to the following calculation regulation:

~~3.~~m) Reading out one bit and updating V

~~4.~~n) Determination of bit according to the position of the partial interval:

```
if (V ≥ R) then
    bit ← 1
    V ← V - R
else
    bit ← 0.
```

16. (original) The method according to claim 1,

characterized in that

the initialization of the probability models is performed depending on a quantization parameter SliceQP and preset model parameters m and n, wherein SliceQP describes the quantization parameter preset at the beginning of a slice and m and n describe the model parameters.

17. (currently amended) The method according to claim 1,

characterized in that

the initialization of the probability models includes the following steps:

~~1.~~k) preState = min(max(1, ((m * SliceQP) >>4)+n), 2*N)

~~2.~~l) **if** (preState <=N) **then**

p_state = N ~~+1~~ - preState

valMPS = 0

else

p_state = preState - (N+1)

valMPS = 1,

wherein valMPS describes the bit corresponding to the MPS, SliceQP describes the quantization parameter preset at the beginning of a slice and m and n describe the model parameters.

18. (original) The method according to claim 1,

characterized in that

the probability estimation of the states is performed using a finite state machine (FSM).

19. (original) The method according to claim 1,

characterized in that

the generation of the representative states is performed offline.

20. (original) The method according to claim 1,

characterized in that

the selection of the states depends on the statistics of the data to be coded and/or on the number of states.

21. (original) An arrangement having at least one processor and/or chip, which is/are implemented such that a method for an arithmetic encoding and decoding of binary states is may be performed, wherein

in a first step a presetable value range for the specification of the interval width R is separated in K representative interval widths $\{Q_1, \ldots, Q_K\}$, a presetable value range for the specification of the probabilities is separated in N representative probability states $\{P_1, \ldots, P_N\}$ and allocation regulations are given, which allocate one Q_K $(1 \leq k \leq K)$ to every interval width R and one P_n $(1 \leq n \leq N)$ to every probability, and wherein in a second step the encoding or decoding of the binary states take place by performing the calculation of the new interval width to be derived in the encoding or decoding process, respectively, using a representative interval width Q_K $(1 \leq k \leq K)$ and a representative probability state P_n $(1 \leq n \leq N)$ by arithmetic operations other than multiplication and division, wherein the representative interval width Q_K is determined by the basic basis interval of the width R and the representative probability state P_n is determined by the probability estimation underlying the symbol to be encoded or to be decoded according to the given allocation regulations.

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22. (original) A computer program which enables a computer after it has been loaded into the storage of the computer to perform a method for an arithmetic encoding and decoding of binary states, wherein

in a first step a presetable value range for the specification of the interval width R is separated in K representative interval widths $\{Q_1, \ldots, Q_K\}$, a presetable value range for the specification of the probabilities is separated in N representative probability states $\{P_1, \ldots, P_N\}$ and allocation regulations are given, which allocate one Q_K ($1 \leq k \leq K$) to every interval width R and one P_n ($1 \leq n \leq N$) to every probability, and wherein in a second step the encoding or decoding of the binary states take place by performing the calculation of the new interval width to be derived in the encoding or decoding process, respectively, using a representative interval width Q_K ($1 \leq k \leq K$) and a representative probability state P_n ($1 \leq n \leq N$) by arithmetic operations other than multiplication and division, wherein the representative interval width Q_K is determined by the basic basis interval of the width R and the representative probability state P_n is determined by the probability estimation underlying the symbol to be encoded or to be decoded according to the given allocation regulations.

23. (original) A computer-readable storage medium on which a computer program is stored which enables a computer after it has been loaded into the storage of the computer to perform a method for an arithmetic encoding and decoding of binary states, wherein

in a first step a presetable value range for the specification of the interval width R is separated in K representative interval widths $\{Q_1, \ldots, Q_K\}$, a presetable value range for the specification of the probabilities is separated in N representative probability states $\{P_1, \ldots, P_N\}$ and allocation regulations are given, which allocate one Q_K $(1 \leq k \leq K)$ to every interval width R and one P_n $(1 \leq n \leq N)$ to every probability, and wherein in a second step the encoding or decoding of the binary states take place by performing the calculation of the new interval width to be derived in the encoding or decoding process, respectively, using a representative interval width Q_K $(1 \leq k \leq K)$ and a representative probability state P_n $(1 \leq n \leq N)$ by arithmetic operations other than multiplication and division, wherein the representative interval width Q_K is determined by the basic basis interval of the width R and the representative probability state P_n is determined by the probability estimation underlying the symbol to be encoded or to be decoded according to the given allocation regulations.

24. (original) The computer program according to claim 22, which is downloaded from an electronic data network, like for example from the internet, onto a data processing means which is connected to the data network.

--25. (new) A method for arithmetically encoding a symbol to be encoded having a binary state based on a current interval width R and a probability representing a probability estimation for the symbol to be encoded, wherein the probability is represented by a probability index for addressing a probability state from a plurality

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of representative probability states, which method comprises the following steps:

encoding the symbol to be encoded by performing the following substeps:

mapping the current interval width to a quantization index from a plurality of representative quantization indices; and

performing the interval separation by accessing an interval division table using the quantization index and the probability index to obtain a partial interval width value.

26. (new) The method of claim 25, wherein the encoding further takes place by the following step:

updating the current interval width using the interval width value to obtain a new, updated interval width.

27. (new) The method of claim 25, wherein the partial interval width value specifies a width of a partial interval for a symbol to be encoded with a less probable state from a current interval with a current interval width.

28. (new) The method of claim 25, wherein updating the current interval width is further performed depending on the binary state of the symbol to be encoded.

29. (new) The method of claim 25, further comprising the following step:

adaptation of the probability estimation, wherein the adaptation of the probability estimation comprises looking up, with the probability index, in an LPS transition rule table (Next_State_LPS) to obtain a new probability index, when the symbol to be encoded has a

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less probable state, and looking up, with the probability index, in an MPS transition rule table (Next_State_MPS) to obtain a new probability index, when the symbol to be encoded has a more probable state.

30. (new) The method of claim 29, further comprising adjusting a value indicative of the more probable state from a state originally indicated to the binary state of the symbol to be encoded, when the probability index is like a predetermined probability index and the symbol to be encoded has a binary state different from the state originally indicated.

31. (new) The method of claim 25, wherein the substep of updating the current interval width comprises the following steps:

equating the new interval width with the difference of current interval width minus the partial interval width value; and

subsequently, if the symbol to be encoded has a less probable state, equating the new interval width with the partial interval width value.

32. (new) The method of claim 25, wherein a current interval is represented by the current interval width and a current offset point, and the encoding is further performed by the following substep:

accumulating the current offset point and a difference of current interval width and partial interval width value to obtain a new, updated offset point, when the symbol to be coded has a less probable state.

33. (new) A method for arithmetically decoding an encoded symbol having a binary state based on a current interval width R and a probability representing a probability

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estimation for the encoded symbol, wherein the probability is represented by a probability index of a probability state from a plurality of representative probability states, wherein the method comprises the following step:

decoding the encoded symbol by performing the following substeps:

mapping the current interval width to a quantization index from a plurality of representative quantization indices; and

performing the interval division by accessing an interval division table using the quantization index and the probability index to obtain a partial interval width value.

34. (new) The method of claim 33, wherein the decoding further takes place by means of the following step:

updating the current interval width using the partial interval width value to obtain a new, updated interval width.

35. (new) The method of claim 33, wherein the partial interval width value specifies a width of a partial interval for an encoded symbol with a less probable state from a current interval with the current interval width.

36. (new) The method of claim 33, wherein updating the current interval width is further performed depending on a value within a new partial interval characterized by the current partial interval width and the value within a new partial interval.

37. (new) The method of claim 36, wherein the decoding is further performed by means of the following substep:

equating the binary state of the encoded symbol with one of a more improbable and a more probable state depending on whether the value within the new partial interval is larger or smaller than a difference of the current interval width and partial interval width value.

38. (new) The method of claim 36, wherein the encoding is further performed by means of updating the value within the new partial interval with a next bit to be read in.

39. (new) The method of claim 36, further comprising the following step:

updating the probability estimation, wherein updating the probability estimation comprises looking up, with the probability index, in an LPS transition rule table (Next_State_LPS) to obtain a new probability index, when the value within the new partial interval is larger than a difference of the current interval width and partial interval width value, and looking up, with the probability index, in an MPS transition rule table (Next_State_MPS) to obtain a new probability index, when the value within the new partial interval is smaller than a difference of the current interval width and partial interval width value.

40. (new) The method of claim 36, further comprising adjusting a value indicative of the more probable state of the encoded symbol from a state originally indicated to a different binary state, when the probability index is like a predetermined probability index and the value within the new partial interval is larger than a difference of the current interval width and partial interval width value.

41. (new) The method of claim 33, wherein the current interval width is represented with an accuracy of b bits, and the

partial interval width value obtained from the interval division table is represented with an accuracy of b-2 bits.

42. (new)The method of claim 33, wherein

the substep of mapping comprises applying a shift and bit masking operation to a computer-internal/binary representation of the current interval width.

43. (new) The method of claim 33, wherein

the substep of mapping comprises applying a shift operation to a computer-internal/binary representation of the current interval width to obtain a quantized value for the current interval width, and a downstream access to a table (Qtab) to obtain the quantization index.

44. (new) The method of claim 33, wherein,

in the interval division table, values for the current interval width corresponding to all possible quantization indices and to all probability indices are filed as product values between quantization index, and in a table Rtab.

45. (new)The method of claim 33, further comprising the following step:

updating the probability estimation, wherein updating the probability estimation is performed by means of transition rules, wherein the transition rules specify which new probability state from a plurality of probability states, based on the symbol to be encoded and/or the encoded symbol, will be used for a next symbol to be encoded and/or an encoding symbol.

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46. (new) The method of claim 33, further comprising the following step:

updating the probability estimation, wherein updating the probability estimation comprises looking up, with the probability index, in a transition rule table (Next_State_LPS) to obtain a new probability index.

47. (new) The method of claim 33, wherein

the number of possible quantization indices and/or the number of the probability states are selected depending on the preset accuracy of the coding and/or depending on the available storage room.

48. (new) The method of claim 33, further comprising the following substep:

renormalizing the new updated offset point and the new, updated interval width.

49. (new) The method of claim 33, wherein

decoding includes the following steps:

a) Determination of the LPS

b) Quantization of R:

q_index = Qtab [R>>q]

c) Determination of R_{LPS} and R:

R_{LPS} = Rtab [q_index, p_state]

R = R - R_{LPS}

d) Determination of bit, depending on the position of the partial interval:

if (V ≥ R) **then**

  bit ← LPS

  V ← V - R

R ← R_{LPS}

if (p_state = 0) then valMPS ← 1 - valMPS

p_state ← Next_State_LPS[p_state]

else

bit ← MPS

p_state ← Next_State_MPS[p_state]

e) Renormalization of R, reading out one bit and updating V,

wherein

q_index describes the index of a quantization value read out of Qtab,

p_state describes the current state,

R_{LPS} describes the interval width corresponding to the LPS,

ValMPS describes the bit corresponding to the MPS and

V describes a value from within the current partial interval.

50. (new) The method of claim 33, wherein,

in encoding and/or decoding, mapping to the quantization index q_index is performed according to the calculation regulation:

q_index = (R >> q) & Qmask

wherein Qmask represents a bit mask suitably selected depending on the number of probability states, R represents the current interval width and q represents a number of bits.

51. (new) The method of claim 33, wherein,

in the presence of a uniform probability distribution,

- in the encoding, the following calculation regulation is performed:

  R ← R >> 1

  if (bit = 1) **then**

  L ← L + R,

  or

  the following calculation regulation is performed:

```
L ← L << 1
if (bit = 1) then
    L ← L + R
```

and, in the last alternative, a renormalization with doubled decision threshold values is performed and no doubling of L and R is carried out.

52. (new) The method of claim 33, wherein,

in the decoding, the following calculation regulation is performed:

```
R ← R >> 1
if (V ≥ R) then
    bit ← 1
    V ← V - R
else
    bit ← 0,
```

or

the following calculation regulation:

m) Reading out one bit and updating V

n) Determination of bit depending on the position of the partial interval:

```
if (V ≥ R) then
    bit ← 1
    V ← V - R
else
    bit ← 0.
```

53. (new) The method of claim 33, wherein

the initialization of the probability models is performed depending on a quantization parameter SliceQP and preset model parameters m and n, wherein SliceQP describes the quantization parameter preset at the beginning of a slice, and m and n describe the model parameters.

54. (new) The method of claim 33, wherein

the initialization of the probability models includes the following steps:

k) preState = min(max(1, ((m * SliceQP) >>4)+n), 2*N)

l) **if** (preState <=N) **then**

p_state = N - preState

valMPS = 0

else

p_state = preState - (N+1)

valMPS = 1,

wherein valMPS describes the bit corresponding to the MPS, SliceQP describes the quantization parameter preset at the beginning of a slice, and m and n describe the model parameters.

55. (new) The method of claim 33, wherein

the probability estimation of the states is performed by means of a finite state machine (FSM).

56. (new) The method of claim 33, wherein

the generation of the probability states is performed offline.

57. (new) The method of claim 33, wherein

the selection of the states depends on the statistics of the data to be coded and/or on the number of the states.

58. (new) An arrangement for arithmetically encoding a symbol to be encoded having a binary state based on a current interval width R and a probability representing a probability estimation for the symbol to be encoded, wherein the probability is represented by a probability index for addressing a probability state from a plurality of representative probability states, the device comprising:

means for encoding the symbol to be encoded, including the following means:

means for mapping the current interval width to a quantization index from a plurality of representative quantization indices; and

means for performing the interval separation by accessing an interval division table using the quantization index and the probability index to obtain a partial interval width value.

59. (new) An arrangement for arithmetically decoding an encoded symbol having a binary state based on a current interval width R and a probability representing a probability estimation for the encoded symbol, wherein the probability is represented by a probability index for addressing a probability state from a plurality of representative probability states, the device comprising:

means for decoding the encoded symbol, comprising the following means:

means for mapping the current interval width to a quantization index from a plurality of representative quantization indices; and

means for performing the interval separation by accessing an interval division table using the quantization index and the probability index to obtain a partial interval width value.

60. (new) A computer program which enables a computer after it has been loaded into the storage of the computer to perform a method for arithmetically encoding a symbol to be encoded having a binary state based on a current interval width R and a probability representing a probability estimation for the symbol to be encoded,

wherein the probability is represented by a probability index for addressing a probability state from a plurality of representative probability states, the method comprising the following steps:

encoding the symbol to be encoded by performing the following sub-steps:

mapping the current interval width to a quantization index from a plurality of representative quantization indices; and

performing the interval separation by accessing an interval division table using the quantization index and the probability index to obtain a partial interval width value.

61. (new) A computer program which enables a computer after it has been loaded into the storage of the computer to perform a method for arithmetically decoding an encoded symbol having a binary state based on a current interval width R and a probability representing a probability estimation for the encoded symbol, wherein the probability is represented by a probability index of a probability state from a plurality of representative probability states, the method comprising the following steps:

decoding the encoded symbol by performing the following sub-steps:

mapping the current interval width to a quantization index from a plurality of representative quantization indices; and

performing the interval division by accessing an interval division table using the quantization index and the probability index to obtain a partial interval width value.

62. (new) A computer-readable storage medium on which a program is stored which enables a computer after it has been loaded into the storage of the computer to perform a method for arithmetically encoding a symbol to be encoded having a binary state based on a current interval width R and a probability representing a probability estimation for the symbol to be encoded, wherein the probability is represented by a probability index for addressing a probability state from a plurality of representative probability states, the method comprising the following steps:

encoding the symbol to be encoded by performing the following sub-steps:

mapping the current interval width to a quantization index from a plurality of representative quantization indices; and

performing the interval separation by accessing an interval division table using the quantization index and the probability index to obtain a partial interval width value.

63. (new) A computer-readable storage medium on which a program is stored which enables a computer after it has been loaded into the storage of the computer to perform a method for arithmetically decoding an encoded symbol having a binary state based on a current interval width R and a probability representing a probability estimation for the encoded symbol, wherein the probability is represented by a probability index of a probability state from a plurality of representative probability states, the method comprising the following steps:

decoding the encoded symbol by performing the following sub-steps:

mapping the current interval width to a quantization index from a plurality of representative quantization indices; and

performing the interval division by accessing an interval division table using the quantization index and the probability index to obtain a partial interval width value.

64. (new) The computer-readable storage medium on which a program is stored which enables a computer after it has been loaded into the storage of the computer to perform a method according to claim 60.

65. (new) The computer-readable storage medium on which a program is stored which enables a computer after it has been loaded into the storage of the computer to perform a method according to claim 61.

--

Remarks:

Reconsideration of the application is respectfully requested.

Claims 1 - 65 are presently pending in the application. Claims 1 - 24 were previously indicated as allowable, subject to certain informalities. New claims 25 - 65 have been added.

On page 2 of the of the above-identified Office Action, the Examiner objected to the Abstract of the Disclosure. An amended Abstract has been submitted herewith.

Further, claims 12, 13, 15 and 17 were objected to for certain informalities. Applicants' have made the amendments suggested in the Office Action. Moreover, in claim 12, step I), two lines have been switched in order to adapt step I) to the corresponding substep d) in claim 13. In claim 17, step l), the variables for updating p_state have been amended in order to bring the sub step into conformity with Fig. 6.

Fig. 5 has been amended. Attached is one revised formal drawing sheet, including a revised Fig. 5, in which "bit ← 0" has been added at the bottom of this figure. Original disclosure for this amendment may be found in original claim 15. A red-lined sheet showing this addition to Fig. 5 is additionally being provided.

 Unified Patents, Ex. 1002

Finally, Applicants appreciatively acknowledge the Examiner's statement that claims 1 - 24 are allowable.

Although, the Office Action states that prosecution on the merits is closed in accordance with the practice under *Ex parte Quayle*, Applicants are currently submitting new claims 25 - 65, which correspond to claims currently pending in the international preliminary Examination procedure of the parallel international patent application PCT/EP 03/04654. MPEP § 714.14 states that such amendments are treated in a manner similar to amendments after final rejection and cites to MPEP §§ 714.12 and 714.13. As such, Applicants submit these new claims herein and respectfully request that they be entered and considered. Generally stated, the independent claims among these new claims are directed to the same kind of invention as the original, allowed independent claims.

Applicants believe that new claims 25 - 65 do not represent subject matter that extends beyond the content of the original disclosure. For example, new claim 25, like original claim 1, is a method for arithmetical encoding and is based on the following matter from the description of the instant application:

- the fact that the symbol to be encoded has a binary state, page 2, line 28, page 3, lines 25 and 28 - 29, page 18, lines 33 - 34 and page 17, line 37;
- the fact that the arithmetic encoding takes place on the basis of a probability, page 17, lines 26 - 31, in connection with page 18, line 22;
- the fact that the probability represents a probability estimation for the symbol to be encoded, page 17, line 26 - page 18, line 6 and line 22;
- the fact that the probability is represented by a probability index which addresses a probability state from a plurality of representative probability states, page 19, liens 2 - 4, page 18, lines 22 - 23, page 9, lines 18 - 21;
- the fact that the encoding of the encoding symbol takes place by means of mapping the current interval width to a quantization index from a plurality of representative quantization indices, page 19, lines 15 - 16 and 20 - 22;
- the fact that the encoding of the symbol to be encoded takes place by means of carrying out the interval separation, page 18, line 4, page 3, lines 30 - 32, page 18, line 3, page 9, and page 2, lines 25 - 26;

- the fact that the interval separation takes place by accessing an interval division table, page 9, lines 10 - 12 and 15 - 21;
- the fact that the access takes place using the quantization index and the probability index, page 9, lines 19 - 21;
- the fact that a partial interval width value is obtained by the access, page 9, line 11.

The passages in the disclosure cited above, correspondingly apply to new independent claims 33, 58, 59 and new claims 60 - 65.

The new dependent claims are based on the original disclosure of the present application as follows:

Claim 26: Page 3, line 33, in connection with page 18, line 3 and Figs. 1 and 2. From the mentioned passages in the disclosure, it can readily be seen that the updating of the interval width R (page 3, line 33) takes place using the interval width value, i.e. by R_{MPS} which, in turn, corresponds to $R-R_{LPS}$. The result is the new, updated interval width R.

Claim 27: Page 9, line 11.

Claim 28: Page 3, lines 32/33, in connection with page 18, line 3, and Figs. 1 and 2. From these passages, it can readily be seen that the updating of the interval width R is performed depending on the binary state of the symbol to be encoded, i.e. "bit" (ct, "if... then").

Claim 29: Original claim 10, as well as Fig. 2 in connection with page 18, lines 30 to 35, and page 3, lines 34/35, in connection with page 18, line 3, and page 17, lines 32/33, in connection with page 18, lines 28 to 30.

Claim 30: Original claim 12, i.e. particularly page 28, lines 29 and 33 in connection with page 19, lines 4 to 8.

Claim 31: Original claim 12, particularly page 28, line 27 as well as 29 and 31.

Claim 32 Page 3, lines 21/22, in connection with page 18, line 3, as well as original claim 12, page 28, line 30, in connection with line 27.

Claim 34: Page 20, lines 16 to 19, in connection with the passages mentioned with respect to claim 26.

Claim 35: Page 20, lines 16 to 19, in connection with the passages mentioned with respect to claim 26.

Claim 36: Page 20, lines 12 to 14, particularly page 29, lines 21 and 24, as well as line 18.

Claim 37: Original claim 13, particularly page 29, line 18, lines 21/22 and 28.

Claim 38: Page 21, lines 12/13.

Claim 39: Page 20, lines 16 to 19, in connection with the passages of the disclosure mentioned with respect to claim 29, and original claim 13, particularly page 29, lines 21, 26 and 29.

Claim 40: The passages of the disclosure given with respect to claim 30, as well as original claim 13, particularly page 29, lines 21 and 25.

Claim 41: Page 19, lines 28 to 32, and page 18, lines 10/11.

Claim 42: Original claim 2.

Claim 43: Original claim 3.

Claim 44: Original claim 5.

Claim 45: Original claim 8.

Claim 46: Original claim 9.

Claim 47: Original claim 11.

Claim 48: Original claim 12.

Claim 49: Original claim 13.

Claim 50: Original claim 14.

Claim 51: Original claim 15.

Claim 53: Original claim 16.

Claim 54: Original claim 17.

Claim 55: Original claim 18.

Claim 56: Original claim 19.

Claim 57: Original claim 20.

See also Figs. 1 - 3, for support.

In view of the foregoing, entry of claims 25 - 65 and reconsideration and allowance of claims 1 - 65 are solicited. The fee for adding the new claims 25 - 65 in the amount of $3,650.00 is being provided herewith.

In the event the Examiner should find any of the claims to be unpatentable, counsel would appreciate receiving a telephone call so that, if possible, patentable language can be worked out.

Additionally, please consider the present as a petition for a one month extension of time, and please provide a one month extension of time, to and including, December 14, 2004, to respond to the present Office Action. The extension fee for response within a period of one (1) month pursuant to Section 1.136(a) in the amount of $120.00 in accordance with Section 1.17 is enclosed herewith.

Please provide any additional extensions of time that may be necessary and charge any other fees that might be due with respect to Sections 1.16 and 1.17 to the Deposit Account of Lerner and Greenberg, P.A., No. 12-1099.

Respectfully submitted,

For Applicants

Kerry P. Sisselman
Reg. No. 37,237

KPS:cgm

December 14, 2004

Lerner and Greenberg, P.A.
Post Office Box 2480
Hollywood, FL 33022-2480
Tel: (954) 925-1100
Fax: (954) 925-1101

Unified Patents, Ex. 1002

Amendments to the Drawings:

Attached is one revised formal drawing sheet, including a revised Fig. 5, in which "bit ← 0" has been added at the bottom of this figure.

Attachment: Replacement Sheet

Annotated Sheet Showing Changes

OIPE JC113
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PATENT & TRADEMARK OFFICE

Encoder:

1. Calculating the new partial interval:

```
L ← L << 1
if (bit = 1) then
     L ← L + R
```

2. Outputting a bit and renormalizing using doubled determination threshold values (without doubling R and L)

Decoder:

1. Reading out a bit and updating V
2. Determination of bit depending on the position of the partial interval:

```
if (V ≥ R) then
     bit ← 1
     V ← V - R
else bit ← 0
```

Fig. 5

```
1. preState = min(max( 1,((m * SliceQP )>>4)+n),126)
2. if (preState <= 63) then
         p_state = 63 - preState
         valMPS = 0
   else
         p_state = preState - 64
         valMPS = 1
```

Fig. 6

 Unified Patents, Ex. 1002

OIPE JC113
DEC 2 0 2004
PATENT & TRADEMARK OFFICE

Encoder:

1. Calculating the new partial interval:

```
L ← L << 1
if (bit = 1) then
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```

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Decoder:

1. Reading out a bit and updating V
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```
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Fig. 5

```
1. preState = min(max(1,((m * SliceQP )>>4)+n),126)
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        p_state = 63 - preState
        valMPS = 0
   else
        p_state = preState - 64
        valMPS = 1
```

Fig. 6

 Unified Patents, Ex. 1002

PATENT APPLICATION FEE DETERMINATION RECORD
Effective October 1, 2003

Application or Docket Number
10 727801

CLAIMS AS FILED - PART I

	(Column 1)	(Column 2)
TOTAL CLAIMS	24	
FOR	NUMBER FILED	NUMBER EXTRA
TOTAL CHARGEABLE CLAIMS	24 minus 20=	* 4
INDEPENDENT CLAIMS	4 minus 3 =	* 1
MULTIPLE DEPENDENT CLAIM PRESENT		☐

* If the difference in column 1 is less than zero, enter "0" in column 2

SMALL ENTITY TYPE ☐ OR OTHER THAN SMALL ENTITY

RATE	FEE		RATE	FEE
BASIC FEE	385.00	OR	BASIC FEE	770.00
XS 9=		OR	XS18=	18
X43=		OR	X86=	86
+145=		OR	+290=	
TOTAL		OR	TOTAL	928

CLAIMS AS AMENDED - PART II

AMENDMENT A	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	* 105	Minus	** 24	= 41
Independent	* 12	Minus	*** 4	= 8
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

SMALL ENTITY OR OTHER THAN SMALL ENTITY

RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
XS 9=		OR	XS18=	
X43=		OR	X86=	
+145=		OR	+290=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

AMENDMENT B	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
XS 9=		OR	XS18=	
X43=		OR	X86=	
+145=		OR	+290=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

AMENDMENT C	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
XS 9=		OR	XS18=	
X43=		OR	X86=	
+145=		OR	+290=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20."
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3."
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

FORM PTO-875 (Rev 10/03) Patent and Trademark Office, U.S. DEPARTMENT OF COMMERCE

Index of Claims

Application No.	Applicant(s)
10/727,801	MARPE ET AL.
Examiner	**Art Unit**
Jean B Jeanglaude	2819

√	Rejected	–	(Through numeral) Cancelled	N	Non-Elected	A	Appeal
=	Allowed	+	Restricted	I	Interference	O	Objected

Claim		Date								
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U.S. Patent and Trademark Office

Part of Paper No. 09092004

Unified Patents, Ex. 1002

IDS

OIPE
FEB 01 2005
PATENT & TRADEMARK OFFICE

Docket No.: S&ZFH030508

I hereby certify that this correspondence is being deposited with the United States Postal Service with sufficient postage as First Class Mail in an envelope addressed to the Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450, on the date indicated below.

By: ____________________ Date: January 28, 2005

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applic. No.	:	10/727,801	Confirmation No: 6855
Applicant	:	Detlef Marpe et al.	
Filed	:	December 4, 2003	
Title	:	Method and Arrangement for Arithmetic Encoding and Decoding Binary States and a Corresponding Computer Program and a Corresponding Computer-Readable Storage Medium	
Art Unit	:	2819	
Examiner	:	Jean Bruner Jeanglaude	
Docket No.	:	S&ZFH030508	
Customer No.	:	24131	

INFORMATION DISCLOSURE STATEMENT UNDER 37 C.F.R. 1.97(C)(2)

Hon. Commissioner for Patents

Sir:

In accordance with 37 C.F.R. 1.98 copies of the following patents and/or publications are submitted herewith:

United States Patent No. 5,592,162 (Printz et al.), dated January 7, 1997;

Dan Chevion et al.: "High Efficiency, Multiplication Free Approximation of Arithmetic Coding", *IEEE 1991, Order No. TH0373-1/91/0000/0043/$01.00, pp. 43-52*;

David S. Taubman et al.: "JPEG2000 Image Compression Fundamentals, Standards and Practice", *Kluwer Academic Publishers, Boston, 2002, pp. 65-77*;

European Office Action dated November 2, 2004.

02/03/2005 RFEKADU1 00000023 10727801
01 FC:1806 180.00 OP

Unified Patents, Ex. 1002

In accordance with 37 C.F.R. 1.97 (c) (2), consideration of this Information Disclosure Statement is requested.

Enclosed is the fee in the amount of $180.00.

Respectfully submitted,

For Applicants

Alfred K. Dassler
52,794

Date: January 28, 2005

Lerner And Greenberg, P.A.
Post Office Box 2480
Hollywood, FL 33022-2480
Tel: (954) 925-1100
Fax: (954) 925-1101

/bmb

Unified Patents, Ex. 1002

OIPE JCIGM
FEB 0 1 2005
PATENT & TRADEMARK OFFICE

FORM PTO-1449 (SUBSTITUTE) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE INFORMATION DISCLOSURE STATEMENT BY APPLICANT (37 CFR 1.98(b))	Attorney Docket No.: S&ZFH030508 Applic. No. 10/727,801 Applicant: Detlef Marpe et al. Filing Date: December 4, 2003 Group Art Unit: 2819

U.S. PATENT DOCUMENTS

EXAMINER INITIALS		PATENT NO.	DATE	PATENTEE	CLASS	SUB CLASS	FILING DATE
	A	5,592,162	01/07/97	Printz et al.			
	B						
	C						
	D						
	E						
	F						
	G						
	H						
	I						

FOREIGN PATENT DOCUMENT

		DOCUMENT NO.	DATE	COUNTRY	CLASS	SUB CLASS	TRANSL. YES	TRANSL. NO
	J							
	K							
	L							
	M							
	N							

OTHER DOCUMENTS (Including Author, Title, Date, Pertinent Pages, etc.)

	O	Dan Chevion et al.: "High Efficiency, Multiplication Free Approximation of Arithmetic Coding", *IEEE 1991, Order No. TH0373-1/91/0000/0043/$01.00, pp. 43-52*
	P	David S. Taubman et al.: "JPEG2000 Image Compression Fundamentals, Standards and Practice", *Kluwer Academic Publishers, Boston, 2002, pp. 65-77*

EXAMINER	DATE CONSIDERED

EXAMINER: Initial if citation considered, whether or not citation is in conformance with MPEP 609; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

Unified Patents, Ex. 1002

FEB 17 2005 OIPE JC103 PATENT & TRADEMARK OFFICE

IFW/RCE

PTO/SB/30 (08-03)
Approved for use through 07/31/2006. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Request For Continued Examination (RCE) Transmittal

Address to:
Mail Stop RCE
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Application Number	10/727,801
Filing Date	December 4, 2003
First Named Inventor	Detlev Marpe, et al.
Art Unit	2819
Examiner Name	Jean Bruner Jeanglaude
Attorney Docket Number	S&ZFH030508

This is a Request for Continued Examination (RCE) under 37 CFR 1.114 of the above-identified application.
Request for Continued Examination (RCE) practice under 37 CFR 1.114 does not apply to any utility or plant application filed prior to June 8, 1995, or to any design application. See Instruction Sheet for RCEs (not to be submitted to the USPTO) on page 2.

1. Submission required under 37 CFR 1.114 Note: If the RCE is proper, any previously filed unentered amendments and amendments enclosed with the RCE will be entered in the order in which they were filed unless applicant instructs otherwise. If applicant does not wish to have any previously filed unentered amendment(s) entered, applicant must request non-entry of such amendment(s).
   a. [X] Previously submitted. If a final Office action is outstanding, any amendments filed after the final Office action may be considered as a submission even if this box is not checked.
      i. [ ] Consider the arguments in the Appeal Brief or Rely Brief previously filed on ________
      ii. [ ] Other ________
   b. [X] Enclosed
      i. [X] Amendment/Reply
      ii. [ ] Affidavit(s)/ Declaration(s)
      iii. [ ] Information Disclosure Statement (IDS)
      iv. [ ] Other ________
2. Miscellaneous
   a. [ ] Suspension of action on the above-identified application is requested under 37 CFR 1.103(c) for a period of ________ months. (Period of suspension shall not exceed 3 months; Fee under 37 CFR 1.17(i) required)
   b. [ ] Other ________
3. Fees The RCE fee under 37 CFR 1.17(e) is required by 37 CFR 1.114 when the RCE is filed.
   a. [X] The Director is hereby authorized to charge the following fees, or credit any overpayments, to Deposit Account No. 12-1099
      i. [X] RCE fee required under 37 CFR 1.17(e)
      ii. [ ] Extension of time fee (37 CFR 1.136 and 1.17)
      iii. [ ] Other ________
   b. [ ] Check in the amount of $ ________ enclosed
   c. [X] Payment by credit card (Form PTO-2038 enclosed)

02/18/2005 MWOLDGE1 00000050 121099 10727801
01 FC:1801 790.00 OP

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED

Name (Print/Type)	Laurence A. Greenberg	Registration No. (Attorney/Agent)	29,308
Signature	[signature]	Date	February 14, 2005

CERTIFICATE OF MAILING OR TRANSMISSION

I hereby certify that this correspondence is being deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: Mail Stop RCE, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 or facsimile transmitted to the U.S. Patent and Trademark Office on the date shown below.

Name (Print/Type)	Laurence A. Greenberg		
Signature	[signature]	Date	February 14, 2005

This collection of information is required by 37 CFR 1.114. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Mail Stop RCE, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

/bb

S&ZFH030508

CERTIFICATION OF MAILING OR TRANSMISSION

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OIPE JC103
FEB 17 2005
PATENT & TRADEMARK OFFICE

[signature] February 14, 2005
Signature Date

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applic. No.	:	10/727,801	Confirmation No. 6855
Applicant	:	Detlev Marpe, et al.	
Filed	:	December 4, 2003	
Title	:	Method and Arrangement for Arithmetic Encoding and Decoding Binary States and a Corresponding Computer Program and a Corresponding Computer-readable Storage Medium	
Group Art Unit	:	2819	
Examiner	:	Jean Bruner Jeanglaude	
Docket No.	:	S&ZFH030508	
Customer No.	:	24131	

P R E L I M I N A R Y A M E N D M E N T

Mail Stop Amendment
Hon. Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

S i r :

Kindly amend the above-identified application as follows:

Amendments to the Claims begin on page 2 of this paper.

Remarks/Arguments begin on page 26 of this paper.

02/18/2005 MWOLDGE1 00000050 10727801
02 FC:1253 900.00 DA

Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1. (original) A method for an arithmetic encoding and decoding of binary states,

characterized in that

in a first step a presetable value range for the specification of the interval width R is separated in K representative interval widths $\{Q_1, \ldots, Q_K\}$, a presetable value range for the specification of the probabilities is separated in N representative probability states $\{P_1, \ldots, P_N\}$ and allocation regulations are given, which allocate one Q_K ($1 \leq k \leq K$) to every interval width R and one P_n ($1 \leq n \leq N$) to every probability, and that in a second step the encoding or decoding of the binary states take place by performing the calculation of the new interval width to be derived in the encoding or decoding process, respectively, using a representative interval width Q_K ($1 \leq k \leq K$) and a representative probability state P_n ($1 \leq n \leq N$) by arithmetic operations other than multiplication and division, wherein the representative interval width Q_K is determined by the basic basis interval of the width R and the representative probability state P_n is determined by the probability estimation underlying the symbol to be encoded or to be decoded according to the given allocation regulations.

2. (original) The method according to claim 1,

characterized in that

based on the interval currently to be evaluated having a width R, for determining the associated interval width Q_K, an index q_index is determined by a shift and bit masking operation applied to the computer-internal/binary representation of R.

3. (original) The method according to claim 1,

characterized in that

based on the interval currently to be evaluated with a width R, for the determination of the associated interval width Q_K, an index q_index is determined by a shift operation applied to the computer-internal/-binary representation of R and a downstream access to a table Qtab, wherein the table Qtab contains the indices of interval widths corresponding to values of R prequantized by a shift operation.

4. (original) The method according to claim 1,

characterized in that

the probability estimation underlying the symbol to be encoded or to be decoded is associated with a probability state P_n with the help of an index p_state.

5. (original) The method according to claim 1,

characterized in that

the values of the interval width R_{LPS} corresponding to all K interval widths and to all N different probability states are entered into a table Rtab as product values (Q_K * P_n).

6. (original) The method according to claim 1,

characterized in that

the determination of the interval width R_{LPS} corresponding to the LPS is performed by an access to a table Rtab, wherein the table Rtab contains the values of the interval width R_{LPS} corresponding to all K quantized values of R and to the N different probability states as product values (Q_K * P_n).

7. (original) The method according to claim 1,

characterized in that

the determination of the interval width R_{LPS} corresponding to the LPS is performed by an access to the table Rtab, wherein, for an evaluation of the table, the quantization index q_index and the index of the probability state p_state are used.

8. (original) The method according to claim 1,

characterized in that

for the N different representative probability states transition rules are preset, wherein the transition rules indicate which new state is used for the next symbol to be encoded or to be decoded based on the currently encoded or decoded symbol.

9. (original) The method according to claim 8,

characterized in that

a table Next_State_LPS is created which contains the index m of the new probability state P_m for the index n of the currently given probability state P_n at the occurrence of a least probable symbol (LPS).

10. (original) The method according to claim 8,

characterized in that

a table Next_State_MPS is created which contains the index m of the new probability state P_m for the index n of the currently given probability state P_n at the occurrence of a most probable symbol (MPS).

11. (original) The method according to claim 1,

characterized in that

the number K of quantization values and/or the number N of the representative states are selected depending on the preset accuracy of the coding and/or depending on the available storage room.

12. (previously presented) The method according to claim 1,

characterized in that

the table-aided encoding includes the following steps:

f) Determination of the LPS

g) Quantization of R:

q_index = Qtab[R>>q]

h) Determination of R_{LPS} and R:

R_{LPS} = Rtab [q_index, p_state]

R = R − R_{LPS}

i) Calculation of the new partial interval:

```
if (bit = LPS) then
     L ← L + R
     R ← R_LPS
     if (p_state = 0) then valMPS ← 1 - valMPS
     p_state ← Next_State_LPS [p_state]
else
     p_state ← Next_State_MPS [p_state]
```

j) Renormalization of L and R, writing bits, wherein

q_index describes the index of a quantization value read out of Qtab,

p_state describes the current state,

R_{LPS} describes the interval width corresponding to the LPS and

valMPS describes the bit corresponding to the MPS.

13. (previously presented) The method according to claim 1,

characterized in that

a table-aided decoding includes the following steps:

a) Determination of the LPS

b) Quantization of R:

q_index = Qtab[R>>q]

c) Determination of R_{LPS} and R:

R_{LPS} = Rtab [q_index, p_state]

R = R - R_{LPS}

d) Determination of bit depending on the position of the partial interval:

```
if (V ≥ R) then
     bit ← LPS
     V ← V - R
     R ← R_LPS
     if (p_state = 0) then valMPS ← 1 - valMPS
     p_state ← Next_State_LPS [p_state]
else
     bit ← MPS
     p_state ← Next_State_MPS [p_state]
```

e) Renormalization of R, reading out one bit and updating V, wherein

q_index describes the index of a quantization value read out of Qtab,

p_state describes the current state,

R_{LPS} describes the interval width corresponding to the LPS,

valMPS	describes the bit corresponding to the MPS, and
V	describes a value from the interior of the current partial interval.

14. (currently amended) The method according to claim 1,

characterized in that

in encoding and/or decoding the calculation of the quantization index q_index is performed in the second substep ~~according to claim 12 and/or 13~~ according to the calculation regulation:

q_index = (R >> q) & Qmask

wherein Qmask illustrates a bit mask suitably selected depending on K.

15. (currently amended) The method according to claim [[~~1~~]] 12,

characterized in that

when a uniform probability distribution is present

in the encoding ~~according to claim 12 the~~ substeps f to i are performed according to the following calculation regulation:

R ← R >> 1

if (bit = 1) **then**

    L ← L + R

or

that the substeps f to i of the encoding ~~according to claim 12~~ are performed according to the following calculation regulation:

L ← L << 1

if (bit = 1) **then**

L ← L + R

and wherein in the last alternative the renormalization [[(]] of substep j ~~according to claim 12)~~ is performed with doubled decision threshold values and no doubling of L and R is performed, and

that in the decoding ~~according to claim 13~~ the substeps a to d are performed according to the following calculation regulation:

R ← R >>1

if (V ≥ R) **then**

bit ← 1

V ← V - R

else

bit ← 0,

or

the substeps a to e of the decoding ~~according to claim 13~~ are performed according to the following calculation regulation:

m) Reading out one bit and updating V

n) Determination of bit according to the position of the partial interval:

if (V ≥ R) **then**

bit ← 1

V ← V - R

else

bit ← 0.

16. (original) The method according to claim 1,

characterized in that

the initialization of the probability models is performed depending on a quantization parameter SliceQP and preset model parameters m and n, wherein SliceQP describes the

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quantization parameter preset at the beginning of a slice and m and n describe the model parameters.

17. (previously presented) The method according to claim 1,

characterized in that

the initialization of the probability models includes the following steps:

```
k) preState = min(max(1, ((m * SliceQP) >>4)+n), 2*N)
l) if (preState <=N) then
          p_state = N  - preState
          valMPS = 0
     else
          p_state = preState - (N+1)
          valMPS = 1,
```

wherein valMPS describes the bit corresponding to the MPS, SliceQP describes the quantization parameter preset at the beginning of a slice and m and n describe the model parameters.

18. (original) The method according to claim 1,

characterized in that

the probability estimation of the states is performed using a finite state machine (FSM).

19. (original) The method according to claim 1,

characterized in that

the generation of the representative states is performed offline.

20. (original) The method according to claim 1,

characterized in that

the selection of the states depends on the statistics of the data to be coded and/or on the number of states.

21. (original) An arrangement having at least one processor and/or chip, which is/are implemented such that a method for an arithmetic encoding and decoding of binary states is may be performed, wherein

in a first step a presetable value range for the specification of the interval width R is separated in K representative interval widths $\{Q_1, \ldots, Q_K\}$, a presetable value range for the specification of the probabilities is separated in N representative probability states $\{P_1, \ldots, P_N\}$ and allocation regulations are given, which allocate one Q_K ($1 \leq k \leq K$) to every interval width R and one P_n ($1 \leq n \leq N$) to every probability, and wherein in a second step the encoding or decoding of the binary states take place by performing the calculation of the new interval width to be derived in the encoding or decoding process, respectively, using a representative interval width Q_K ($1 \leq k \leq K$) and a representative probability state P_n ($1 \leq n \leq N$) by arithmetic operations other than multiplication and division, wherein the representative interval width Q_K is determined by the basic basis interval of the width R and the representative probability state P_n is determined by the probability estimation underlying the symbol to be encoded or to be decoded according to the given allocation regulations.

22. (original) A computer program which enables a computer after it has been loaded into the storage of the computer to perform a method for an arithmetic encoding and decoding of binary states, wherein

in a first step a presetable value range for the specification of the interval width R is separated in K representative interval widths $\{Q_1, \ldots, Q_K\}$, a presetable value range for the specification of the probabilities is separated in N representative probability states $\{P_1, \ldots, P_N\}$ and allocation regulations are given, which allocate one Q_K $(1 \le k \le K)$ to every interval width R and one P_n $(1 \le n \le N)$ to every probability, and wherein in a second step the encoding or decoding of the binary states take place by performing the calculation of the new interval width to be derived in the encoding or decoding process, respectively, using a representative interval width Q_K $(1 \le k \le K)$ and a representative probability state P_n $(1 \le n \le N)$ by arithmetic operations other than multiplication and division, wherein the representative interval width Q_K is determined by the basic basis interval of the width R and the representative probability state P_n is determined by the probability estimation underlying the symbol to be encoded or to be decoded according to the given allocation regulations.

23. (original) A computer-readable storage medium on which a computer program is stored which enables a computer after it has been loaded into the storage of the computer to perform a method for an arithmetic encoding and decoding of binary states, wherein

in a first step a presetable value range for the specification of the interval width R is separated in K representative interval widths $\{Q_1, \ldots, Q_K\}$, a presetable value range for the specification of the probabilities is separated in N representative probability states $\{P_1, \ldots, P_N\}$ and allocation regulations are given, which allocate one Q_K $(1 \leq k \leq K)$ to every interval width R and one P_n $(1 \leq n \leq N)$ to every probability, and wherein in a second step the encoding or decoding of the binary states take place by performing the calculation of the new interval width to be derived in the encoding or decoding process, respectively, using a representative interval width Q_K $(1 \leq k \leq K)$ and a representative probability state P_n $(1 \leq n \leq N)$ by arithmetic operations other than multiplication and division, wherein the representative interval width Q_K is determined by the basic basis interval of the width R and the representative probability state P_n is determined by the probability estimation underlying the symbol to be encoded or to be decoded according to the given allocation regulations.

24. (original) The computer program according to claim 22, which is downloaded from an electronic data network, like for example from the internet, onto a data processing means which is connected to the data network.

25. (previously presented) A method for arithmetically encoding a symbol to be encoded having a binary state based on a current interval width R and a probability representing a probability estimation for the symbol to be encoded, wherein the probability is represented by a probability index for addressing a probability state from

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a plurality of representative probability states, which method comprises the following steps:

encoding the symbol to be encoded by performing the following substeps:

mapping the current interval width to a quantization index from a plurality of representative quantization indices; and

performing the interval separation by accessing an interval division table using the quantization index and the probability index to obtain a partial interval width value.

26. (previously presented) The method of claim 25, wherein the encoding further takes place by the following step:

updating the current interval width using the interval width value to obtain a new, updated interval width.

27. (previously presented) The method of claim 25, wherein the partial interval width value specifies a width of a partial interval for a symbol to be encoded with a less probable state from a current interval with a current interval width.

28. (previously presented) The method of claim 25, wherein updating the current interval width is further performed depending on the binary state of the symbol to be encoded.

29. (previously presented) The method of claim 25, further comprising the following step:

adaptation of the probability estimation, wherein the adaptation of the probability estimation comprises looking up, with the probability index, in an LPS

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transition rule table (Next_State_LPS) to obtain a new probability index, when the symbol to be encoded has a less probable state, and looking up, with the probability index, in an MPS transition rule table (Next_State_MPS) to obtain a new probability index, when the symbol to be encoded has a more probable state.

30. (previously presented) The method of claim 29, further comprising adjusting a value indicative of the more probable state from a state originally indicated to the binary state of the symbol to be encoded, when the probability index is like a predetermined probability index and the symbol to be encoded has a binary state different from the state originally indicated.

31. (previously presented) The method of claim 25, wherein the substep of updating the current interval width comprises the following steps:

equating the new interval width with the difference of current interval width minus the partial interval width value; and

subsequently, if the symbol to be encoded has a less probable state, equating the new interval width with the partial interval width value.

32. (previously presented) The method of claim 25, wherein a current interval is represented by the current interval width and a current offset point, and the encoding is further performed by the following substep:

accumulating the current offset point and a difference of current interval width and partial interval width value to obtain a new, updated offset point, when the symbol to be coded has a less probable state.

33. (previously presented) A method for arithmetically decoding an encoded symbol having a binary state based on a current interval width R and a probability representing a probability estimation for the encoded symbol, wherein the probability is represented by a probability index of a probability state from a plurality of representative probability states, wherein the method comprises the following step:

decoding the encoded symbol by performing the following substeps:

mapping the current interval width to a quantization index from a plurality of representative quantization indices; and

performing the interval division by accessing an interval division table using the quantization index and the probability index to obtain a partial interval width value.

34. (previously presented) The method of claim 33, wherein the decoding further takes place by means of the following step:

updating the current interval width using the partial interval width value to obtain a new, updated interval width.

35. (previously presented) The method of claim 33, wherein the partial interval width value specifies a width of a partial interval for an encoded symbol with a less probable state from a current interval with the current interval width.

36. (previously presented) The method of claim 33, wherein updating the current interval width is further performed depending on a value within a new partial interval

characterized by the current partial interval width and the value within a new partial interval.

37. (previously presented) The method of claim 36, wherein the decoding is further performed by means of the following substep:

equating the binary state of the encoded symbol with one of a more improbable and a more probable state depending on whether the value within the new partial interval is larger or smaller than a difference of the current interval width and partial interval width value.

38. (previously presented) The method of claim 36, wherein the encoding is further performed by means of updating the value within the new partial interval with a next bit to be read in.

39. (previously presented) The method of claim 36, further comprising the following step:

updating the probability estimation, wherein updating the probability estimation comprises looking up, with the probability index, in an LPS transition rule table (Next_State_LPS) to obtain a new probability index, when the value within the new partial interval is larger than a difference of the current interval width and partial interval width value, and looking up, with the probability index, in an MPS transition rule table (Next_State_MPS) to obtain a new probability index, when the value within the new partial interval is smaller than a difference of the current interval width and partial interval width value.

40. (previously presented) The method of claim 36, further comprising adjusting a value indicative of the more probable state of the encoded symbol from a state originally indicated to a different binary state, when

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the probability index is like a predetermined probability index and the value within the new partial interval is larger than a difference of the current interval width and partial interval width value.

41. (previously presented) The method of claim 33, wherein the current interval width is represented with an accuracy of b bits, and the partial interval width value obtained from the interval division table is represented with an accuracy of b-2 bits.

42. (previously presented)The method of claim 33, wherein

the substep of mapping comprises applying a shift and bit masking operation to a computer-internal/binary representation of the current interval width.

43. (previously presented) The method of claim 33, wherein

the substep of mapping comprises applying a shift operation to a computer-internal/binary representation of the current interval width to obtain a quantized value for the current interval width, and a downstream access to a table (Qtab) to obtain the quantization index.

44. (previously presented) The method of claim 33, wherein,

in the interval division table, values for the current interval width corresponding to all possible quantization indices and to all probability indices are filed as product values between quantization index, and in a table Rtab.

45. (previously presented) The method of claim 33, further comprising the following step:

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updating the probability estimation, wherein updating the probability estimation is performed by means of transition rules, wherein the transition rules specify which new probability state from a plurality of probability states, based on the symbol to be encoded and/or the encoded symbol, will be used for a next symbol to be encoded and/or an encoding symbol.

46. (previously presented) The method of claim 33, further comprising the following step:

updating the probability estimation, wherein updating the probability estimation comprises looking up, with the probability index, in a transition rule table (Next_State_LPS) to obtain a new probability index.

47. (previously presented) The method of claim 33, wherein

the number of possible quantization indices and/or the number of the probability states are selected depending on the preset accuracy of the coding and/or depending on the available storage room.

48. (previously presented) The method of claim 33, further comprising the following substep:

renormalizing the new updated offset point and the new, updated interval width.

49. (previously presented) The method of claim 33, wherein

decoding includes the following steps:

a) Determination of the LPS
b) Quantization of R:
   q_index = Qtab [R>>q]

c) Determination of R_{LPS} and R:
   R_{LPS} = Rtab [q_index, p_state]

R = R − R_{LPS}

d) Determination of bit, depending on the position of the partial interval:

if (V ≥ R) **then**

bit ← LPS

V ← V − R

R ← R_{LPS}

if (p_state = 0) then valMPS ← 1 − valMPS

p_state ← Next_State_LPS[p_state]

else

bit ← MPS

p_state ← Next_State_MPS[p_state]

e) Renormalization of R, reading out one bit and updating V,

wherein

q_index describes the index of a quantization value read out of Qtab,

p_state describes the current state,

R_{LPS} describes the interval width corresponding to the LPS,

ValMPS describes the bit corresponding to the MPS and

V describes a value from within the current partial interval.

50. (previously presented) The method of claim 33, wherein,

in encoding and/or decoding, mapping to the quantization index q_index is performed according to the calculation regulation:

q_**index** = (R >> q) & Qmask

wherein Qmask represents a bit mask suitably selected depending on the number of probability states, R represents the current interval width and q represents a number of bits.

51. (previously presented) The method of claim 33, wherein,

in the presence of a uniform probability distribution,

- in the encoding, the following calculation regulation is performed:

  R ← R >> 1

  if (bit = 1) **then**

  L ← L + R,

  or

  the following calculation regulation is performed:

  L ← L << 1

  if (bit = 1) **then**

  L ← L + R

  and, in the last alternative, a renormalization with doubled decision threshold values is performed and no doubling of L and R is carried out.

52. (previously presented) The method of claim 33, wherein,

in the decoding, the following calculation regulation is performed:

R ← R >> 1

if (V ≥ R) **then**

bit ← 1

V ← V − R

else

bit ← 0,

or

the following calculation regulation:

m) Reading out one bit and updating V

n) Determination of bit depending on the position of the partial interval:

if (V ≥ R) **then**

bit ← 1

V ← V − R

else

bit ← 0.

53. (previously presented) The method of claim 33, wherein

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the initialization of the probability models is performed depending on a quantization parameter SliceQP and preset model parameters m and n, wherein SliceQP describes the quantization parameter preset at the beginning of a slice, and m and n describe the model parameters.

54. (previously presented) The method of claim 33, wherein

the initialization of the probability models includes the following steps:

```
k) preState = min(max(1, ((m * SliceQP) >>4)+n), 2*N)
l) if (preState <=N) then
      p_state = N - preState
      valMPS = 0
   else
      p_state = preState - (N+1)
      valMPS = 1,
```

wherein valMPS describes the bit corresponding to the MPS, SliceQP describes the quantization parameter preset at the beginning of a slice, and m and n describe the model parameters.

55. (previously presented) The method of claim 33, wherein

the probability estimation of the states is performed by means of a finite state machine (FSM).

56. (previously presented) The method of claim 33, wherein

the generation of the probability states is performed offline.

57. (previously presented) The method of claim 33, wherein

the selection of the states depends on the statistics of the data to be coded and/or on the number of the states.

58. (previously presented) An arrangement for arithmetically encoding a symbol to be encoded having a binary state based on a current interval width R and a probability representing a probability estimation for the symbol to be encoded, wherein the probability is represented by a probability index for addressing a probability state from a plurality of representative probability states, the device comprising:

means for encoding the symbol to be encoded, including the following means:

means for mapping the current interval width to a quantization index from a plurality of representative quantization indices; and

means for performing the interval separation by accessing an interval division table using the quantization index and the probability index to obtain a partial interval width value.

59. (previously presented) An arrangement for arithmetically decoding an encoded symbol having a binary state based on a current interval width R and a probability representing a probability estimation for the encoded symbol, wherein the probability is represented by a probability index for addressing a probability state from a plurality of representative probability states, the device comprising:

means for decoding the encoded symbol, comprising the following means:

means for mapping the current interval width to a quantization index from a plurality of representative quantization indices; and

means for performing the interval separation by accessing an interval division table using the quantization index and the probability index to obtain a partial interval width value.

60. (previously presented) A computer program which enables a computer after it has been loaded into the storage of the computer to perform a method for arithmetically encoding a symbol to be encoded having a binary state based on a current interval width R and a probability representing a probability estimation for the symbol to be encoded, wherein the probability is represented by a probability index for addressing a probability state from a plurality of representative probability states, the method comprising the following steps:

encoding the symbol to be encoded by performing the following sub-steps:

mapping the current interval width to a quantization index from a plurality of representative quantization indices; and

performing the interval separation by accessing an interval division table using the quantization index and the probability index to obtain a partial interval width value.

61. (previously presented) A computer program which enables a computer after it has been loaded into the storage of the computer to perform a method for arithmetically decoding an encoded symbol having a binary state based on a current interval width R and a probability representing a probability estimation for the encoded symbol, wherein the probability is represented by a probability index of a probability state from a plurality of representative probability states, the method comprising the following steps:

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decoding the encoded symbol by performing the following sub-steps:

mapping the current interval width to a quantization index from a plurality of representative quantization indices; and

performing the interval division by accessing an interval division table using the quantization index and the probability index to obtain a partial interval width value.

62. (previously presented) A computer-readable storage medium on which a program is stored which enables a computer after it has been loaded into the storage of the computer to perform a method for arithmetically encoding a symbol to be encoded having a binary state based on a current interval width R and a probability representing a probability estimation for the symbol to be encoded, wherein the probability is represented by a probability index for addressing a probability state from a plurality of representative probability states, the method comprising the following steps:

encoding the symbol to be encoded by performing the following sub-steps:

mapping the current interval width to a quantization index from a plurality of representative quantization indices; and

performing the interval separation by accessing an interval division table using the quantization index and the probability index to obtain a partial interval width value.

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63. (previously presented) A computer-readable storage medium on which a program is stored which enables a computer after it has been loaded into the storage of the computer to perform a method for arithmetically decoding an encoded symbol having a binary state based on a current interval width R and a probability representing a probability estimation for the encoded symbol, wherein the probability is represented by a probability index of a probability state from a plurality of representative probability states, the method comprising the following steps:

decoding the encoded symbol by performing the following sub-steps:

mapping the current interval width to a quantization index from a plurality of representative quantization indices; and

performing the interval division by accessing an interval division table using the quantization index and the probability index to obtain a partial interval width value.

64. (canceled).

65. (canceled).

Remarks:

Reconsideration of the application is respectfully requested.

Claims 1 - 63 are presently pending in the application. Claims 1 - 24 were previously indicated as allowable, subject to certain informalities. Claims 14 and 15 have been amended. Claims 64 and 65 have been canceled.

In the event the Examiner should find any of the claims to be unpatentable, counsel would appreciate receiving a telephone call so that, if possible, patentable language can be worked out.

In a conversation with Examiner Jeanglaude of Friday, February 11, 2005, it was discussed that the Advisory Action in the present case would be withdrawn, and that a Notice of Non-Compliance would be issued instead, in order to permit the Applicants to file a Request for Continued Examination and the present Preliminary Amendment. A restarting of the period for response was discussed, and Examiner Jeanglaude indicated that he would ask his Supervisor to restart the period for response to the Notice of Non-Compliance and provide Applicants with one-month to respond. The present Preliminary Amendment is being filed prior to Applicants' receipt of said Notice of Non-Compliance. As such, it is believed that no extensions of time are presently necessary.

However, in the event that the period for response was not restarted by the mailing of the Notice of Non-Compliance, please consider the present as a petition for a further two month extension of time, to and including, February 14, 2004. A previous first month extension of time was requested in a Response filed in the present case on December 14, 2005 and the fee of $120.00 was previously paid. In the event that a further extension of time is deemed necessary, please charge the Deposit Account of Lerner and Greenberg, P.A., No. 12-1099 for the additional fee of $900.00 for the further extension of time (i.e., $1,020 minus $120, which was previously paid).

Please provide any additional extensions of time that may be necessary and charge any other fees that might be due with respect to Sections 1.16 and 1.17 to the Deposit Account of Lerner and Greenberg, P.A., No. 12-1099.

Respectfully submitted,

For Applicants

Kerry P. Sisselman
Reg. No. 37,237

KPS:cgm

February 14, 2005

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/727,801	12/04/2003	Detlef Marpe	S&ZFH030508	6855

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EXAMINER
JEANGLAUDE, JEAN BRUNER

ART UNIT	PAPER NUMBER
2819	

DATE MAILED: 02/18/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

PTO-90C (Rev. 10/03)

Unified Patents, Ex. 1002

AK

Interview Summary	Application No.	Applicant(s)	
	10/727,801	MARPE ET AL.	
	Examiner	Art Unit	
	Jean B. Jeanglaude	2819	

All participants (applicant, applicant's representative, PTO personnel):

(1) *Jean B. Jeanglaude (The Examiner)*. (3)_____.

(2) *Kerry P. Sisselman (The Applicant's Rep.)*. (4)_____.

Date of Interview: *08 February 2005*.

Type: a)☒ Telephonic b)☐ Video Conference
c)☐ Personal [copy given to: 1)☐ applicant 2)☐ applicant's representative]

Exhibit shown or demonstration conducted: d)☐ Yes e)☒ No.
If Yes, brief description: _____.

Claim(s) discussed: *1-65*.

Identification of prior art discussed: _____.

Agreement with respect to the claims f)☒ was reached. g)☐ was not reached. h)☐ N/A.

Substance of Interview including description of the general nature of what was agreed to if an agreement was reached, or any other comments: *An interview was held with the Applicant's Representative, Kerry P. Sisselman, on Tuesday February 8, 2005 regarding an advisory action that was mailed to the applicant on February 2, 2005. The advisory action was discussed and it was agreed that the advisory action will be withdrawn and a non-compliance action will be mailed to the applicant.* .

(A fuller description, if necessary, and a copy of the amendments which the examiner agreed would render the claims allowable, if available, must be attached. Also, where no copy of the amendments that would render the claims allowable is available, a summary thereof must be attached.)

THE FORMAL WRITTEN REPLY TO THE LAST OFFICE ACTION MUST INCLUDE THE SUBSTANCE OF THE INTERVIEW. (See MPEP Section 713.04). If a reply to the last Office action has already been filed, APPLICANT IS GIVEN ONE MONTH FROM THIS INTERVIEW DATE, OR THE MAILING DATE OF THIS INTERVIEW SUMMARY FORM, WHICHEVER IS LATER, TO FILE A STATEMENT OF THE SUBSTANCE OF THE INTERVIEW. See Summary of Record of Interview requirements on reverse side or on attached sheet.

Jean Bruner Jeanglaude
JEAN JEANGLAUDE
PRIMARY EXAMINER

Examiner Note: You must sign this form unless it is an Attachment to a signed Office action.

____
Examiner's signature, if required

Notice of Non-Compliant Amendment (37 CFR 1.121)	Application No.	Applicant(s)	
	10/727,801	MARPE ET AL.	
	Examiner	**Art Unit**	
	Jean B. Jeanglaude	2819	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

The amendment document filed on _20 December 2004_ is considered non-compliant because it has failed to meet the requirements of 37 CFR 1.121. In order for the amendment document to be compliant, correction of the following item(s) is required.

THE FOLLOWING MARKED (X) ITEM(S) CAUSE THE AMENDMENT DOCUMENT TO BE NON-COMPLIANT:

- ☐ 1. Amendments to the specification:
  - ☐ A. Amended paragraph(s) do not include markings.
  - ☐ B. New paragraph(s) should not be underlined.
  - ☐ C. Other _____.
- ☐ 2. Abstract:
  - ☐ A. Not presented on a separate sheet. 37 CFR 1.72.
  - ☐ B. Other _____.
- ☐ 3. Amendments to the drawings:
  - ☐ A. The drawings are not properly identified in the top margin as "Replacement Sheet," "New Sheet," or "Annotated Sheet" as required by 37 CFR 1.121(d).
  - ☐ B. The practice of submitting proposed drawing correction has been eliminated. Replacement drawings showing amended figures, without markings, in compliance with 37 CFR 1.84 are required.
  - ☐ C. Other _____.
- ☒ 4. Amendments to the claims:
  - ☐ A. A complete listing of all of the claims is not present.
  - ☐ B. The listing of claims does not include the text of all pending claims (including withdrawn claims)
  - ☐ C. Each claim has not been provided with the proper status identifier, and as such, the individual status of each claim cannot be identified. Note: the status of every claim must be indicated after its claim number by using one of the following status identifiers: (Original), (Currently amended), (Canceled), (Previously presented), (New), (Not entered), (Withdrawn) and (Withdrawn-currently amended).
  - ☐ D. The claims of this amendment paper have not been presented in ascending numerical order.
  - ☒ E. Other: _no other claimss should be added to the case._.

For further explanation of the amendment format required by 37 CFR 1.121, see MPEP § 714 and the USPTO website at http://www.uspto.gov/web/offices/pac/dapp/opla/preognotice/officeflyer.pdf .

TIME PERIODS FOR FILING A REPLY TO THIS NOTICE:

1. Applicant is given **no new time period** if the non-compliant amendment is an after-final amendment or an amendment filed after allowance. If applicant wishes to resubmit the non-compliant after-final amendment with corrections, the **entire corrected amendment** must be resubmitted within the time period set forth in the final Office action.

2. Applicant is given **one month**, or thirty (30) days, whichever is longer, from the mail date of this notice to supply the **corrected section** of the non-compliant amendment in compliance with 37 CFR 1.121, if the non-compliant amendment is one of the following: a preliminary amendment, a non-final amendment (including a submission for a request for continued examination (RCE) under 37 CFR 1.114), a supplemental amendment filed within a suspension period under 37 CFR 1.103(a) or (c), and an amendment filed in response to a *Quayle* action.

   Extensions of time are available under 37 CFR 1.136(a) only if the non-compliant amendment is a non-final amendment or an amendment filed in response to a *Quayle* action.

   Failure to timely respond to this notice will result in:
   Abandonment of the application if the non-compliant amendment is a non-final amendment or an amendment filed in response to a *Quayle* action; or
   Non-entry of the amendment if the non-compliant amendment is a preliminary amendment or supplemental amendment.

Remarks

An interview was held with the Applicant's Representative, Kerry P. Sisselman, on Tuesday February 8, 2005 regarding an advisory action that was mailed to the applicant on February 2, 2005. The advisory action was discussed and it was agreed that the advisory action will be withdrawn and a non-compliance action will be mailed to the applicant.

Response to Amendments

The reply filed on 12-20-2004 is not fully responsive to the prior Office Action because it was stated in the last office action that the prosecution of the case is closed. The applicant way not add more claims to an application to response to the Ex-Parte Quayle office action that was mailed on 09-14-04. Since the period for reply set forth in the prior Office action has expired, this application will become abandoned unless applicant corrects the deficiency and obtains an extension of time under 37 CFR 1.136(a).

The date on which the petition under 37 CFR 1.136(a) and the appropriate extension fee have been filed is the date for purposes of determining the period of extension and the corresponding amount of the fee. In no case may an applicant reply outside the SIX (6) MONTH statutory period or obtain an extension for more than FIVE (5) MONTHS beyond the date for reply set forth in an Office action. A fully responsive reply must be timely filed to avoid abandonment of this application.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Jean B. Jeanglaude whose telephone number is 571-

272-1804. The examiner can normally be reached on Monday - Friday 7:30 A. M. - 5:00 P.M..

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Michael Tokar can be reached on 571-272-1812. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Jean Bruner Jeanglaude

Jean Bruner Jeanglaude
Primary Examiner
February 11, 2005

PATENT APPLICATION FEE DETERMINATION RECORD
Effective December 8, 2004

2-17-05 RCE

Application or Docket Number: 10727801

CLAIMS AS FILED - PART I

	(Column 1)	(Column 2)
TOTAL CLAIMS		
FOR	NUMBER FILED	NUMBER EXTRA
TOTAL CHARGEABLE CLAIMS	65 minus ~~20~~ 65 =	* —
INDEPENDENT CLAIMS	12 minus ~~3~~ 12 =	* —
MULTIPLE DEPENDENT CLAIM PRESENT		☐

* If the difference in column 1 is less than zero, enter "0" in column 2

SMALL ENTITY TYPE ☐ OR OTHER THAN SMALL ENTITY

RATE	FEE		RATE	FEE
BASIC FEE	395.00	OR	BASIC FEE	790.00
XS 25=		OR	XS 50=	
X 100=		OR	X 200=	
+ 180=		OR	+ 360=	
TOTAL		OR	TOTAL	790

CLAIMS AS AMENDED - PART II

AMENDMENT A

2-17-05	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	* 63	Minus	** 65	= —
Independent	* 12	Minus	*** 12	= —
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

SMALL ENTITY OR OTHER THAN SMALL ENTITY

RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
X$25=		OR	X$50=	
X100=		OR	X200=	
+180=		OR	+360=	
TOTAL ADDIT. FEE	—	OR	TOTAL ADDIT. FEE	—

AMENDMENT B

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
X$25=		OR	X$50=	
X100=		OR	X200=	
+180=		OR	+360=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

AMENDMENT C

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
X$25=		OR	X$50=	
X100=		OR	X200=	
+180=		OR	+360=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20."
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3."
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

FORM PTO-875 (Rev. 10/03)

Patent and Trademark Office, U.S. DEPARTMENT OF COMMERCE

Unified Patents, Ex. 1002

Index of Claims

Application No.	Applicant(s)
10/727,801	MARPE ET AL.
Examiner	**Art Unit**
Jean B Jeanglaude	2819

Mark	Meaning	Mark	Meaning	Mark	Meaning	Mark	Meaning
√	Rejected	–	(Through numeral) Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

Claim Final	Claim Original	Date 09-09-04
	1	=
	2	=
	3	=
	4	=
	5	=
	6	=
	7	=
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Claim Final	Claim Original	Date
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Claim Final	Claim Original	Date
	101	
	102	
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U.S. Patent and Trademark Office

Part of Paper No. 09092004

Unified Patents, Ex. 1002

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CERTIFICATION OF MAILING OR TRANSMISSION

I hereby certify that this correspondence is being deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to the Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 or facsimile transmitted to the U.S. Patent and Trademark Office on the date shown below.

[signature] Signature — February 25, 2005 Date

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applic. No.	:	10/727,801 Confirmation No. 6855
Applicant	:	Detlef Marpe, et al.
Filed	:	December 4, 2003
Title	:	Method and Arrangement for Arithmetic Encoding and Decoding Binary States and a Corresponding Computer Program and a Corresponding Computer-readable Storage Medium
Group Art Unit	:	2819
Examiner	:	Jean Bruner Jeanglaude
Docket No.	:	S&ZFH030508
Customer No.	:	24131

RESPONSE TO NOTICE OF NON-COMPLIANT AMENDMENT

Mail Stop Amendment
Hon. Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

S i r :

Responsive to the Notice of Non-Compliant Amendment dated

February 18, 2005, kindly consider the following.

Remarks/Arguments begin on page 2 of this paper.

Remarks:

Reconsideration of the application is respectfully requested.

Applicants' would like to thank Examiner Jeanglaude for the courtesy shown to Applicants' representative in a series of telephone calls leading up to, including and after the Telephonic interview of February 8, 2005.

In the present case, Applicants received a first Office Action dated September 13, 2004, allowing all claims 1 - 24, but for the correction of certain informalities. The Office Action indicated that except for the formal matters, prosecution as to the merits was closed in accordance with the practice under Ex parte Quayle.

In response to the Office Action, Applicants addressed the formal matters and added new claims 25 - 65. An Advisory Action, dated February 2, 2005 was mailed to Applicants, in which new claims 25 - 65 were objected to. It was indicated in the Advisory Action that the proposed amendments would not be entered.

In response to the Advisory Action, Applicants' representative requested by telephone conversation with the Examiner that the Advisory Action be withdrawn and a Notice of Allowance be issued, as to claims 1 - 24, along with a notice of entry of the amendment in part, pursuant to MPEP §714.20(C), which states:

> "(C) In an application in which prosecution on the merits is closed, i.e., after the issuance of an Ex *Parte Quayle* action, where an amendment is presented curing the noted formal defect and adding one or more claims some or all of which are in the opinion of the examiner not patentable, or will require a further search, the amendment in such a case will be entered only as to the formal matter. Applicant has no right to have new claims considered or entered at this point in the prosecution." [emphasis in original]

During the telephone conversation, Examiner Jeanglaude pointed out additional informalities in Applicants' claims 14 and 15 that would need to be corrected prior to issuance of a notice of allowability on claims 1 - 24.

In a subsequent telephone conversation, it was discussed that Examiner Jeanglaude would issue the present Notice of Non-Compliant Amendment, which would restart the period for response and provide thirty (30) days for the Applicants to file a Request for Continuing Examination (RCE) with a Preliminary Amendment, so as to have all sixty-five claims entered and considered. On February 14, 2005, Applicants filed the agreed upon RCE with a Preliminary Amendment addressing the informalities raised in previously presented claims 14 and 15.

It is believed that the filing of the RCE and Preliminary Amendment in the present case, as was agreed between the Examiner and Applicants' representative, has addressed the issues raised in the present Notice of Non-Compliant Amendment, and that nothing further is needed from Applicants' at this time.

Because it is believed that the Notice of Non-Compliant Amendment restarted the time period for Applicants' response, Applicants' believe that no additional extension of time fees were necessary for the filing of the RCE on February 14, 2005. The Notice of Non-Compliant Amendment itself indicates that a new time period of the longer of one month or thirty days is provided to Applicants when, as in the present case, the Notice of Non-Compliant Amendment was issued based on an amendment filed in response to a Quayle action. However, Applicants' representative's deposit account was charged $900.00 for a further extension of time when the RCE was filed on February 14, 2005. Applicants' representative plans to file a separate paper requesting a refund for the fees charged for the extension of time.

As such, it is believed that the Preliminary Amendment filed in the present case addresses the issues raised in the Notice of Non-Compliant Amendment, and further puts claims 1 - 65 in

 Unified Patents, Ex. 1002

condition for allowance. Allowance of claims 1 - 65 is therefore, respectfully requested.

In the event that the Examiner should find any of the claims to be unpatentable, counsel would appreciate receiving a telephone call so that, if possible, patentable language can be worked out.

If an extension of time for this paper is required, petition for extension is herewith made.

Please charge any fees that might be due with respect to Sections 1.16 and 1.17 to the Deposit Account of Lerner and Greenberg, P.A., No. 12-1099.

Respectfully submitted,

For Applicants

Kerry P. Sisselman
Reg. No. 37,237

KPS:cgm

February 25, 2005

Lerner and Greenberg, P.A.
Post Office Box 2480
Hollywood, FL 33022-2480
Tel: (954) 925-1100
Fax: (954) 925-1101

 Unified Patents, Ex. 1002

PATENT APPLICATION FEE DETERMINATION RECORD
Effective December 8, 2004

2/1705 + RCE

Application or Docket Number: 10727801

CLAIMS AS FILED - PART I

	(Column 1)	(Column 2)
TOTAL CLAIMS		
FOR	NUMBER FILED	NUMBER EXTRA
TOTAL CHARGEABLE CLAIMS	65 minus 65 =	* —
INDEPENDENT CLAIMS	12 minus 12 =	* —
MULTIPLE DEPENDENT CLAIM PRESENT		☐

* If the difference in column 1 is less than zero, enter "0" in column 2

SMALL ENTITY TYPE ☐ RATE	FEE	OR	OTHER THAN SMALL ENTITY RATE	FEE
BASIC FEE	395.00	OR	BASIC FEE	790.00
XS 25 =		OR	XS 50 =	
X 100 =		OR	X 200 =	
+ 180 =		OR	+ 360 =	
TOTAL		OR	TOTAL	790

CLAIMS AS AMENDED - PART II

AMENDMENT A

2/1705	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	* 63	Minus	** 65	= —
Independent	* 12	Minus	*** 12	= —
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

SMALL ENTITY RATE	ADDITIONAL FEE	OR	OTHER THAN SMALL ENTITY RATE	ADDITIONAL FEE
X$ 25 =		OR	X$ 50 =	
X 100 =		OR	X 200 =	
+ 180 =		OR	+ 360 =	
TOTAL ADDIT. FEE	—	OR	TOTAL ADDIT. FEE	—

AMENDMENT B

2/28/05	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	* 63	Minus	** 65	=
Independent	* 12	Minus	*** 12	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

SMALL ENTITY RATE	ADDITIONAL FEE	OR	OTHER THAN SMALL ENTITY RATE	ADDITIONAL FEE
X$ 25 =		OR	X$ 50 =	
X 100 =		OR	X 200 =	
+ 180 =		OR	+ 360 =	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

AMENDMENT C

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

SMALL ENTITY RATE	ADDITIONAL FEE	OR	OTHER THAN SMALL ENTITY RATE	ADDITIONAL FEE
X$ 25 =		OR	X$ 50 =	
X 100 =		OR	X 200 =	
+ 180 =		OR	+ 360 =	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20."
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3."
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

PTO-875 (Rev. 10/03)

Patent and Trademark Office, U.S. DEPARTMENT OF COMMERCE

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OIPE JCS FEB 2 8 2005 PATENT & TRADEMARK OFFICE

DEP&REF RM# 807

DIVISION

2005 MAR -3 AM 9:14

Attorney's Docket No: S&ZFH030508

I hereby certify that this correspondence is being deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450, on the date indicated below.

By: ______________________ Date: February 25, 2005

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applic. No.	:	10/727,801	Confirmation No.: 6855
Inventor	:	Detlef Marpe, et al.	
Filed	:	December 4, 2003	
TC/A.U.	:	2819	
Examiner	:	Jean Bruner Jeanglaude	
Customer No.:		**24131**	

Hon. Commissioner for Patents
Alexandria, VA 22313-1450

Adjustment date: 04/15/2005 SDIRETA2
0 /2005 MWOLDGE1 00000050 121099 10727801
0 :1253 900.00 CR

Adjustment Date: 04/15/2005 SDIRETA2
0 /2005 MWOLDGE1 00000050 121099 10727801
0 :1253 900.00 CR

REQUEST FOR REFUND

Sir:

For the reasons set forth below, applicants herewith request a refund in the amount of $900.00 which was charged to counsel's deposit account on February 18, 2005.

- Applicants submitted an amendment in the above-identified application on December 14, 2004 as a response to the Office action of September 14, 2004.
- Applicants then received an *Advisory Action* and responded thereto by filing a *Preliminary Amendment* together with an RCE on February 14, 2005.
- However, as acknowledged by the Examiner in an interview held with counsel on February 8, 2005, the *Advisory Action* was improper and the Examiner agreed to withdraw the *Advisory Action* and issue a *Notice of Non-Compliant Amendment*, which restarts the period for reply and grants applicants thirty (30) days for taking action.

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In view of the foregoing, applicants respectfully request that the amount of $900.00 be credited to counsel's Deposit Account No. 12-1099 of Lerner and Greenberg, P.A., since no extension fee was in fact due.

Applicants have also submitted a *Response to the Notice of Non-Compliant Amendment* on this date in which the events leading to this request for refund are outlined in detail. Applicants enclose a copy of that response.

Respectfully submitted,

Laurence A. Greenberg (29,308)

Date: February 25, 2005
LERNER AND GREENBERG, P.A.
Post Office Box 2480
Hollywood, Florida 33022-2480
Tel: (954) 925-1100
Fax: (954) 925-1101
/bb

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Search | Clear | Interrupt

Search History

DATE: Friday, March 04, 2005 Printable Copy Create Case

Set Name side by side	Query	Hit Count	Set Name result set
	DB=PGPB,USPT,USOC,EPAB,JPAB,DWPI,TDBD; PLUR=YES; OP=OR		
L25	L24 and 123	17	L25
L24	341/$.ccls.	37167	L24
L23	L22 and 110 and 19 and 18	79	L23
L22	(arithmetic with (cod$3 or encod$3)) same 13	888	L22
L21	4891643.pn. or 6075471.pn.	4	L21
L20	5592162.pn.	2	L20
L19	L16 and (interval$ same (split$ or divid$3) same 110 same 15)	1	L19
L18	L16 and (interval$ same (split$ or divid$3) same 110 same 15)	1	L18
L17	L16 and (interval$ same separat$ same (split$ or divid$3) same 110 same 15)	0	L17
L16	L15 and decod$3	560	L16
L15	113 and 112 and 111 and 110 and 19 and 18 and 17 and 16 and 15 and 14 and 13 and 12 and 11	612	L15
L14	L13 same 112 same 111 same 110 same 19 same 18 same 17 same 16 same 15 same 14 same 13 same 12 same 11	0	L14

L13	part$	8739009	L13
L12	division or divid$3	2625938	L12
L11	access$	1736147	L11
L10	quantiz$	63996	L10
L9	interval$	1317912	L9
L8	map$	405473	L8
L7	stat$3	7980790	L7
L6	symbol$1	365468	L6
L5	index or indic$	4877682	L5
L4	estimat$3 or evaluat$3	1013180	L4
L3	probability	191458	L3
L2	binary or bit$1	993116	L2
L1	encod$3 or cod$3	2677746	L1

END OF SEARCH HISTORY

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

NOTICE OF ALLOWANCE AND FEE(S) DUE

24131 7590 03/23/2005

LERNER AND GREENBERG, PA
P O BOX 2480
HOLLYWOOD, FL 33022-2480

EXAMINER	
JEANGLAUDE, JEAN BRUNER	
ART UNIT	PAPER NUMBER
2819	

DATE MAILED: 03/23/2005

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/727,801	12/04/2003	Detlef Marpe	S&ZFH030508	6855

TITLE OF INVENTION: METHOD AND ARRANGEMENT FOR ARITHMETIC ENCODING AND DECODING BINARY STATES AND A CORRESPONDING COMPUTER PROGRAM AND A CORRESPONDING COMPUTER-READABLE STORAGE MEDIUM

APPLN. TYPE	SMALL ENTITY	ISSUE FEE	PUBLICATION FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	$1400	$300	$1700	06/23/2005

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE REFLECTS A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE APPLIED IN THIS APPLICATION. THE PTOL-85B (OR AN EQUIVALENT) MUST BE RETURNED WITHIN THIS PERIOD EVEN IF NO FEE IS DUE OR THE APPLICATION WILL BE REGARDED AS ABANDONED.

HOW TO REPLY TO THIS NOTICE:

I. Review the SMALL ENTITY status shown above.

If the SMALL ENTITY is shown as YES, verify your current SMALL ENTITY status:

A. If the status is the same, pay the TOTAL FEE(S) DUE shown above.

B. If the status above is to be removed, check box 5b on Part B - Fee(s) Transmittal and pay the PUBLICATION FEE (if required) and twice the amount of the ISSUE FEE shown above, or

If the SMALL ENTITY is shown as NO:

A. Pay TOTAL FEE(S) DUE shown above, or

B. If applicant claimed SMALL ENTITY status before, or is now claiming SMALL ENTITY status, check box 5a on Part B - Fee(s) Transmittal and pay the PUBLICATION FEE (if required) and 1/2 the ISSUE FEE shown above.

II. PART B - FEE(S) TRANSMITTAL should be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). Even if the fee(s) have already been paid, Part B - Fee(s) Transmittal should be completed and returned. If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
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P.O. Box 1450
Alexandria, Virginia 22313-1450

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INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

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24131 7590 03/23/2005

LERNER AND GREENBERG, PA
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Certificate of Mailing or Transmission
I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (703) 746-4000, on the date indicated below.

(Depositor's name)

(Signature)

(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/727,801	12/04/2003	Detlef Marpe	S&ZFH030508	6855

TITLE OF INVENTION: METHOD AND ARRANGEMENT FOR ARITHMETIC ENCODING AND DECODING BINARY STATES AND A CORRESPONDING COMPUTER PROGRAM AND A CORRESPONDING COMPUTER-READABLE STORAGE MEDIUM

APPLN. TYPE	SMALL ENTITY	ISSUE FEE	PUBLICATION FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	$1400	$300	$1700	06/23/2005

EXAMINER	ART UNIT	CLASS-SUBCLASS
JEANGLAUDE, JEAN BRUNER	2819	341-106000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
   - ☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
   - ☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
   (1) the names of up to 3 registered patent attorneys or agents OR, alternatively,
   (2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.
   1 ______
   2 ______
   3 ______

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE

(B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ☐ Individual ☐ Corporation or other private group entity ☐ Government

4a. The following fee(s) are enclosed:
- ☐ Issue Fee
- ☐ Publication Fee (No small entity discount permitted)
- ☐ Advance Order - # of Copies ______

4b. Payment of Fee(s):
- ☐ A check in the amount of the fee(s) is enclosed.
- ☐ Payment by credit card. Form PTO-2038 is attached.
- ☐ The Director is hereby authorized by charge the required fee(s), or credit any overpayment, to Deposit Account Number ______ (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)
- ☐ a. Applicant claims SMALL ENTITY status. See 37 CFR 1.27.
- ☐ b. Applicant is no longer claiming SMALL ENTITY status. See 37 CFR 1.27(g)(2).

The Director of the USPTO is requested to apply the Issue Fee and Publication Fee (if any) or to re-apply any previously paid issue fee to the application identified above.
NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

Authorized Signature ______ Date ______

Typed or printed name ______ Registration No. ______

This collection of information is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/727,801	12/04/2003	Detlef Marpe	S&ZFH030508	6855

24131 7590 03/23/2005

LERNER AND GREENBERG, PA
P O BOX 2480
HOLLYWOOD, FL 33022-2480

EXAMINER	
JEANGLAUDE, JEAN BRUNER	
ART UNIT	**PAPER NUMBER**
2819	

DATE MAILED: 03/23/2005

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment to date is 0 day(s). If the issue fee is paid on the date that is three months after the mailing date of this notice and the patent issues on the Tuesday before the date that is 28 weeks (six and a half months) after the mailing date of this notice, the Patent Term Adjustment will be 0 day(s).

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571) 272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at (703) 305-8283.

PTOL-85 (Rev. 12/04) Approved for use through 04/30/2007.

Notice of Allowability	Application No. 10/727,801	Applicant(s) MARPE ET AL.	
	Examiner Jean B. Jeanglaude	**Art Unit** 2819	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to RCE filed on 2-17-05.
2. ☒ The allowed claim(s) is/are 1-63.
3. ☒ The drawings filed on 04 December 2003 are accepted by the Examiner.
4. ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
   a) ☐ All b) ☐ Some* c) ☒ None of the:
   1. ☒ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.
6. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   (a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached
   1) ☐ hereto or 2) ☐ to Paper No./Mail Date _____.
   (b) ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
7. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☒ Notice of References Cited (PTO-892)
2. ☐ Notice of Draftperson's Patent Drawing Review (PTO-948)
3. ☒ Information Disclosure Statements (PTO-1449 or PTO/SB/08), Paper No./Mail Date 10-06-04;2-17-05
4. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
5. ☐ Notice of Informal Patent Application (PTO-152)
6. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____ .
7. ☐ Examiner's Amendment/Comment
8. ☒ Examiner's Statement of Reasons for Allowance
9. ☐ Other _____.

Jean Bruner Jeanglaude

Jean Bruner Jeanglaude
Primary Examiner

Reasons For Allowance

Claims 1 – 63 are allowable.

1. The following is an examiner's statement of reasons for allowance: in combination with other limitations of the claims the prior arts made of record fail to suggest a system and method for an arithmetic encoding and decoding of binary states is may be performed, wherein in a first step a presetable value range for the specification of the interval width R is separated in K representative interval widths {Q_i,..., Q_k}, a presetable value range for the specification of the probabilities is separated in N representative probability states {P_1,..., P_N} and allocation regulations are given, which allocate one Q_K (1 ≤ k ≤ K) to every interval width R and one Pn (1 ≤ n ≤ N) to every probability, and wherein in a second step the encoding or decoding of the binary states take place by performing the calculation of the new interval width to be derived in the encoding or decoding process, respectively, using a representative interval width Q_K (1 ≤ k ≤ K) and a representative probability state Pn (1 ≤ n ≤ N) by arithmetic operations other than multiplication and division, wherein the representative interval width QK is determined by the basic basis interval of the width R and the representative probability state Pn is determined by the probability estimation underlying the symbol to be encoded or to be decoded according to the giving allocation regulations. Moreover, in combination with other limitations of the claims the prior arts made of record fail to suggest a system and method that comprise a means for mapping a current interval width to a quantization index from a plurality of representative quantization indices; and means for performing an interval separation by

accessing an interval division table using the quantization index and the probability index to obtain a partial interval width value.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Conclusion

2. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. (See PTO-892).

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Jean B. Jeanglaude whose telephone number is 571-272-1804. The examiner can normally be reached on Monday - Friday 7:30 A. M. - 5:00 P.M..

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Michael Tokar can be reached on 571-272-1812. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Jean Bruner Jeanglaude

Jean Bruner Jeanglaude
Primary Examiner
March 4, 2005

Unified Patents, Ex. 1002

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OCT 06 2004
PATENT & TRADEMARK OFFICE

FORM PTO-1449 (SUBSTITUTE) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE INFORMATION DISCLOSURE STATEMENT BY APPLICANT (37 CFR 1.98(b))	Attorney Docket No.: S&ZFH030508 Applic. No. 10/727,801 Applicant: Detlef Marpe, et al. Filing Date: December 4, 2003 Group Art Unit: 2819

OTHER DOCUMENTS (Including Author, Title, Date, Pertinent Pages, etc.)

JBJZ		Ref 1.01: **Title:** Draft ITU-T Recommendation and Final Draft International Standard Joint Video Specification (ITU-T Rec. H.264I ISO/IEC 14496-10 AVC). **From:** Joint Video Team (JVT) of ISO/IEC MPEG & ITU-T VCEG (ISO/IEC JTC1/SC29/WG11 and ITU-T SG16 Q.6). **Pages: 1-250.** 7-14 March 2003.
JBJZ		Ref 1.02: **Title:** Overview of the H.264/AVC Video Coding Standard. **Author:** Thomas Wiegand, Gary J. Sullivan, Senior Member, IEEE, Gisele Bjontegaard, and Ajay Luthra, Senior Member, IEEE. **Pages: 560-576**, Vol 13, No 7, July 2003.
JBJZ		Ref 1.03: **Title:** Information Technology-Generic Coding Moving Pictures and Associated Audio Information: Video. **From:** International Standard 13818-2 Recommendation ITU-T H.26. **Pages: 1-224.** (no date)
JBJZ		Ref 1.04: **Title:** Draft Text of Recommendation H.263 Version 2 ("H.263+") for Decision. **From:** International Telecommunication Union. **Pages: 1-143.** 1997-2000 (no month)
JBJZ		Ref 1.05: **Title:** Information Technology-Coding of Audio Visual Objects-Part 2: Visual. **From:** International Organization for Standardization Organization International Normalization ISO/IEC JTC1/SC29/WG 11 Coding of Moving Picture and Audio. **Pages: 1-526.** July 2001
JBJZ		Ref 1.06: **Title:** DCT Coding for Motion Video Storage Using Adaptive Arithmetic Coding. **Author:** C.A. Gonzalez, L. Allman, T. McCarthy, P. Wendt. **Pages: 145-154**, 1990 (no month)
JBJZ		Ref 1.07: **Title:** Adaptive Codes for H.26L. **From:** ITU - Telecommunications Standardization Sector. **Pages: 1-7** 9-12 Jan. 2001
JBJZ		Ref 1.08: **Title:** Further Results for CABAC Entropy Coding Scheme. **From:** ITU -Telecommunications Standardization Sector. **Pages: 1-8.** 2-4 April 2001

Unified Patents, Ex. 1002

JBJV			Ref 1.09: **Title:** Improved CABAC. **From:** Joint Video Team (JVT) of ISO/IEC MPEG & ITU-T VCEG (ISO/IEC JTC1/SC29/WG11 and ITU-T SG16 Q.6). **Pages: 1-6.** Jan 29-Feb 1 2002
			Ref 1.10: **Title:** New Results in Improved CABAC. **From:** Joint Video Team (JVT) of ISO/IEC MPEG & ITU-T VCEG (ISO/IEC JTC1/SC29/WG11 and ITU-T SG16 Q.6). **Pages: 1-12.** March 2002
			Ref 1.11: **Title:** Improved CABAC. **From:** ITU-Telecommunications Standardization Sector. **Pages: 1-9.** 4-6 Dec 2001
			Ref 1.12: **Title:** Fast Arithmetic Coding for CABAC. **From:** Joint Video Team (JVT) of ISO/IEC MPEG & ITU-T VCEG (ISO/IEC JTC1/SC29/WG11 and ITU-T SG16 Q.6). **Pages: 1-11.** 1995 (no month)
			Ref 1.13: **Title:** CABAC and Slices. **From:** Joint Video Team (JVT) of ISO/IEC MPEG & ITU-T VCEG (ISO/IEC JTC1/SC29/WG11 and ITU-T SG16 Q.6). **Pages: 1-17.** July 2002
			Ref 1.14: **Title:** Analysis and Simplification of Intra Prediction. **From:** Joint Video Team (JVT) of ISO/IEC MPEG & ITU-T VCEG (ISO/IEC JTC1/SC29/WG11 and ITU-T SG16 Q.6). July 2002
			Ref 1.15: **Title:** Proposed Cleanup Changes for CABAC. **From:** Joint Video Team (JVT) of ISO/IEC MPEG & ITU-T VCEG (ISO/IEC JTC1/SC29/WG11 and ITU-T SG16 Q.6). **Pages: 1-7.** Oct 2002
			Ref 1.16: **Title:** CABAC Cleanup and Complexity Reduction. **From:** Joint Video Team (JVT) of ISO/IEC MPEG & ITU-T VCEG (ISO/IEC JTC1/SC29/WG11 and ITU-T SG16 Q.6). **Pages: 1-20.** Oct 2002
			Ref 1.17: **Title:** Final CABAC Cleanup. **From:** Joint Video Team (JVT) of ISO/IEC MPEG & ITU-T VCEG (ISO/IEC JTC1/SC29/WG11 and ITU-T SG16 Q.6). **Pages: 1-24,** Dec. 2002.
			Ref 1.18: **Title:** Very Low Bit-Rate Video Coding Using Wavelet-Based Techniques. **Author:** Detlev Marpe and Hans L. Cycon, Vol 9, No. 1, Feb. 1999 **Pages: 85-94**
			Ref 1.19: **Title:** Wavelet-Based Very Low Bit-Rate Video Coding Using Image Warping and Overlapped Block Motion Compensation. **Author:** G. Heising, D. Marpe, H.L. Cycon and A.P. Petukhov. **Pages: 93-101**, April 2001
			Ref 1.20: **Title:** Motion-Compensated 3-D Subband Coding of Video. **Author:** Seung-Jong Choi and John W. Woods, Fellow IEEE. **Pages: 155-167**, Vol 8, No 2, February 1999.
			Ref 1.21: **Title:** A New Fast and Efficient Image Codec Based on Set Partitioning in Hierarchical Trees*. **Author:** Amir Said (Faculty of Electrical Engineering) and William A. Pearlman (Department of Electrical, Computer, and Systems Engineering Renesselar Polytechnic Institute). **Pages: 1-15.** May 1993.
JBJV			Ref 1.22: **Title:** Efficient Pre-Coding Techniques for Wavelet-Based Image Compression. **Author:** Detlev Marpe & Hans L. Cycon. **Pages:**

			45-51. (No date)
JBJL			Ref 1.23: **Title:** Universal Modeling and Coding. **Author:** Jorma Rissanen and Glen G. Langdon, Jr., Senior Member, IEEE. **Pages: 12-23**, Vol 27, No 1, January 1981.
			Ref 1.24: **Title:** Universal Coding Information, Prediction, and Estimation. **Author:** Jorma Rissanen, Vol 30, No 4 July **Pages: 629-636**, 1984.
			Ref 1.27: **Title:** Applications of Universal Context Modeling to Lossless Compression of Grey-Scale Images. **Author:** Marcelo J. Weinberger, Member, IEEE, Jorma J. Rissanen, Senior Member, IEEE, and Ronald B. Arps. **Pages: 575-586**, Vol 5, No 4, April 1996.
			Ref 1.29: **Title:** A Compression Method for Clustered Bit-Vectors. **Author:** Jukka Teuhola (Department of Computer Science, University of Turka). **Application: XP-001000934.** OCT 1978
			Ref 1.30: **Title:** Optimal Source Codes for Geometrically Distributed Integer Alphabets. **Author:** Robert G. Gallager, fellow, IEEE, David C. Vanvoorhis, member, IEEE. **Pages:** 228-230, March 1975.
			Ref 1.32: **Title:** An Overview of the Basic Principles of the Q-Coder Adaptive Binary Arithmetic Coder. **Author:** W.B. Pennebaker, J.L. Mitchell, G.G. Langdon, Jr., and R.B. Arps, Vol 32, No 6, NOV 1988. **Pages: 717-726.**
			Ref 1.31: **Title:** A Context Modeling Algorithm and its Application in Video Compression. **Author:** Marta Mrak, Detlev Marpe, and Thomas Wiegand. (No date)
			Ref 1.33: **Title:** A Muliplication-Free Multialphabet Arithmetic Code. **Author:** Jorma Rissanen and K.M. Mohiuddin, Vol 37, No 2, ~~1989~~ **Pages: 93-98.**, Feb 1989
			Ref 1.34: **Title:** Practical Implementations of Arithmetic Code. **Author:** Paul G. Howard and Jeffrey Scott Vitter. **Pages: 1-30.** OCT 16-18, 1991
			Ref 1.35: **Title:** Sample Data Coding. **From:** Chapter 12. **Pages: 474-484.** (No date)
			Ref 1.37: **Title:** Arithmetic Code Revisited. **Author:** Alistair Moffat (The University of Melbourne), Radford M. Neal (University of Toronto), and Ian H. Witten (zthe University of Waikato). Vol 16, No 3, July 1998 **Pages: 256-294.**
JBJL			Ref 1.38: **Title:** Rate-Constrained Coder Control and Comparison of Video Coding Standards. **Author:** IEEE Transactions on Circuits and Systems for Video Technology, Vol. 13, No. 7, July 2003. Thomas Wiegand, Heiko Schwarz, Anthony Joch, Faouzi Kossentini, Senior Members, IEEE, and Gary J. Sullivan, Senior Member, IEEE. Vol 13, No 7, July 2003 **Pages: 689-703.**

Unified Patents, Ex. 1002

JBJL			Ref 2.1: **Title:** Draft ITU-T Recommendation and Final Draft International Standard of Joint Video Specification (ITU-T rec. H.264 I ISO/IEC 14496-10 AVC). **From:** Joint Video Team (JVT) of SO/IEC MPEG & ITU-T VCEG (ISO/IEC JTC1/SC29/WG11 and ITU-T SG 16 Q.6). **Pages 1-249.** 7-14 March 2003,
			Ref 2.03x: **Title:** Line Transmission of Non-Telephone Signals / Video Codec for Audiovisual Services AT p x 64 kbit/s. **From:** International Telecommunication Union H.261. **Pages: 1-25**, June 1994.
			Ref 2.06x: **Title:** H.264/AVC Over IP. **From:** Stephan Wenger. **Pages: 645-656.** Vol 13, No 7, July 2003.
			Ref 2.07: **Title:** H.264/AVC in Wireless Environments. **Author:** Thomas Stockhammer, Miska M. Hannuksela, and Thomas Wiegand. **Pages: 657-673.** Vol 13, No 7, July 2003
			Ref 2.08: **Title:** Motion-and Aliasing-Compensated Prediction for Hybrid Video Coding. **Author:** Thomas Wedi and Hand Georg Musmann. **Pages: 577-586**, Vol 13, No 7, July 2003
			Ref 2.9: **Title:** Long-Term Memory Motion-Compensated Prediction. **Author:** Thomas Wiegand, Xiaozheng Zhang, and Bernd Girod, Fellow, IEEE. **Pages: 70-84.** Vol 9, No 1, Feb. 1999.
			Ref 2.11: **Title:** A Locally Optimal Design Algorithm for Block-Based Multi-Hypothesis Motion-Compensated Prediction. **Author:** Markus Flierl, Thomas Wiegand, and Bernd Girod Telecommunications Laboratory University of Erlangen-Nürnberg, Germany. **Pages: 1-10**, March 1998.
			Ref 2.12: **Title:** Generalized B Pictures and the Draft H.264/AVC Video-Compression Standard. **Author:** Markus Flierl, Student Member, IEEE, and Bernd Girod, Fellow, IEEE. **Pages: 587-597**, Vol 13, No 7, July 2003.
			Ref 2.13: **Title:** Rate-Constrained Coder Control and Compression of Video Coding Standards. **From:** Thomas Wiegand, Heiko Schwarz, Anthony Joch, Faouzi Kossentini, Senior Member, IEEE, and Gary J. Sullivan, Senior Member, IEEE. **Pages: 688-703**, Vol 13, No 7, July 2003
			Ref 2.14: **Title:** H.264/AVC Over IP. **Author:** Stephan Wenger. **Pages: 645-656.** Vol 13, No 7, July 2003
			Ref 2.15: **Title:** The SP-and Si-Frames Design for H.264/AVC. **Author:** Marta Karcewicz and Ragip Kurceren, Member, IEEE. **Pages: 637-644**, Vol. 13, No 7, July 2003.
			Ref 2.16: **Title:** Context-Based Adaptive Binary Arithmetic Coding in the H/264/AVC Video Compression Standard. **Author:** Detlev Marpe, Member, IEEE, Heiko Schwarz, and Thomas Wiegand. **Pages: 620-636**, Vol 13, No 7, July 2003
JBJL			Ref 2.17: **Title:** Low-Complexity Transform and Quantization in

JBJB		H.264/AVC. **From:** Henrique S. Malvar, Fellow, IEEE, Antti Hallapuro, Marta Karczewicz, and Louis Kerofsky, Member, IEEE. **Pages: 598-603**, Vol 13, No 7, July 2003
		Ref 2.18: **Title:** Adaptive Deblocking Filter. **Author:** Peter List, Anthony Joch, Jani Lainema, Gisle Bjontegaard, and Marta Karczewicz. **Pages: 614-619**, Vol 13, No 7, July 2003.
		Ref 2.19: **Title:** A Generalized Hypothetical Reference Decoder for H.264/AVC. **Author:** Jordi Ribas-Cobrera, Member, IEEE, Philip A. Chou, Senior Member, IEEE, and Shankar L. Regunathan. **Pages: 674-687**, Vol 13, No 7, July 2003.
		Ref A: **Title:** Draft ITU-T Recommendation and Final Draft International Standard of Joint Video Specification (ITU-T Rec. zh.264 I ISO/IEC 14496-10 AVC). **From:** Joint Video Team (JVT) of ISO/IEC MPEG & ITU-T VCEG (ISO.IEC JTC1/SC29/WG11 and ITU-T SG16 Q.6). **Pages: 1-253**, 23-27 May 2003.
		Ref B: **Title:** A Highly Efficient Multiplication-Free Binary Arithmetic Coder and its Application in Video Coding. **Author:** Detlev Marpe and Thomas Wiegand. **Pages: 1-4**, ~~2003~~. 14-17 Sept 2003.
		Ref C: **Title:** Proposed Editorial Changes and Cleanup of CABAC. **From:** Joint Video Team (JVT) of ISO/IEC MPEG & ITU-T VCEG (ISO.IEC JTC1/SC29/WG11 and ITU-T SG16 Q.6). **Pages: 1-10**, 22-26 July 2002,
		Ref D: **Title:** Study of Final Committee Draft of Joint Video Specification (ITU-T Rec. H.264 I ISO/IEC 14496-10 AVC). **From:** Joint Video Team (JVT) of ISO/IEC MPEG & ITU-T VCEG (ISO.IEC JTC1/SC29/WG11 and ITU-T SG16 Q.6). **Pages: 1-239.** 5-13 Dec 2002.
		Ref E: **Title:** Study of Final Committee Draft and Joint Video Specification (ITU-T Rec. H.264 I ISO/IEC 14496-10 AVC). **From:** Joint Video Team (JVT) of ISO/IEC MPEG & ITU-T VCEG (ISO.IEC JTC1/SC29/WG11 and ITU-T SG16 Q.6). **Pages: 1-227**, 5-13 Dec. 2002
JBJB		Ref F: **Title:** CABAC and Slices. **From:** Joint Video Team (JVT) of ISO/IEC MPEG & ITU-T VCEG (ISO.IEC JTC1/SC29/WG11 and ITU-T SG16 Q.6). **Pages: 1-17.** 22-26 July 2002.

EXAMINER Jean Bruner Jeanglaude	DATE CONSIDERED 3/04/05

EXAMINER: Initial if citation considered, whether or not citation is in conformance with MPEP 609; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

FORM PTO-1449 (SUBSTITUTE) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE INFORMATION DISCLOSURE STATEMENT BY APPLICANT (37 CFR 1.98(b))	Attorney Docket No.: S&ZFH030508 Applic. No. 10/727,801 Applicant Detlef Marpe, et al. Filing Date Group Art Unit

Unified Patents, Ex. 1002

	December 4, 2003 2819

OIPE JC164 FEB 01 2005 PATENT & TRADEMARK OFFICE

FORM PTO-1449 (SUBSTITUTE)

U.S. DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE

INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(37 CFR 1.98(b))

Attorney Docket No.:	Applic. No.
S&ZFH030508	10/727,801
Applicant	
Detlef Marpe et al.	
Filing Date	Group Art Unit
December 4, 2003	2819

U.S. PATENT DOCUMENTS

EXAMINER INITIALS		PATENT NO.	DATE	PATENTEE	CLASS	SUB CLASS	FILING DATE
JBJZ	A	5,592,162	01/07/97	Printz et al.	—	—	—
	B						
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FOREIGN PATENT DOCUMENT

		DOCUMENT NO.	DATE	COUNTRY	CLASS	SUB CLASS	TRANSL. YES	NO
	J							
	K							
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	M							
	N							

OTHER DOCUMENTS (Including Author, Title, Date, Pertinent Pages, etc.)

JBJZ	O	Dan Chevion et al.: "High Efficiency, Multiplication Free Approximation of Arithmetic Coding", *IEEE 1991, Order No. TH0373-1/91/0000/0043/$01.00, pp. 43-52* 8-11 April 1991
JBJZ	P	David S. Taubman et al.: "JPEG2000 Image Compression Fundamentals, Standards and Practice", *Kluwer Academic Publishers, Boston, 2002, pp. 65-77* (1 August 2002)

EXAMINER	DATE CONSIDERED
Jean Bruner Jeanglaude	3/4/05

EXAMINER: Initial if citation considered, whether or not citation is in conformance with MPEP 609; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

Unified Patents, Ex. 1002

Notice of References Cited

Application/Control No.	10/727,801
Applicant(s)/Patent Under Reexamination	MARPE ET AL.
Examiner	Jean B. Jeanglaude
Art Unit	2819
	Page 1 of 1

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	C	US-5,475,388	12-1995	Gormish et al.	341/107
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*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N					
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*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	Marpe et al. (PUb. No. 2005/0012648), "Apparatus and methods For entropy-encoding or entropy-decoding using an initializaiton of context Variables", filed on July 17, 2003.
	V	Gavrilescu et al. (Pub. No. 2005/0027521), Embedded Multiple Description Scalar Quantizers For Progressive Image Transmission", filed on March 30, 2004.
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Issue Classification	Application/Control No.	Applicant(s)/Patent under Reexamination	
	10/727,801	MARPE ET AL.	
	Examiner	Art Unit	
	Jean B. Jeanglaude	2819	

ISSUE CLASSIFICATION

ORIGINAL		CROSS REFERENCE(S)							
CLASS	SUBCLASS	CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)						
341	106	341	107						

INTERNATIONAL CLASSIFICATION				
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N/A
(Assistant Examiner) (Date)

Jean Bruner Jeanglaude
Jean Bruner Jeanglaude 03-04-05
(Primary Examiner) (Date)

TBell 3-18-05
(Legal Instruments Examiner) (Date)

Total Claims Allowed: 63

O.G. Print Claim(s)	O.G. Print Fig.
1	1

☒ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
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Search Notes

Application/Control No.	Applicant(s)/Patent under Reexamination
10/727,801	MARPE ET AL.
Examiner	**Art Unit**
Jean B. Jeanglaude	2819

SEARCHED

Class	Subclass	Date	Examiner
Search	updated	3/4/2005	JBJG
382	239	3/4/2005	JBJG

INTERFERENCE SEARCHED

Class	Subclass	Date	Examiner
341	**106**	3/4/2005	**JBJG**
341	107	3/4/2005	JBJG

SEARCH NOTES (INCLUDING SEARCH STRATEGY)

	DATE	EXMR
WEST	3/4/2005	JBJG

Index of Claims	Application/Control No.	Applicant(s)/Patent under Reexamination
	10/727,801	MARPE ET AL.
	Examiner	**Art Unit**
	Jean B. Jeanglaude	2819

√	Rejected	–	(Through numeral) Cancelled	N	Non-Elected	A	Appeal
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BIBDATASHEET

Bib Data Sheet

CONFIRMATION NO. 6855

SERIAL NUMBER	FILING DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
10/727,801	12/04/2003 RULE	341	2819	S&ZFH030508

APPLICANTS

Detlef Marpe, Berlin, GERMANY;

Thomas Wiegand, Berlin, GERMANY;

** CONTINUING DATA ************************ Yes [initials]

This application is a CON of PCT/EP03/04654 05/02/2003

** FOREIGN APPLICATIONS ******************** Yes [initials]

GERMANY 102 20 962.6 05/02/2002

IF REQUIRED, FOREIGN FILING LICENSE GRANTED
** 03/03/2004

	STATE OR COUNTRY	SHEETS DRAWING	TOTAL CLAIMS	INDEPENDENT CLAIMS
Foreign Priority claimed ☑ yes ☐ no 35 USC 119 (a-d) conditions met ☐ yes ☑ no ☐ Met after Allowance Verified and Acknowledged [signature] Examiner's Signature [initials] Initials	GERMANY	4	24	~~4~~ 12

ADDRESS
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TITLE
Method and arrangement for arithmetic encoding and decoding binary states and a corresponding computer program and a corresponding computer-readable storage medium

FILING FEE RECEIVED		
1058	FEES: Authority has been given in Paper No. _________ to charge/credit DEPOSIT ACCOUNT No. _________ for following:	☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other ____________ ☐ Credit

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Docket No.: S&ZFH030508

I hereby certify that this correspondence is being deposited with the United States Postal Service as First Class Mail in an envelope addressed to the Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on the date indicated below.

By: ________________ Date: May 3, 2005

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applic. No.	: 10/727,801	Confirmation No: 6855
Applicant	: Detlef Marpe, et al.	
Filed	: December 4, 2003	
Art Unit	: 2819	
Examiner	: Jean Bruner Jeanglaude	
Title	: Method and Arrangement for Arithmetic Encoding and Decoding Binary States and a Corresponding Computer Program and a Corresponding Computer-Readable Storage Medium	
Docket No.	: S&ZFH030508	
Customer No.	: 24131	

CLAIM FOR PRIORITY

Commissioner for Patents,
P.O. Box 1450, Alexandria, VA 22313-1450

Sir:

Claim is hereby made for a right of priority under Title 35, U.S. Code, Section 119, based upon the German Patent Application 102 20 962.6, filed May 2, 2002.

A certified copy of the above-mentioned foreign patent application is being submitted herewith.

Respectfully submitted,

Laurence A. Greenberg
Reg. No. 29,308

Date: May 3, 2005
Lerner and Greenberg, P.A.
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Unified Patents, Ex. 1002

BUNDESREPUBLIK DEUTSCHLAND

Prioritätsbescheinigung über die Einreichung einer Patentanmeldung

Aktenzeichen:	102 20 962.6
Anmeldetag:	2. Mai 2002
Anmelder/Inhaber:	Heinrich Hertz Institut für Nachrichtentechnik Berlin GmbH, 10587 Berlin/DE
Bezeichnung:	Verfahren und Anordnung zur tabellengestützten binären arithmetischen Enkodierung und Dekodierung sowie ein entsprechendes Computerprogrammprodukt und ein entsprechendes computerlesbares Speichermedium
IPC:	H 03 M, G 06 T

Die angehefteten Stücke sind eine richtige und genaue Wiedergabe der ursprünglichen Unterlagen dieser Patentanmeldung.

München, den 13. April 2005
Deutsches Patent- und Markenamt
Der Präsident
Im Auftrag

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PRIORITY DOCUMENT

Sieck

A 9161
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Unified Patents, Ex. 1002

Verfahren und Anordnung zur tabellengestützten binären arithmetischen Enkodierung und Dekodierung sowie ein entsprechendes Computerprogrammprodukt und ein entsprechendes computerlesbares Speichermedium

Beschreibung

Die Erfindung betrifft ein Verfahren und eine Anordnung zur tabellengestützten binären arithmetischen Enkodierung und Dekodierung sowie ein entsprechendes Computerprogrammprodukt und ein entsprechendes computerlesbares Speichermedium, welche insbesondere bei der digitalen Datenkompression eingesetzt werden können.

Die vorliegende Erfindung beschreibt ein neues effizientes Verfahren zur binären arithmetischen Kodierung. Der Bedarf nach binärer arithmetischer Kodierung entsteht in den verschiedensten Anwendungsbereichen der digitalen Datenkompression; hier sind vor allem Anwendungen in den Bereichen der digitalen Bildkompression von beispielhaften Interesse. In zahlreichen Standards zur Bildkodierung, wie etwa JPEG, JPEG-2000, JPEG-LS und JBIG wurden Verfahren zur binären arithmetischen Kodierung definiert. Neuere Standardisierungsaktivitäten lassen auch den zukünftigen Einsatz derartiger Kodiertechniken im Bereich der Videokodierung (H.26L/JVT) erkennen [1].

Die Vorteile der arithmetischen Kodierung (AK) gegenüber der bisher in der Praxis häufig verwendeten Huffman-Kodierung [2] lassen sich im wesentlichen durch drei Merkmale charakterisieren:

1. Mit der Verwendung der arithmetischen Kodierung läßt sich durch einfache Adaptionsmechanismen eine dynamische Anpassung an die vorhandene Quellenstatistik erzielen (Adaptivität).
2. Die arithmetische Kodierung erlaubt die Zuweisung von einer nicht ganzzahligen Anzahl von Bits pro zu kodierendem Symbol und ist damit geeignet, Kodierresultate zu erzielen, die eine Approximation der Entropie als der theoretisch gegebenen unteren Schranke darstellen (Entropie-Approximation) [3].
3. Unter Zuhilfenahme geeigneter Kontextmodelle lassen sich mit der arithmetischen Kodierung statistische Bindungen zwischen Symbolen zur weiteren Datenreduktion ausnutzen (Intersymbol-Redundanz) [4].

Als Nachteil einer Anwendung der arithmetischen Kodierung wird der im Vergleich zur Huffman-Kodierung i. a. erhöhte Rechenaufwand angesehen.

Das Konzept der arithmetischen Kodierung geht zurück auf die grundlegenden Arbeiten zur Informationstheorie von Shannon [5]. Erste konzeptionelle Konstruktionsmethoden wurden in [6] erstmals von Elias veröffentlicht. Eine erste LIFO (last-in-first-out) Variante der arithmetischen Kodierung wurde von Rissanen [7] entworfen und später von verschiedenen Autoren zu FIFO-Ausbildungen (first-in-first-out) modifiziert [8][9][10].

Gemeinsam ist allen diesen Arbeiten das zugrundeliegende Prinzip der rekursiven Teilintervallzerlegung: Entsprechend den gegebenen Wahrscheinlichkeiten $P(„0")$ und $P(„1")$ zweier Ereignisse {„0", "1"} eines binären Alphabets wird ein anfänglich gegebenes Intervall, z.B. das Intervall [0, 1), je nach Auftreten von Einzelereignissen rekursiv in Teilintervalle zerlegt. Dabei ist Größe des resultierenden Teilintervalls als Produkt der Einzelwahrscheinlichkeiten der aufgetretenen Ereignisse proportional zur Wahrscheinlichkeit der Folge der Einzelereignisse. Da jedes Ereignis S_i mit der Wahrscheinlichkeit $P(S_i)$ einen Beitrag von $H(S_i) = -log(P(S_i))$ des theoretischen Informationsgehalts $H(S_i)$ von S_i zur Gesamtrate beiträgt, ergibt sich eine Beziehung zwischen der Anzahl N_{Bit} der Bits zur Darstellung des Teilintervalls und der Entropie der Folge von Einzelereignissen, die durch die rechte Seite der folgenden Gleichung angegeben ist

$$N_{Bit} = -\log \prod_i P(S_i) = -\sum_i \log P(S_i) \quad .$$

Das Grundprinzip erfordert jedoch zunächst eine (theoretisch) unbegrenzte Genauigkeit in der Darstellung des resultierenden Teilintervalls und hat darüber hinaus den Nachteil, dass erst nach Kodierung des letzten Ereignisses die Bits zur Repräsentierung des resultierenden Teilintervalls ausgegeben werden können. Für praktische Anwendungszwecke war es daher entscheidend, Mechanismen für eine inkrementelle Ausgabe von Bits bei gleichzeitiger Darstellung mit Zahlen vorgegebener fester Genauigkeit zu entwickeln. Diese wurden erstmals in den Arbeiten [3][7][11] vorgestellt.

In Figur 1 sind die wesentlichen Operationen zur binären arithmetischen Kodierung skizziert. In der dargestellten Implementierung wird das aktuelle Teilintervall durch die beiden Werte L und R repräsentiert, wobei L den Aufsatzpunkt und R die Größe (Breite) des Teilintervalls bezeichnet und beide Größen mit jeweils b-bit Ganzzahlen dargestellt werden. Die Kodierung eines $bit \in \{0, 1\}$ erfolgt dabei im wesentlichen in 5 Teilschritten: Im ersten Schritt wird anhand der Wahrscheinlichkeitsschätzung der Wert des weniger wahrscheinlichen Symbols ermittelt. Für dieses Symbol, auch *LPS* (least probable symbol) in Unterscheidung zum *MPS* (most probable symbol) genannt, wird die Wahrscheinlichkeitsschätzung P_{LPS} im zweiten Schritt zur Berechnung der Breite R_{LPS} des entsprechenden Teilintervalls herangezogen. Je nach Wert des zu kodierenden Bits *bit* werden L und R im dritten Schritt aktualisiert. Im vierten Schritt wird die Wahrscheinlichkeitsschätzung je nach Wert des gerade kodierten Bits aktualisiert und schließlich wird das Codeintervall R im letzten Schritt einer sogenannten Renormalisierung unterzogen, d. h. R wird so reskaliert, dass die Bedingung $R \in (2^{b-2}, 2^{b-1}]$ erfüllt ist. Dabei wird bei jeder Skalierungsoperation ein Bit ausgegeben. Für weitere Details sei auf [10] verwiesen.

Der wesentliche Nachteil einer Implementierung, wie oben skizziert, besteht nun darin, dass die Berechnung der Intervallbreite R_{LPS} eine Multiplikation pro zu kodierendem Symbol erfordert. Üblicherweise sind Multiplikationsoperationen, insbesondere, wenn sie in Hardware realisiert werden, aufwändig und kostenintensiv. In mehreren Forschungsarbeiten wurden daher Verfahren untersucht, diese Multiplikationsoperation durch eine geeignete Approximation zu ersetzen [11][12][13][14]. Hierbei können die zu diesem Thema veröffentlichten Verfahren grob in drei Kategorien eingeteilt werden.

Die erste Gruppe von Vorschlägen zu einer multiplikationsfreien, binären arithmetischen Kodierung basiert auf dem Ansatz, die geschätzten Wahrscheinlichkeiten p_{LPS} so zu approximieren, dass die Multiplikation im 2. Schritt von Figur 1 durch eine (oder mehrere) Schiebe- und Additionsoperation(en) ersetzt werden kann [11][14]. Hierzu werden im einfachsten Fall die Wahrscheinlichkeiten p_{LPS} durch Werte in der Form 2^{-q} mit ganzahligem $q > 0$ angenähert.

In der zweiten Kategorie von approximativen Verfahren wird vorgeschlagen, den Wertebereich von R durch diskrete Werte in der Form $(½ - r)$ zu approximieren, wobei $r \in \{0\} \cup \{2^{-k} \mid k > 0,\ k \text{ ganzzahlig}\}$ gewählt wird [15][16].

Die dritte Kategorie von Verfahren zeichnet sich schließlich dadurch aus, dass dort sämtliche arithmetische Operationen durch Tabellenzugriffe ersetzt werden. Zu dieser Gruppe von Verfahren gehören einerseits der im JPEG-Standard verwendete Q-Coder und verwandte Verfahren, wie der QM- und MQ-Coder [12], und andererseits der quasi-arithmetische Koder [13]. Während das letztgenannte Verfahren eine drastische Einschränkung der zur Repräsentierung von R verwendeten Anzahl b von Bits vornimmt, um zu akzeptabel dimensionierten Tabellen zu gelangen, wird im Q-Coder die Renormalisierung von R so gestaltet, dass R zumindest näherungsweise durch 1 approximiert werden kann. Auf diese Art und Weise wird die Multiplikation zur Be-

BUNDESREPUBLIK DEUTSCHLAND

Prioritätsbescheinigung über die Einreichung einer Patentanmeldung

Aktenzeichen: 102 20 962.6

Anmeldetag: 2. Mai 2002

Anmelder/Inhaber: Heinrich Hertz Institut für Nachrichtentechnik Berlin GmbH, 10587 Berlin/DE

Bezeichnung: Verfahren und Anordnung zur tabellengestützten binären arithmetischen Enkodierung und Dekodierung sowie ein entsprechendes Computerprogrammprodukt und ein entsprechendes computerlesbares Speichermedium

IPC: H 03 M, G 06 T

Die angehefteten Stücke sind eine richtige und genaue Wiedergabe der ursprünglichen Unterlagen dieser Patentanmeldung.

München, den 13. April 2005
Deutsches Patent- und Markenamt
Der Präsident
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stimmung von R_{LPS} vermieden. Zusätzlich wird die Wahrscheinlichkeitsschätzung mittels einer Tabelle in Form einer Finite-State Machine betrieben. Für weitere Einzelheiten hierzu sei auf [12] verwiesen.

Der Erfindung liegt die Aufgabe zugrunde, ein Verfahren und eine Anordnung zur tabellengestützten binären arithmetischen Enkodierung und Dekodierung sowie ein entsprechendes Computerprogrammprodukt und ein entsprechendes computerlesbares Speichermedium anzugeben, welche die erwähnten Nachteile beheben, insbesondere (a) keine Multiplikationen erfordert, (b) eine Wahrscheinlichkeitsschätzung ohne Berechnungsaufwand erlaubt und (c) gleichzeitig ein Höchstmaß an Kodiereffizienz über einen weiten Bereich von typischerweise auftretenden Symbolwahrscheinlichkeiten gewährleistet.

Diese Aufgabe wird erfindungsgemäß gelöst durch die Merkmale im kennzeichnenden Teil der Ansprüche 1, 6, 7 und 8 im Zusammenwirken mit den Merkmalen im Oberbegriff. Zweckmäßige Ausgestaltungen der Erfindung sind in den Unteransprüchen enthalten.

Ein Verfahren zur tabellengestützten binären arithmetischen Enkodierung und Dekodierung wird vorteilhafterweise so durchgeführt, daß zwei oder mehrere Tabellen zur adaptiven arithmetischen Codierung genutzt werden.

Eine Anordnung zur tabellengestützten binären arithmetischen Enkodierung und Dekodierung umfasst mindestens einen Prozessor, der (die) derart eingerichtet ist (sind), dass ein Verfahren zur

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tabellengestützten binären arithmetischen Enkodierung und Dekodierung gemäß einem der Ansprüche 1 bis 5 durchführbar ist.

Ein Computerprogramm-Erzeugnis zur tabellengestützten binären arithmetischen Enkodierung und Dekodierung umfasst ein computerlesbares Speichermedium, auf dem ein Programm gespeichert ist, das es einem Computer ermöglicht, nachdem es in den Speicher des Computers geladen worden ist, ein Verfahren zur tabellengestützten binären arithmetischen Enkodierung und Dekodierung gemäß einem der Ansprüche 1 bis 5 durchzuführen.

Zur Durchführung eines Verfahrens zur tabellengestützten binären arithmetischen Enkodierung und Dekodierung wird vorteilhafterweise ein computerlesbares Speichermedium genutzt, auf dem ein Programm gespeichert ist, das es einem Computer ermöglicht, nachdem es in den Speicher des Computers geladen worden ist, ein Verfahren zur tabellengestützten binären arithmetischen Enkodierung und Dekodierung gemäß einem der Ansprüche 1 bis 5 durchzuführen.

Das neue Verfahren zeichnet sich durch die Kombination dreier Merkmale aus. Zunächst erfolgt, ähnlich wie im Q-Coder die Wahrscheinlichkeitsschätzung mittels einer endlichen Zustandsmaschine (FSM: finite state machine), wobei die Generierung der N repräsentativen Zustände der FSM offline erfolgt. Die entsprechenden Übergangsregeln werden dabei in Form von Tabellen abgelegt.

Zweites charakteristisches Merkmal der Erfindung ist eine Vorquantisierung der Intervallbreite R auf eine Anzahl von K vorab definierten Quantisierungswerten.

Dies erlaubt bei geeigneter Dimensionierung von K und N die Erstellung einer Tabelle, die alle $K \times N$ Kombinationen von vorab berechneten Produktwerten $R \times P_{LPS}$ zu einer multiplikationsfreien Bestimmung von R_{LPS} enthält.

Für die Verwendung der vorgestellten Erfindung in einer Umgebung, in der verschiedene Kontextmodelle zum Einsatz kommen, unter denen sich auch solche mit (nahezu) uniformer Wahrscheinlichkeitsverteilung befinden, wird als zusätzliches (optionales) Element ein separater Zweig in der Kodiermaschine vorgesehen, in der sich unter der Annahme einer Gleichverteilung die Bestimmung der Größen L und R sowie die Renormalisierung vom Rechenaufwand her nochmals deutlich reduziert.

Insgesamt beurteilt, erbringt die Erfindung insbesondere den Vorteil, dass sie einen guten Kompromiss zwischen hoher Kodiereffizienz auf der einen Seite und geringem Rechenaufwand auf der anderen Seite ermöglicht.

Die Erfindung wird nachfolgend anhand eines in der Zeichnung dargestellten Ausführungsbeispiels näher erläutert.

Es zeigen:

Figur 1	Darstellung der wesentlichen Operationen zur binären arithmetischen Kodierung;
Figur 2	Modifiziertes Schema zur tabellengestützten arithmetischen Enkodierung;
Figur 3	Prinzip der tabellengestützten arithmetischen Decodierung;
Figur 4	Prinzip der En- bzw. Dekodierung für binäre Daten mit uniformer Verteilung.

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Zunächst einmal soll jedoch der theoretische Hintergrund etwas näher erläutert werden:

Tabellengestützte Wahrscheinlichkeitsschätzung

Wie oben bereits näher erläutert, beruht die Wirkungsweise der arithmetischen Kodierung auf einer möglichst guten Schätzung der Auftrittswahrscheinlichkeit der zu kodierenden Symbole. Um eine Adaption an instationäre Quellenstatistiken zu ermöglichen, muss diese Schätzung im Laufe des Kodierungsprozesses aktualisiert werden. In der Regel werden hierzu herkömmlicherweise Verfahren verwendet, die mit Hilfe skalierter Häufigkeitszähler der kodierten Ereignisse operieren [17]. Bezeichnen c_{LPS} und c_{MPS} Zähler für die Auftrittshäufigkeiten von *LPS* und *MPS*, so lässt sich mittels dieser Zähler die Schätzung

$$P_{LPS} = \frac{c_{LPS}}{c_{LPS} + c_{MPS}} \qquad (1)$$

vornehmen und damit die in Figur 1 skizzierte Operation der Intervallunterteilung ausführen. Für praktische Zwecke nachteilig ist die in Gleichung (1) erforderliche Division. Häufig ist es jedoch zweckmäßig und erforderlich, bei Überschreitung eines vorgegebenen Schwellwerts C_{max} des Gesamtzählers $c_{Total} = c_{MPS} + c_{LPS}$ eine Reskalierung der Zählerstände vorzunehmen. (Man beachte in diesem Zusammenhang, dass bei einer *b*-bit-Darstellung von *L* und *R* die kleinste Wahrscheinlichkeit, die noch korrekt dargestellt werden kann, 2^{-b+2} beträgt, so dass zur Vermeidung der Unterschreitung dieser unteren Grenze gegebenenfalls eine Reskalierung der Zählerstände erforderlich ist.) Bei geeigneter Wahl von C_{max} lassen sich die reziproken Werte von c_{Total} tabellieren, so dass die in Gleichung (1) erforderliche Division durch einen Tabellenzugriff sowie eine Multiplikations- und Schiebeoperation ersetzt werden kann.

Um jedoch auch diese arithmetischen Operationen zu vermeiden, wird in der vorliegenden Erfindung ein vollständig tabellengestütztes Verfahren zur Wahrscheinlichkeitsschätzung verwendet.

Zu diesem Zweck werden vorab in einer Trainingsphase repräsentative Wahrscheinlichkeitszustände $\{P_k \mid 0 \leq k < N_{max}\}$ ausgewählt, wobei die Auswahl der Zustände einerseits von der Statistik der zu kodierenden Daten und andererseits von der Nebenbedingung der vorgegebenen Maximalanzahl N_{max} von Zuständen abhängt. Zusätzlich werden Übergangsregeln definiert, die angegeben, welcher neue Zustand ausgehend von dem aktuell kodierten Symbol für das nächste zu kodierende Symbol verwendet werden soll. Diese Übergangsregeln werden in Form zweier Tabellen bereitgestellt: $\{Next\_State\_LPS_k \mid 0 \leq k < N_{max}\}$ und $\{Next\_State\_MPS_k \mid 0 \leq k < N_{max}\}$, wobei die Tabellen für den Index n des aktuell gegebenen Wahrscheinlichkeitszustands P_n den Index m des neuen Wahrscheinlichkeitszustands P_m bei Auftreten eines LPS bzw. MPS liefern. Hervorzuheben sei an dieser Stelle, dass zur Wahrscheinlichkeitsschätzung im arithmetischen Enkoder bzw. Dekoder, so wie er hier vorgeschlagen wird, keine explizite Tabellierung der Wahrscheinlichkeitszustände notwendig ist. Vielmehr werden die Zustände nur anhand ihrer entsprechenden Indizes implizit adressiert, wie im nachfolgenden Abschnitt beschrieben.

Tabellengestützte Intervallunterteilung

Figur 2 zeigt das modifizierte Schema zur tabellengestützten arithmetischen Kodierung, wie sie hier vorgeschlagen wird. Nach Bestimmung des *LPS* wird zunächst die gegebene Intervallbreite *R* mittels einer tabellierten Abbildung *Qtab* und einer geeigneten Schiebeoperation (um *q* bit) auf einen quantisierten Wert *Q* abgebildet. In der Regel wird hier eine relativ grobe Quantisierung $K = 4...8$ verschiedene Werte vorgenommen. Auch hier erfolgt, ähnlich wie im Fall der Wahrscheinlichkeitsschätzung, keine explizite Bestimmung von *Q*; vielmehr wird nur ein Index *q_index* auf *Q* übergeben. Dieser Index wird nun zusammen mit dem Index *p_state* zur Charakterisierung des aktuellen Wahrscheinlichkeitszustands für die Bestimmung der Intervallbreite R_{LPS} verwendet. Dazu wird der entsprechende Eintrag der Tabelle *Rtab* verwendet. Dort sind die zu allen *K* quantisierten Werten von *R* und N_{max} verschiedenen Wahrscheinlichkeitszuständen korrespondierenden $K \cdot N_{max}$ Produktwerte $R \times P_{LPS}$ abgelegt. Für praktische Implementierungen ist hier eine Möglichkeit gegeben, zwischen dem Speicherbedarf für die Tabellengröße und der arithmetischen Genauigkeit, die letztlich auch die Effizienz der Kodierung bestimmt, abzuwägen. Beide Zielgrößen werden durch die Granularität der Repräsentierung von R und P_{LPS} bestimmt.

Im vierten Schritt der Figur 2 ist gezeigt, wie die Aktualisierung des Wahrscheinlichkeitszustands *p_state* in Abhängigkeit des gerade kodierten Ereignisses *bit* vorgenommen wird. Hier werden die im vorigen Abschnitt „Tabellengestützte Wahrscheinlichkeitsschätzung" bereits erwähnten Übergangstabellen *Next_State_LPS* und *Next_State_MPS* benutzt. Diese Operationen entsprechen dem in Figur 1 im 4. Schritt angegebenen, aber nicht näher spezifizierten Aktualisierungsprozeß.

Figur 3 zeigt das korrespondierende Ablaufschema der tabellengestützten arithmetischen Dekodierung. Zur

Charakterisierung des aktuellen Teilintervalls wird im Dekoder die Intervallbreite R und ein Wert V verwendet. Letzterer liegt im Innern des Teilintervalls und wird mit jedem gelesenen Bit sukzessive verfeinert. Wie aus der Figur 3 hervorgeht, werden die Operationen zur Wahrscheinlichkeitsschätzung und Bestimmung der Intervallbreite R entsprechend denen des Enkoders nachgeführt.

Kodierung mit uniformer Wahrscheinlichkeitsverteilung

In Anwendungen, in denen z. B. vorzeichenbehaftete Werte kodiert werden sollen, deren Wahrscheinlichkeitsverteilung symmetrisch um die Null angeordnet ist, wird man zur Kodierung der Vorzeicheninformation in der Regel von einer Gleichverteilung ausgehen können. Da diese Information einerseits mit in den arithmetischen Bitstrom eingebettet werden soll, es anderseits aber nicht sinnvoll ist, für den Fall einer Wahrscheinlichkeit von $P \approx 0.5$ den immer noch relativ aufwändigen Apparat der tabellengestützten Wahrscheinlichkeitsschätzung und Intervallunterteilung zu benutzen, wird vorgeschlagen für diesen Spezialfall, optional eine gesonderte Enkoder-/Dekoder Prozedur zu benutzen, die sich wie folgt darstellt.

Im Enkoder lässt sich für diesen Spezialfall die Intervallbreite des neuen Teilintervalls durch eine einfache Schiebeoperation entsprechend einer Halbierung der Breite des Ausgangsintervalls R bestimmen. Je nach Wert des zu kodierenden Bits wird dann die obere bzw. untere Hälfte von R als neues Teilintervall gewählt (vgl. Figur 4). Die anschließende Renormalisierung und Ausgabe von Bits erfolgt wie im obigen Fall der tabellengestützten Lösung.

Im entsprechenden Dekoder reduzieren sich die notwendigen Operationen darauf, das zu dekodierende Bit anhand des Werts von *V* relativ zur aktuellen Intervallbreite *R* durch eine einfache Vergleichsoperation zu bestimmen. In dem Fall, dass das dekodierte Bit gesetzt wird, ist *V* um den Betrag von *R* zu reduzieren. Wie in Figur 4 dargestellt, wird die Dekodierung durch die Renormalisierung und die Aktualisierung von V mit dem nächsten einzulesenden Bit abgeschlossen.

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Patentansprüche

1. Verfahren zur tabellengestützten binären arithmetischen Enkodierung und Dekodierung, wobei zwei oder mehrere Tabellen zur adaptiven arithmetischen Codierung genutzt werden.

2. Verfahren nach Anspruch 1,

   dadurch gekennzeichnet, daß

   die Tabellen zur adaptiven arithmetischen Codierung in Bild- und Videocodierern und -decodierern zur Übertragung der Syntaxelemente Bewegungsvektoren, Coded-Block-Pattern und/oder Texturinformation eingesetzt werden.

3. Verfahren nach einem der vorangehenden Ansprüche,

   dadurch gekennzeichnet, daß

   eine Tabelle die Zustandsübergänge des arithmetischen Codieres/Decodierers und eine andere die Zustandsübergänge für die Wahrscheinlichkeitsschätzung der Syntaxelemente darstellt.

4. Verfahren nach einem der vorangehenden Ansprüche,

   dadurch gekennzeichnet, daß

   eine Bestimmung des Least-Probable-Symbols und des Most-Probable-Symbols und somit eine effizientere und adaptive Verarbeitung der binären Eingangssymbole erfolgt.

5. Verfahren nach einem der vorangehenden Ansprüche, dadurch gekennzeichnet, daß

eine vereinfachte Codierung von Syntaxelementen mit approximativ uniformer Wahrscheinlichkeit durch einen Beipass durchgeführt wird.

6. Anordnung mit mindestens einem Prozessor, der (die) derart eingerichtet ist (sind), dass ein Verfahren zur tabellengestützten binären arithmetischen Enkodierung und Dekodierung gemäß einem der Ansprüche 1 bis 5 durchführbar ist.

7. Computerprogramm-Erzeugnis, dass ein computerlesbares Speichermedium umfasst, auf dem ein Programm gespeichert ist, das es einem Computer ermöglicht, nachdem es in den Speicher des Computers geladen worden ist, ein Verfahren zur tabellengestützten binären arithmetischen Enkodierung und Dekodierung gemäß einem der Ansprüche 1 bis 5 durchzuführen.

8. Computerlesbares Speichermedium, auf dem ein Programm gespeichert ist, das es einem Computer ermöglicht, nachdem es in den Speicher des Computers geladen worden ist, ein Verfahren zur tabellengestützten binären arithmetischen Enkodierung und Dekodierung gemäß einem der Ansprüche 1 bis 5 durchzuführen.

```
1. Bestimmung des LPS
2. Berechnung der Größen R_LPS und R_MPS:
   R_LPS = R x P_LPS
   R_MPS = R - R_LPS
3. Berechnung des neuen Teilintervalls:
   if (bit = LPS) then
         L ← L + R_MPS
         R ← R_LPS
   else
         R ← R_MPS
4. Aktualisierung der Wahrscheinlichkeitsschätzung P_LPS
5. Ausgabe von Bits und Renormalisierung von R
```

Fig. 1

```
1. Bestimmung des LPS
2. Quantisierung von R:
   q_index = Qtab[R>>q]
3. Bestimmung von R_LPS und R_MPS:
   R_LPS = Rtab[q_index,p_state]
   R_MPS = R - R_LPS
4. Berechnung des neuen Teilintervalls:
   if (bit = LPS) then
         L ← L + R_MPS
         R ← R_LPS
         p_state ← Next_State_LPS[p_state]
   else
         R ← R_MPS
         p_state ← Next_State_MPS[p_state]
```

Fig. 2

```
1. Bestimmung des LPS
2. Quantisierung von R:
   q_index = Qtab[R>>q]
3. Bestimmung von R_LPS und R_MPS:
   R_LPS = Rtab[q_index,p_state]
   R_MPS = R - R_LPS
4. Bestimmung von bit, je nach Lage des
   Teilintervalls:
   if (V ≥ R_MPS) then
         bit ← LPS
         V ← V - R_MPS
         R ← R_LPS
         p_state ← Next_State_LPS[p_state]
   else
         bit ← MPS
         R ← R_MPS
         p_state ← Next_State_MPS[p_state]
5. Renormalisierung von R, Auslesen eines Bits
   und Aktualisierung von V
```

Fig. 3

```
Enkoder:

  1. Berechnung des neuen Teilintervalls:
     R ← R >> 1
     if (bit = 1) then
           L ← L + R
  2. Ausgabe von Bits und Renormalisierung von R

Dekoder:

  1. Bestimmung von bit, je nach Lage des
     Teilintervalls:
     if (V ≥ R) then
           bit ← 1
           V ← V - R
     else
           bit ← 0
  2. Auslesen eines Bits, Renormalisierung von R und
     Aktualisierung von V
```

Fig. 4

Zusammenfassung

Die Erfindung beschreibt ein Verfahren und eine Anordnung zur tabellengestützten binären arithmetischen Enkodierung und Dekodierung sowie ein entsprechendes Computerprogrammprodukt und ein entsprechendes computerlesbares Speichermedium, welche insbesondere bei der digitalen Datenkompression eingesetzt werden können.

Hierfür wird vorgeschlagen, zur tabellengestützten binären arithmetischen Enkodierung und Dekodierung zwei oder mehrere Tabellen zur adaptiven arithmetischen Codierung zu nutzen.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/727,801	12/04/2003	Detlef Marpe	S&ZFH030508	6855

TITLE OF INVENTION: METHOD AND ARRANGEMENT FOR ARITHMETIC ENCODING AND DECODING BINARY STATES AND A CORRESPONDING COMPUTER PROGRAM AND A CORRESPONDING COMPUTER-READABLE STORAGE MEDIUM

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Authorized Signature ______ Date 6/23/05

Typed or printed name RALPH E. LOCHER REG. NO. 41,947 Registration No. RALPH E. LOCHER REG. NO. 41,947

This collection of information is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450.

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UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/727,801	12/04/2003	Detlef Marpe	S&ZFH030508	6855

24131 7590 08/11/2005

LERNER AND GREENBERG, PA
P O BOX 2480
HOLLYWOOD, FL 33022-2480

EXAMINER	
JEANGLAUDE, JEAN BRUNER	
ART UNIT	PAPER NUMBER
2819	

DATE MAILED: 08/11/2005

PRIORITY ACKNOWLEDGMENT

☒ 1. Receipt is acknowledged of priority papers submitted under 35 U.S.C. 119. The papers have been placed of record in the file.

☐ 2. Applicant's claim for priority, based on papers filed in parent Application Number ________________ submitted under 35 U.S.C. 119, is acknowledged.

☐ 3. The priority papers, submitted ________________, after payment of the issue fee are

☐ acknowledged
While the priority claim or certified copy filed will be placed in the file record, neither will be reviewed and the patent when published will not include the priority claim.
See 37 CFR 1.55(a)(2).

☐ not acknowledged since the processing fee in 37 CFR 1.17(i) has not been received.

☐ 4. For utility and plant applications filed on or after November 29, 2000, the priority claim is not entered because the claim was not presented within the time limit required by 37 CFR 1.55(a)(1). A petition to accept a delayed claim for priority under 35 U.S.C. 119(a) - (d) or (f), or 365(a) may be filed. See 37 CFR 1.55(c) and MPEP 201.14(a).

for [signature]
Manager, Publishing Division
Office of Patent Publication
(703) 305-8388

PTOL-147 (Rev. 10/03)

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

POWER OF ATTORNEY TO PROSECUTE APPLICATIONS BEFORE THE USPTO

I hereby revoke all previous powers of attorney given in the application identified in the attached statement under 37 CFR 3.73(b).

I hereby appoint:

☑ Practitioners associated with the Customer Number: 136446

OR

☐ Practitioner(s) named below (if more than ten patent practitioners are to be named, then a customer number must be used):

Name	Registration Number	Name	Registration Number

as attorney(s) or agent(s) to represent the undersigned before the United States Patent and Trademark Office (USPTO) in connection with any and all patent applications assigned only to the undersigned according to the USPTO assignment records or assignment documents attached to this form in accordance with 37 CFR 3.73(b).

Please change the correspondence address for the application identified in the attached statement under 37 CFR 3.73(b) to:

☑ The address associated with Customer Number: 136446

OR

☐ Firm or Individual Name			
Address			
City		State	Zip
Country			
Telephone		Email	

Assignee Name and Address:

GE Video Compression, LLC
1 Research Circle, K1-4A59E
Niskayuna, NY 12309

A copy of this form, together with a statement under 37 CFR 3.73(b) (Form PTO/SB/96 or equivalent) is required to be filed in each application in which this form is used. The statement under 37 CFR 3.73(b) may be completed by one of the practitioners appointed in this form if the appointed practitioner is authorized to act on behalf of the assignee, and must identify the application in which this Power of Attorney is to be filed.

SIGNATURE of Assignee of Record

The individual whose signature and title is supplied below is authorized to act on behalf of the assignee

Signature	[signature]	Date	10/25/2015
Name	Kenneth R. Glick	Telephone	518-431-6859
Title	Manager		

This collection of information is required by 37 CFR 1.31, 1.32 and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

STATEMENT UNDER 37 CFR 3.73(b)

Applicant/Patent Owner: GE VIDEO COMPRESSION, LLC

Application No./Patent No.: 10/727801/6943710 Filed/Issue Date: 2003-12-04/2005-09-13

Titled: METHOD AND ARRANGEMENT FOR ARITHMETIC ENCODING AND DECODING BINARY STATES AND A CORRESPONDING COMPUTER PROGRAM AND A CORRESPONDING COMPUTER-READABLE STORAGE MEDIUM

GE VIDEO COMPRESSION, LLC , a ____________
(Name of Assignee) (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.

states that it is:

1. [X] the assignee of the entire right, title, and interest in;

2. [ ] an assignee of less than the entire right, title, and interest in
(The extent (by percentage) of its ownership interest is ________ %); or

3. [ ] the assignee of an undivided interest in the entirety of (a complete assignment from one of the joint inventors was made)

the patent application/patent identified above, by virtue of either:

A. [ ] An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel ____________, Frame ____________, or for which a copy therefore is attached.

OR

B. [X] A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

1. From: Detlef Marpe, Thomas Wiegand To: FRAUNHOFER-GESELLSCHAFT ZUR FORD
The document was recorded in the United States Patent and Trademark Office at
Reel 016725 , Frame 0234 , or for which a copy thereof is attached.

2. From: FRAUNHOFER-GESELLSCHAFT ZUR FORD To: GE VIDEO COMPRESSION, LLC
The document was recorded in the United States Patent and Trademark Office at
Reel 036132 , Frame 0402 , or for which a copy thereof is attached.

3. From: ____________ To: ____________
The document was recorded in the United States Patent and Trademark Office at
Reel ____________ , Frame ____________, or for which a copy thereof is attached.

[ ] Additional documents in the chain of title are listed on a supplemental sheet(s).

[X] As required by 37 CFR 3.73(b)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (*i.e.*, a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

/Manu Bansal/ 2015-11-05
Signature Date

Manu Bansal, Reg. No. L0610 Patent Agent
Printed or Typed Name Title

This collection of information is required by 37 CFR 3.73(b). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Acknowledgement Receipt

EFS ID:	24000082
Application Number:	10727801
International Application Number:	
Confirmation Number:	6855
Title of Invention:	METHOD AND ARRANGEMENT FOR ARITHMETIC ENCODING AND DECODING BINARY STATES AND A CORRESPONDING COMPUTER PROGRAM AND A CORRESPONDING COMPUTER-READABLE STORAGE MEDIUM
First Named Inventor/Applicant Name:	Detlef Marpe
Customer Number:	24131
Filer:	Manu Bansal/allie bernardo
Filer Authorized By:	Manu Bansal
Attorney Docket Number:	S&ZFH030508
Receipt Date:	05-NOV-2015
Filing Date:	04-DEC-2003
Time Stamp:	15:37:38
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Power of Attorney	POA-B.pdf	528093 499a67a65e1fcc6b98d575743cf279e0c13b1b4d	no	1

Warnings:

Information:

Unified Patents, Ex. 1002

2	Assignee showing of ownership per 37 CFR 3.73	10727801.pdf	426909 05b27c944ff350856984f1d13f9302752d2dc4eb	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	955002	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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United States Patent and Trademark Office
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www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
10/727,801	12/04/2003	Detlef Marpe	

CONFIRMATION NO. 6855

POWER OF ATTORNEY NOTICE

OC000000078565253

24131
LERNER GREENBERG STEMER LLP
P O BOX 2480
HOLLYWOOD, FL 33022-2480

Date Mailed: 11/10/2015

NOTICE REGARDING CHANGE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 11/05/2015.

- The Power of Attorney to you in this application has been revoked by the assignee who has intervened as provided by 37 CFR 3.71. Future correspondence will be mailed to the new address of record(37 CFR 1.33).

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/rmturner myles/

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Alexandria, Virginia 22313-1450
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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
10/727,801	12/04/2003	Detlef Marpe	

CONFIRMATION NO. 6855

POA ACCEPTANCE LETTER

OC000000078565440

136446
GE Video Compression, LLC
c/o Pillsbury Winthrop Shaw Pittman, LLP
PO Box 10500
McLean, VA 22102

Date Mailed: 11/10/2015

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 11/05/2015.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/rmturner myles/

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
10/727,801	12/04/2003	Detlef Marpe	

CONFIRMATION NO. 6855

24131
LERNER GREENBERG STEMER LLP
P O BOX 2480
HOLLYWOOD, FL 33022-2480

POWER OF ATTORNEY NOTICE

OC000000078565405

Date Mailed: 11/10/2015

NOTICE REGARDING CHANGE OF POWER OF ATTORNEY

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/rmturner myles/