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Auyeung

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[54] **METHOD AND APPARATUS FOR ADAPTIVE ENTROPY ENCODING/DECODING OF QUANTIZED TRANSFORM COEFFICIENTS IN A VIDEO COMPRESSION SYSTEM**

“Video Codec Test Model, TMN4”, ITU Telecommunication Standardization Sector, Study Group 15, Working Party 15/1, LBC-94.

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[51] Int. Cl.⁶ **H04N 7/26; H04N 7/30**

[52] U.S. Cl. **348/403; 348/405; 348/404; 348/419; 348/420**

[58] Field of Search **348/384, 395, 348/403, 405, 395, 404, 419, 420**

[56] **References Cited**

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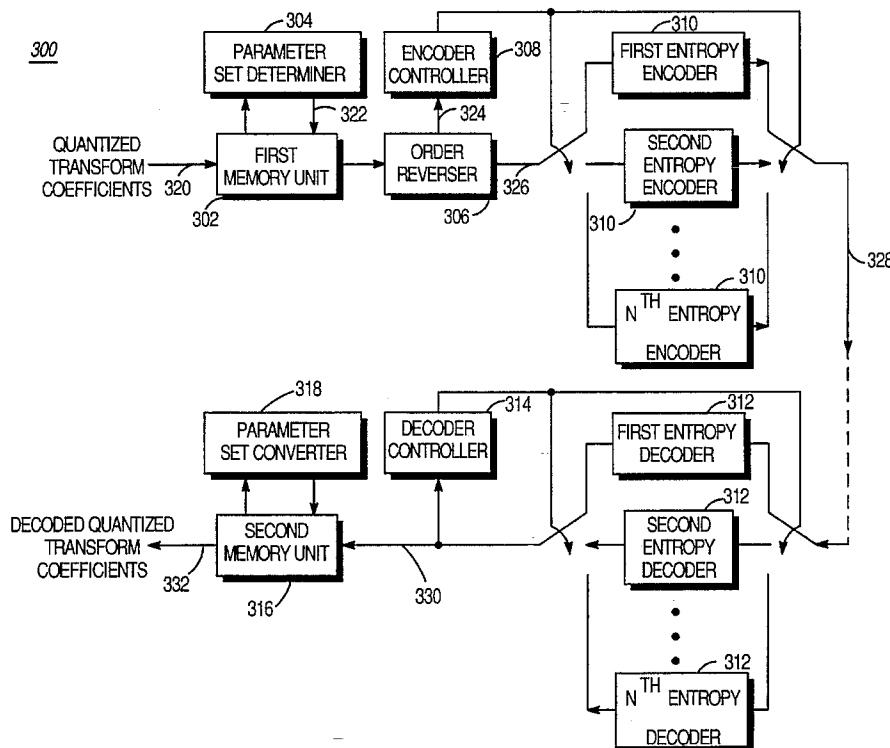
OTHER PUBLICATIONS

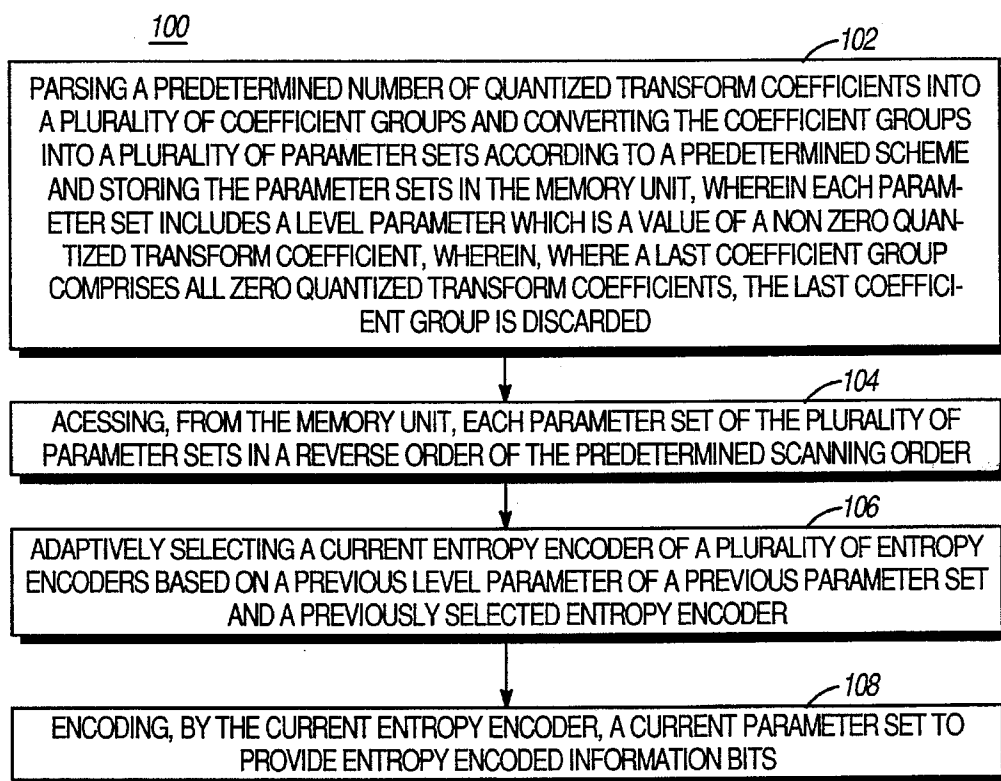
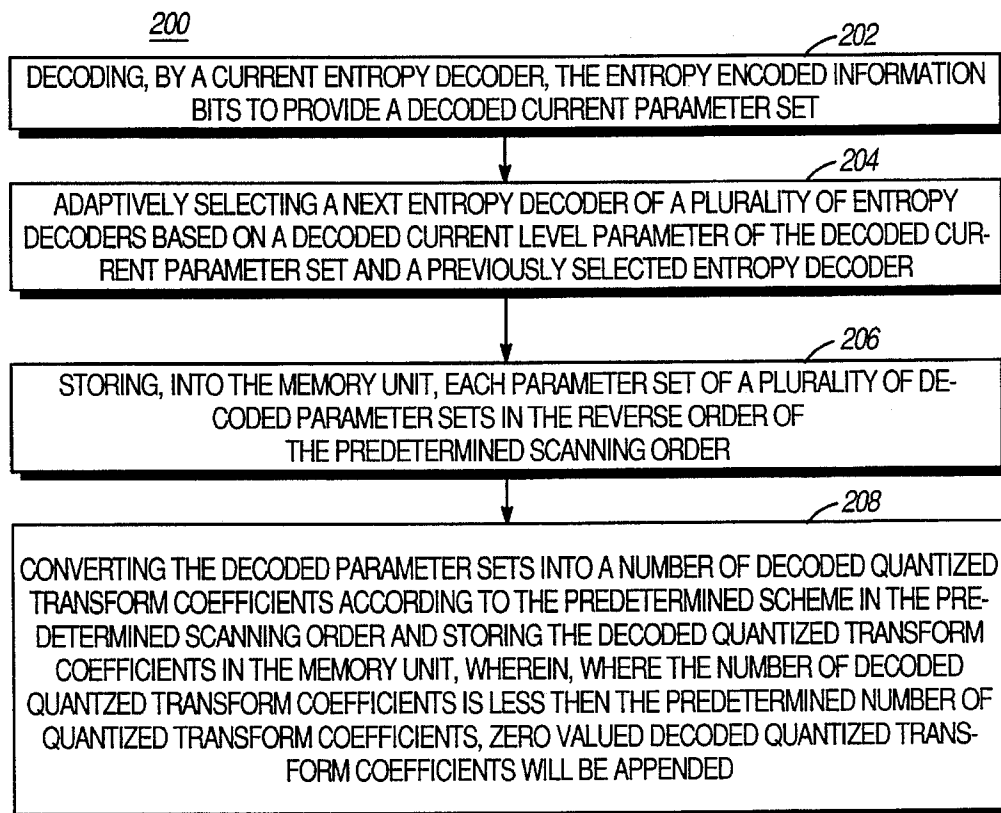
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[57] **ABSTRACT**

The present invention is a method (100) and apparatus (300) for adaptive entropy encoding/decoding of a plurality of quantized transform coefficients in a video/image compression system. For encoding, first, a predetermined number of quantized transform coefficients are received in a predetermined order, giving a generally decreasing average power. Then the quantized transform coefficients are parsed into a plurality of coefficient groups. When the last coefficient group comprises all zero quantized coefficients, it is discarded. The coefficient groups are then converted into a plurality of parameter sets in the predetermined order. A current parameter set is obtained from the parameter sets in the reverse order of the predetermined order. A current entropy encoder is selected adaptively based on the previously selected entropy encoder and the previous parameter set. The current parameter set is encoded by the current entropy encoder to provide entropy encoded information bits.

18 Claims, 3 Drawing Sheets



*Fig.1**Fig.2*

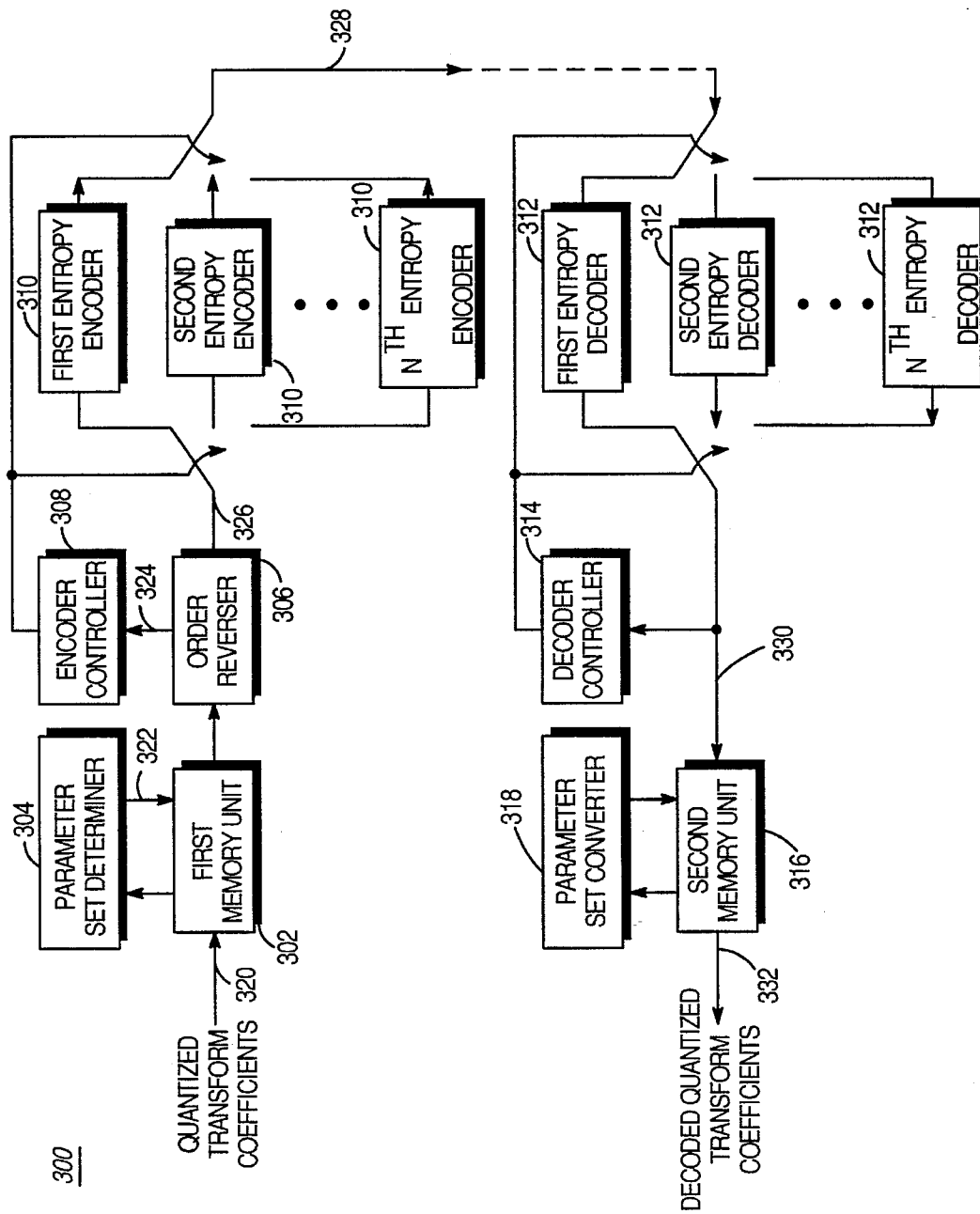


Fig.3

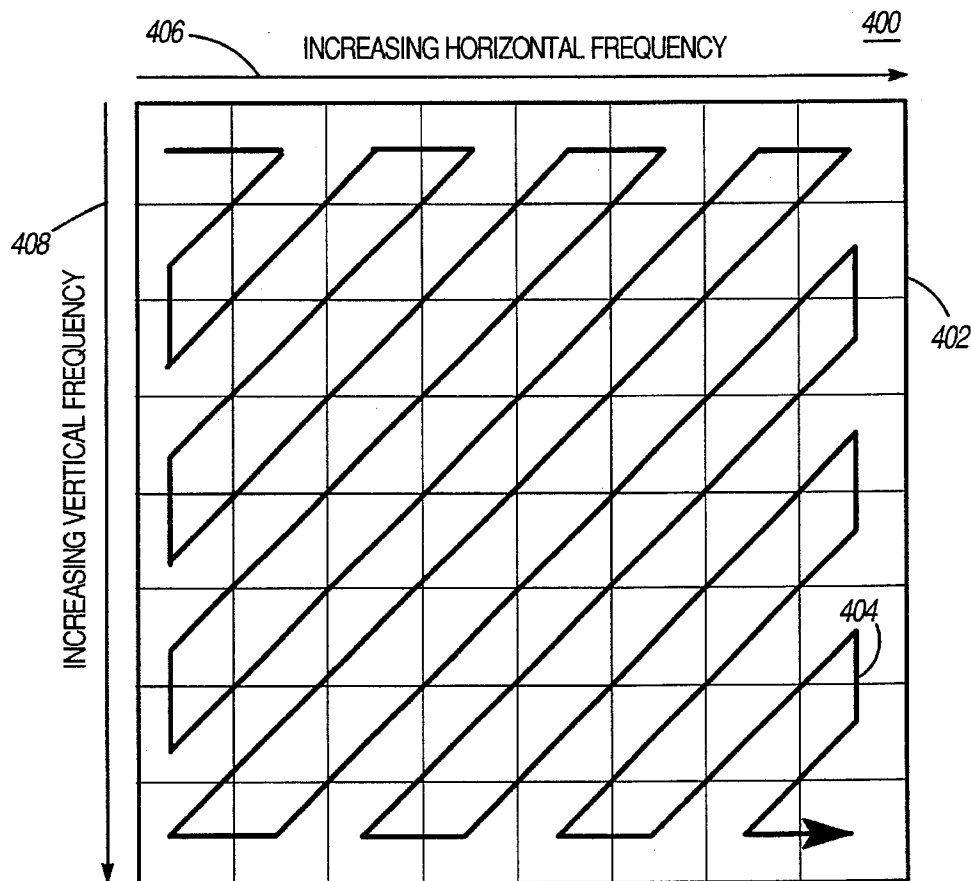


Fig.4

— PRIOR ART —

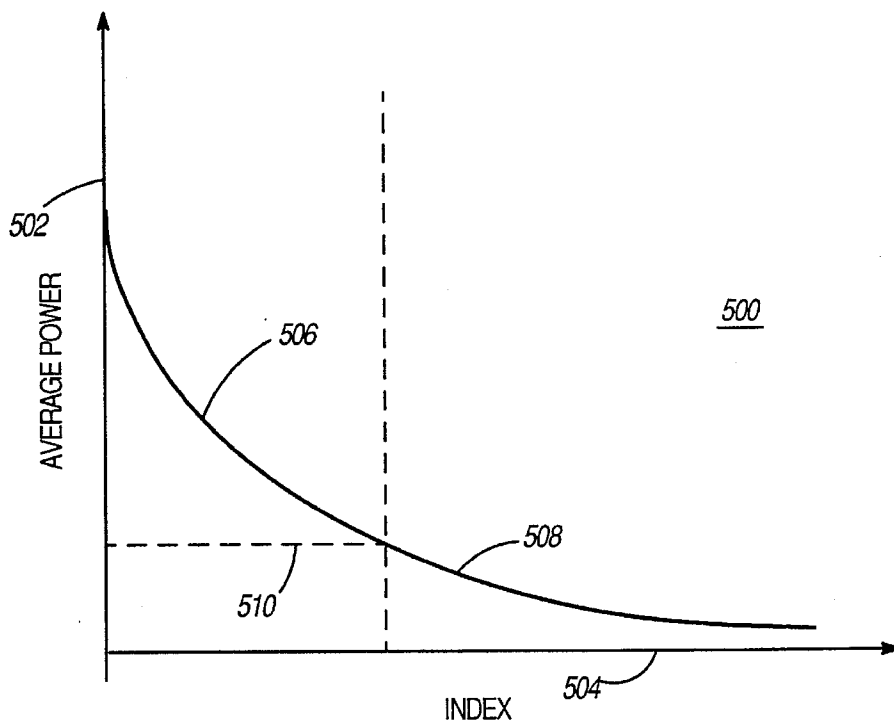


Fig.5

**METHOD AND APPARATUS FOR ADAPTIVE
ENTROPY ENCODING/DECODING OF
QUANTIZED TRANSFORM COEFFICIENTS
IN A VIDEO COMPRESSION SYSTEM**

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates generally to the field of video compression, and in particular, to entropy coding.

2. Description of the Prior Art

Video systems are known to include a plurality of communication devices and communication channels, which provide the communication medium for the communication devices. For example, the communication channel may be wireline connections or radio frequency, RF, carriers. To increase the efficiency of the video system, video that needs to be communicated over the communication medium is digitally compressed. Digital compression reduces the number of bits needed to represent the video while maintaining perceptual quality of the video. The reduction in bits allows more efficient use of channel bandwidth and reduces storage requirements. To achieve digital video compression, each communication device may include an encoder and a decoder. The encoder allows a communication device to compress video before transmission over a communication channel. The decoder enables the communication device to receive compressed video from a communication channel and render it visible. Communication devices that may use digital video compression include high definition television transmitters and receivers, cable television transmitters and receivers, video telephones, computers and portable radios.

Several emerging standards for digital video compression are being developed, including International Telecommunications Union (ITU), ITU-T Recommendation H.26P, the International Standards Organization/International Electrotechnical Committee (ISO/IEC), and International Standard MPEG-4. These standards are likely to use transform coding as part of the building blocks for good coding efficiency. Currently, the Expert's Group on Very Low Bitrate Visual Telephony, LBC, is considering using the discrete cosine transform for coding efficiency. The Moving Pictures Expert's Group, MPEG, is also likely to use the discrete cosine transform or other type of transform. To achieve compression, the transform coefficients are quantized and entropy coded.

Therefore, to maximize the compression capability, a need exists for a method and apparatus for entropy coding the quantized transform coefficients more efficiently than the emerged standard H.261, MPEG-1, and MPEG-2, especially for low bit rate applications.

SUMMARY OF THE INVENTION

The present invention is a method and apparatus for adaptive entropy encoding/decoding of a plurality of quantized transform coefficients in a video/image compression system. For encoding, first, a predetermined number of quantized transform coefficients are received in a predetermined order, giving a generally decreasing average power. Then the quantized transform coefficients are parsed into a plurality of coefficient groups. When the last coefficient group comprises all zero quantized coefficients, it is discarded. The coefficient groups are then converted into a plurality of parameter sets in the predetermined order. A current

parameter set is obtained from the parameter sets in the reverse order of the predetermined order. A current entropy encoder is selected adaptively based on the previously selected entropy encoder and the previous parameter set. The current parameter set is encoded by the current entropy encoder to provide entropy encoded information bits.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a flow diagram of steps for one embodiment of a method for adaptive entropy encoding in accordance with the present invention.

FIG. 2 is a flow diagram of steps for one embodiment of a method for adaptive entropy decoding in accordance with the present invention.

FIG. 3 is a block diagram of one embodiment of an apparatus for adaptive entropy encoding/decoding in accordance with the present invention.

FIG. 4 is an exemplary prior art illustration of a method of scanning and transforming a two dimensional block to provide a one dimensional array of scanned coefficients.

FIG. 5 is a graphical depiction of the average power, in general, of the scanned coefficients with respect to the index; a distinction between lower and higher power coefficient is made in accordance with the present invention.

**DESCRIPTION OF A PREFERRED
EMBODIMENT**

The present invention is a method and an apparatus for adaptive entropy encoding/decoding of a plurality of quantized transform coefficients in a video/image compression system. For encoding, first, a predetermined number of quantized transform coefficients are received in a predetermined order giving a generally decreasing average power. Then the quantized transform coefficients are parsed into a plurality of coefficient groups. When a last coefficient group comprises all zero quantized coefficients, the last coefficient group is discarded. The coefficient groups are then converted into a plurality of parameter sets in the predetermined order. A current parameter set is obtained from the parameter sets in the reverse order of the predetermined order. A current entropy encoder is selected adaptively based on the previously selected entropy encoder and the previous parameter set. The current parameter set is encoded by the current entropy encoder to provide entropy encoded information bits.

This invention may be used with a compression algorithm that processes a picture into two-dimensional blocks of quantized transform coefficients with predetermined transform sizes. Each block is then scanned into a one-dimensional array in a predetermined order giving generally decreasing average power.

The one-dimensional array of quantized transform coefficients are parsed into a sequence of coefficient groups as shown by the following example. For example, consider an array having 64 coefficients, only five of which are non-zero:

$$\{0,0,1,0,-2,3,0,1,0,0,1,0,0,\dots\} \quad (1)$$

After parsing, the coefficient groups are

$$\{0,0,1\},\{0,-2\},\{3\},\{0,1\},\{0,0,1\}. \quad (2)$$

In general, the number of coefficient groups is the same as the number of non-zero coefficients since the last group $\{0,$

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