INTERNATIONAL STANDARD

ISO/IEC 11172-2

First edition
1993-08-01

Information technology — Coding of moving pictures and associated audio for digital storage media at up to about 1,5 Mbit/s —

Part 2: Video

Technologies de l'information — Codage de l'image animée et du son associé pour les supports de stockage numérique jusqu'à environ 1,5 Mbit/s —

Partie 2: Vidéo

Reference number
ISO/IEC 11172-2:1993(E)

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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work.

In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

International Standard ISO/IEC 11172-2 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Sub-Committee SC 29, *Coded representation of audio, picture, multimedia and hypermedia information.*

ISO/IEC 11172 consists of the following parts, under the general title *Information technology — Coding of moving pictures and associated audio for digital storage media at up to about 1,5 Mbit/s*:

— *Part 1: Systems*

— *Part 2: Video*

— *Part 3: Audio*

— *Part 4: Compliance testing*

Annexes A, B and C form an integral part of this part of ISO/IEC 11172. Annexes D, E and F are for information only.

Introduction

Note -- Readers interested in an overview of the MPEG Video layer should read this Introduction and then proceed to annex D, before returning to clauses 1 and 2.

0.1 Purpose

This part of ISO/IEC 11172 was developed in response to the growing need for a common format for representing compressed video on various digital storage media such as CDs, DATs, Winchester disks and optical drives. This part of ISO/IEC 11172 specifies a coded representation that can be used for compressing video sequences to bitrates around 1,5 Mbit/s. The use of this part of ISO/IEC 11172 means that motion video can be manipulated as a form of computer data and can be transmitted and received over existing and future networks. The coded representation can be used with both 625-line and 525-line television and provides flexibility for use with workstation and personal computer displays.

This part of ISO/IEC 11172 was developed to operate principally from storage media offering a continuous transfer rate of about 1,5 Mbit/s. Nevertheless it can be used more widely than this because the approach taken is generic.

0.1.1 Coding parameters

The intention in developing this part of ISO/IEC 11172 has been to define a source coding algorithm with a large degree of flexibility that can be used in many different applications. To achieve this goal, a number of the parameters defining the characteristics of coded bitstreams and decoders are contained in the bitstream itself. This allows for example, the algorithm to be used for pictures with a variety of sizes and aspect ratios and on channels or devices operating at a wide range of bitrates.

Because of the large range of the characteristics of bitstreams that can be represented by this part of ISO/IEC 11172, a sub-set of these coding parameters known as the "Constrained Parameters" has been defined. The aim in defining the constrained parameters is to offer guidance about a widely useful range of parameters. Conforming to this set of constraints is not a requirement of this part of ISO/IEC 11172. A flag in the bitstream indicates whether or not it is a Constrained Parameters bitstream.

Summary of the Constrained Parameters:

Horizontal picture size	Less than or equal to 768 pels
Vertical picture size	Less than or equal to 576 lines
Picture area	Less than or equal to 396 macroblocks
Pel rate	Less than or equal to 396x25 macroblocks/s
Picture rate	Less than or equal to 30 Hz
Motion vector range	Less than -64 to +63,5 pels (using half-pel vectors) [backward_f_code and forward_f_code <= 4 (see table D.7)]
Input buffer size (in VBV model)	Less than or equal to 327 680 bits
Bitrate	Less than or equal to 1 856 000 bits/s (constant bitrate)

0.2 Overview of the algorithm

The coded representation defined in this part of ISO/IEC 11172 achieves a high compression ratio while preserving good picture quality. The algorithm is not lossless as the exact pel values are not preserved during coding. The choice of the techniques is based on the need to balance a high picture quality and compression ratio with the requirement to make random access to the coded bitstream. Obtaining good picture quality at the bitrates of interest demands a very high compression ratio, which is not achievable with intraframe coding alone. The need for random access, however, is best satisfied with pure intraframe coding. This requires a careful balance between intra- and interframe coding and between recursive and non-recursive temporal redundancy reduction.

A number of techniques are used to achieve a high compression ratio. The first, which is almost independent from this part of ISO/IEC 11172, is to select an appropriate spatial resolution for the signal. The algorithm then uses block-based motion compensation to reduce the temporal redundancy. Motion compensation is used for causal prediction of the current picture from a previous picture, for non-causal prediction of the current picture from a future picture, or for interpolative prediction from past and future pictures. Motion vectors are defined for each 16-pel by 16-line region of the picture. The difference signal, the prediction error, is further compressed using the discrete cosine transform (DCT) to remove spatial correlation before it is quantized in an irreversible process that discards the less important information. Finally, the motion vectors are combined with the DCT information, and coded using variable length codes.

0.2.1 Temporal processing

Because of the conflicting requirements of random access and highly efficient compression, three main picture types are defined. Intra-coded pictures (I-Pictures) are coded without reference to other pictures. They provide access points to the coded sequence where decoding can begin, but are coded with only a moderate compression ratio. Predictive coded pictures (P-Pictures) are coded more efficiently using motion compensated prediction from a past intra or predictive coded picture and are generally used as a reference for further prediction. Bidirectionally-predictive coded pictures (B-Pictures) provide the highest degree of compression but require both past and future reference pictures for motion compensation. Bidirectionally-predictive coded pictures are never used as references for prediction. The organisation of the three picture types in a sequence is very flexible. The choice is left to the encoder and will depend on the requirements of the application. Figure 1 illustrates the relationship between the three different picture types.

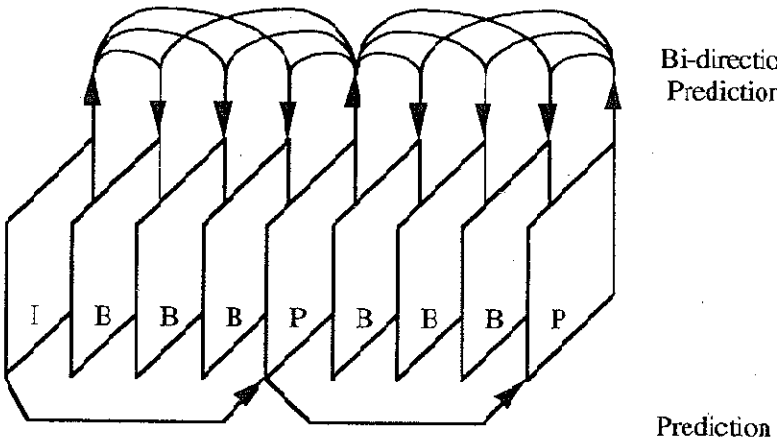

Figure 1 -- Example of temporal picture structure

The fourth picture type defined in this part of ISO/IEC 11172, the D-picture, is provided to allow a simple, but limited quality, fast-forward playback mode.

0.2.2 Motion representation - macroblocks

The choice of 16 by 16 macroblocks for the motion-compensation unit is a result of the trade-off between increasing the coding efficiency provided by using motion information and the overhead needed to store it. Each macroblock can be one of a number of different types. For example, intra-coded, forward-predictive-coded, backward-predictive coded, and bidirectionally-predictive-coded macroblocks are permitted in bidirectionally-predictive coded pictures. Depending on the type of the macroblock, motion vector information and other side information are stored with the compressed prediction error signal in each macroblock. The motion vectors are encoded differentially with respect to the last coded motion vector, using variable-length codes. The maximum length of the vectors that may be represented can be programmed, on a picture-by-picture basis, so that the most demanding applications can be met without compromising the performance of the system in more normal situations.

It is the responsibility of the encoder to calculate appropriate motion vectors. This part of ISO/IEC 11172 does not specify how this should be done.

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