METHOD AND APPARATUS FOR DECODING VIDEO SIGNALS

This invention relates to a method of and apparatus for decoding a currently received one of a series of two-layer coded video signals each of which includes a base layer of coded base data and coded motion vector data, and an enhancement layer of coded enhancement data being the differences between the uncoded video signal and a reconstruction of the immediately previous base video signal from the base layer.

In this application the phrase video signals refers to a digital representation of a video source.

This so called two-layer coding of video signals was devised for use on ATM networks which may suffer cell loss causing large disruption in the transported data streams on variable bit rate (VBR) channels.

An example of a two-layer coding scheme is disclosed in US patent number 4,933,762 in which transmission is via a main path and an auxiliary path of a variable rate digital transmission network. When the main path is not capable of dispatching the totality of the picture information, auxiliary information is dispatched via the auxiliary path.

A drawback of conditional replenishment systems where only the significant differences between successive video signals (or frames) are coded and transmitted when more efficient interframe coders are used is that transmission errors are not confined to a single decoded frame but propagate into later frames.

Masahiro Wada in an article titled "Selective Recovery of Video Packet Loss Using Error Concealment", IEEE Journal on Selected Areas in Communications, Vol 7 (1989) June no 5, New York US describes an error concealment method for a single channel (i.e. one layer) transmission scheme over a VBR channel. When a decoder detects a video packet loss, picture quality is partially recovered by motion-

compensated error concealment in which blocks from the previously received video frame are shifted by the average motion vectors of the blocks which neighbour those used for concealment. This method may prove adequate for one or two missing blocks but may cause a greater disturbance for a larger group of missing blocks. Experiments by the Applicant have shown that as many as four blocks can be fitted into a cell, or packet, and when cell loss occurs on an ATM network, it usually happens in bursts of cells, perhaps between three and ten, resulting in tens of missing blocks.

Preferably, the base layer carries data for a base mode picture together with vital information such as synchronisation data and should, therefore, be transmitted at a constant bit rate on a "guaranteed" constant bit rate channel.

The enhancement layer coding the differences between the video signal being coded and a video frame reconstructed from the base layer alone (which will also be referred to as "enhancement data"), brings the base mode picture up to the final required quality. The enhancement layer will, in general, have a fluctuating bit rate and can be transmitted via a VBR channel. Should any of this information be lost it will not affect tracking of the reconstructed frames but will only result in a momentary reversion to base mode quality. The occasional loss of resolution is compensated by obtaining the benefits of VBR transmission, for example, cost efficient use of the network channels.

Such coded video signals can be decoded by decoding the base layer to obtain a base video signal, decoding the enhancement layer to obtain enhancement data, and combining the base video signal and the enhancement data to obtain the final decoded video signal.

This two-layer coding scheme has been verified by computer simulation on a two-layer adaption of the CCITT

of the information in the missing cells to reconstruct the video signal thereby increasing the resolution of the picture generated by it in comparison to the prior art two-layer decoders.

A preferred embodiment of the invention will now be described, by way of example only, and its principle of operation explained in more detail with reference to the accompanying drawings of which:

Figure 1 is a schematic block diagram of a prior art, two-layer video coder the output of which may be decoded by the method and apparatus of the present invention;

Figure 2 is a schematic diagram of a decoder according to the present invention;

Figure 3 is a graph of the S/N ratio improvement of a video sequence obtained by the decoder of Figure 2 compared to the same decoder operated without the use of interpolated data to replace missing enhancement data; and

Figures 4a and 4b are copies of photographs showing the quality of the decoded picture of the same standard video sequence used to obtain the results of Figure 3 suffering 10% cell loss from the enhancement layer without and with, respectively, use of interpolated data.

Referring first to Figure 1, a schematic prior art video signal coder is shown which provides two-layer coding of the type to which the method and apparatus of present invention is applicable and which will now be described generally to aid understanding of the invention. The coder structure of Figure 1 is a modification to a coder implementing the CCITT H.261 coding scheme. Those parts corresponding to the H.261 scheme lie within the broken lines.

Figure 1 shows the steps of coding a video signal. Separate elements of the diagram do not necessarily represent discrete physical devices carrying out the particular process step.

An incoming (current) video signal, being one of a series, is coupled to an input 1 and has subtracted from it a video signal reconstituted from the immediately previous coded base video signal after compensation for any motion vector data which will be coded along with the code for the current video signal. This reconstituted video signal is obtained from a frame store 2. The subtraction is represented by the subtracter 4.

The resulting difference video signal, which is that to be coded for transmission, is transformed by a DCT 6 and subsequently quantised by a variable quantizer 8. The quantizer 8 is controlled to maintain an output buffer 10 (which stores the quantized data along with other essential information multiplexed with the quantized data by multiplexer and VLC ~~12~~ 17) with contents within preset upper and lower limits.

The output from the buffer 10 constitutes the base layer output from which a base video signal can be reconstituted at a decoder in known manner and as will be described with reference to Figure 2.

The base video signal is also reconstituted within the H.261 type coder of Figure 1 by an inverse quantizer 12 and an inverse DCT 14.

The reconstituted base video signal from the ~~inverse~~ adder ~~DCT~~ 16 14 for the immediately previous input video signal is compared to the current incoming video signal by a motion estimator 18 which determines the motion vectors for this current video signal. The ~~reconstituted base video signal and~~ output from the inverse quantiser 14 ~~is also~~ added to the existing contents of frame store 2 as denoted by adder 16.

The motion estimator 18 is also coupled to the multiplexer ~~12~~ 17 which incorporates the motion vectors in the base layer for the video signal being coded and to frame store 2 so that the frame store's 2 contents correspond to that obtained by a decoder decoding the base layer.

The differences between the current incoming video signal and the video signal as would be reconstructed from the immediately previous base layer is derived by subtracting the latter from the former as is denoted by subtracter 20 which is shown coupled to the video signal input 1 and the adder 16. The difference signal is then quantized by a fine quantizer 22 and output via multiplexer 24 as an enhancement layer at output 25.

In one implementation of encoder the enhancement layer is obtained in the transform domain by subtracting the output of the inverse quantizer 12 from the output of DCT 6 and coupling the difference to the fine quantizer and VLC 22.

The base layer is transmitted on a constant bit rate guaranteed channel which ensures a minimum picture quality is obtained by a receiving decoder. The enhancement layer may be transmitted on a variable bit rate VBR channel to improve the received picture quality when received and take advantage of VBR facilities.

A known decoder for decoding the two-layer coded video signal provided by the coder of Figure 1 is shown schematically by part of Figure 2 which as with Figure 1, shows the process of decoding individual elements not necessarily corresponding to discrete physical items. The known decoder of Figure 2 comprises those processes outwith the dotted boxes. These decoding processes will be described first. Those elements inside the dotted box of Figure 2 comprise additional, exemplary, processes for carrying out the present invention and will be described later.

The decoder of Figure 2 outwith the dotted boxes operates as follows. A received base layer is coupled to a VLD and demultiplexer 40 via a buffer 42. The output of the demultiplexer 40 is converted to a video signal by inverse quantizer 44 and inverse DCT 46. This decoded base layer signal is used to obtain a base video signal in known

CLAIMS

1. A method of decoding a currently received one of a series of two-layer coded video signals, each ~~of which signal includes~~ including a base layer of coded base data and coded motion vector data, and an enhancement layer of coded enhancement data being the differences between the uncoded video signal and a reconstruction of the immediately previous base layer, the method including the steps of:

a) decoding the base layer to obtain a base video signal;

b) decoding the enhancement layer to obtain enhancement data; and

c) combining the base video signal and the enhancement data to obtain a decoded video signal;

and characterised in that the method further includes the steps of:

d) detecting whether any enhancement data is missing from the enhancement layer; and, in such a case

e) interpolating the missing enhancement data by modifying ~~from~~ the enhancement data of the immediately previously received coded video signal ~~and~~ in accordance with the motion vectors of the currently received base layer.

2. A method as claimed in claim 1 in which the enhancement data of the immediately previously received coded video signal are obtained by determining the differences between the immediately previous decoded video signal and a reference base video signal reconstructed from the base layer of the immediately previous received, coded video signal.

3. A method as claimed in claim 2 in which the decoded video signal is stored in a frame store (60).

4. A method as claimed in any preceding claim in which the detection of whether any enhancement data are missing from the enhancement layer is carried out by inspecting the received enhancement layer.

5. A decoder for decoding a currently received one of series of two-layer coded video signals, each ~~of which~~ two-layer coded video signal including ~~includes~~ a base layer of coded base data and coded motion vector data, and an enhancement layer of coded enhancement data being the differences between the uncoded video signal and a reconstruction of the immediately previous base video ~~signal~~ layer, the decoder including:

a) a first decoding means (40, 44, 46, 48, 50) for decoding the base layer to obtain a base video signal;

b) a second decoding means (52, 54, 56) for decoding the enhancement layer to obtain enhancement data;

c) combining means (52) for combining the base video signal and the enhancement data to obtain a decoded video signal: ~~and~~ characterised in that the decoder it includes

d) a ~~fail-loss~~ detection means (66) for detecting whether any enhancement data is missing from the enhancement layer;

e) interpolating means (50, 60, 62, 64) for providing interpolation data comprising the enhancement data of the immediately previous received coded video signal modified in accordance with the motion vectors of the currently received base layer; and

f) means (52, 68) for replacing any missing enhancement data with interpolated data.

6. A decoder as claimed in claim 5 in which the interpolating means includes a first frame store (50) for storing a reference base video signal which is a reconstruction from the base layer of the immediately previous received coded video signal, a second frame store (60) for storing a second frame which is the immediately previous decoded video signal, differencing means (62) for obtaining the enhancement data by subtracting the reference base video signal from the immediately previous decoded video signal, and displacement means (64) for displacing the immediately previous enhancement data in accordance with the received motion vectors.