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A TRANSCODER

This invention relates to transcoders for the conversion of video signals between a first and a second coding scheme.

There are many occasions when it is necessary to transmit moving picture television over long distances via a transmission link. Broadcast quality television requires in excess of 100Mbit/s when transmitted in digital form which is expensive to transmit and requires links of high bandwidth. An acceptable degree of degradation in the picture quality can be introduced to reduce the information content being transmitted. Additionally or alternatively, compression coding techniques may be used which take advantage of the high degree of spatial and temporal redundancies in the video signals being encoded. So, for example, for video conferencing applications compression down to a bit rate of a few hundred kbit/s is possible whereas videophone-quality pictures including sound can be compressed down to only 64kbit/s, equivalent to a single telephone circuit.

Redundancy reduction techniques assume there is spatial and/or temporal correlation between neighbouring pixels or blocks of pixels. The details of correlation are encoded as well as the differences between the assumptions and the actual pixels or blocks. Typically each frame of an image to be coded comprises an array of picture elements (pixels) which are divided into blocks of NxM pixels.

Predictive coding exploits the assumption that a value within a frame is related to some neighbouring values, in the same or a different frame, and the value may therefore be calculated at the receiver instead of being transmitted. It is only necessary to transmit the prediction error arising from such an assumption. For instance the first pixel of a frame may be transmitted exactly whilst each subsequent pixel is transmitted as a difference from its predecessor. In more complex schemes the prediction may be a combination of a number of pixels.

Transform coding exploits the correlation of pixel magnitudes within a frame by transforming the magnitudes into another set of values, many of which are relatively small and can therefore be coded using fewer bits. The most common form of transform coding uses the Discrete Cosine Transforn (DCT). A block of NxM pixels is transformed into an array of NxM transform coefficients. The resulting array of coefficients is then quantised by dividing each coefficient by a variable quantisation factor. The quantised coefficients may be coded in variable length code, for instance a Huffman code.

Another coding technique is motion compensation in which a picture is divided into blocks of pixels and each block of the current frame is compared with the corresponding block of a reference frame, which may be a previous or a subsequent frame, and with regions shifted in position from that block, and that region of the reference frame which the block most closely resembles is identified. The vector difference in position between the identified region and the block in question is termed a motion vector and is used to shift the identified region of the reference frame into the position of the relevant block in the current frame. Motion vectors are generated for all the blocks of the current frame and these are used to derive a predicted frame from the reference frame. The differences between the current and predicted frame are, on average, smaller than those between the current and reference frame and can be encoded using a lower bit rate. A decoder which already has the reference frame stored can thus reproduce the current frame using the motion vectors and the difference values. A signal may be coded using any of the aforementioned coding techniques, either separately or in combination.

There are circumstances when it is desirable to employ a transcoder which can accept a received data stream encoded according to a first scheme and output an encoded data stream encoded according to a second coding scheme. If one had a decoder which operated according to a second coding scheme

then such a transcoder would allow reception of the transmission encoded according to the first coding scheme. For example, a transcoder could be used to convert a 64kbit/s video signal, conforming to CCITT standard H.261, from an ISDN video terminal to a 32kbit/s signal for transmission over a Digital European Cordless telephone (DECT) network.

Known transcoders decode video encoded according to a first coding scheme into an uncompressed video signal which is then encoded by an encoder according to the second coding scheme to output a new compressed data stream. Thus, a full decoding operation is carried out to reconstitute the original video signal and then this video signal is encoded to provide a new coded data stream according to the second coding scheme. Motion vectors have to be generated for the signal encoded according to the new format and this accounts for a large proportion of the processing time of conventional transcoders.

According to the present invention there is provided a transcoder comprising a decoder for decoding a video signal encoded according to a first coding scheme employing motion compensation techniques and an encoder for encoding the decoded video signal according to a second coding scheme characterised in that the decoder extracts the motion compensation information from the video signal and transfers the motion compensation information to the encoded video signal output from the encoder.

The motion compensation information may be transferred unmodified from the decoder to the output of the encoder, thereby reducing the processing required in the transcoder. Alternatively, the motion compensation information may be modified in accordance with the compression ratios of the two coding schemes.

The decoder and encoder may operate with a non-constant clock rate and thus the capacity of the in the main data path can be reduced over conventional transcoders.

It is not necessary for the motion compensation block size of the two coding schemes to be the same. If the

resolution of the two schemes is the same, then the motion vectors can be transferred unchanged if the block size is changed, but some will need to be duplicated or discarded as appropriate. For example, if the motion compensation block size of the first coding scheme is 16x16 pixels and that of the second coding scheme is 8x8, then the motion vector for one 16x16 block can be used for the four co-sited 8x8 blocks of the second scheme. If the block size of the first coding scheme is 8x8 pixels and that of the second coding scheme is 16x16 pixels, there is an excess of motion vectors for the second coding scheme. Thus, for instance, an average of the four relevant motion vectors may be calculated and used.

If the resolution of the input picture is different from the resolution of the output picture resolution, the vectors may be scaled appropriately. For example, if the motion compensation blocks of both coding schemes are 16x16 pixels, the input resolution is 352x288 pixels and the output resolution is 176x144 pixels, the vectors input to the transcoder are divided by two before being transferred to the encoded video signal. The computational complexity is small compared to conventional motion vector estimation.

When predictive coding is used, discrepancies may arise between the data transmitted from the original encoder and that decoded at the destination decoder, owing to transmission errors. Decoded images formed at the final decoder will therefore contain artifacts which will increase with time unless non-predictive coding is occasionally employed to restore the integrity of the decoded signal. However, the original encoder may not employ non-predictive coding sufficiently often for an acceptable decoded image to be constructed at the destination encoder if a transcoder is employed of which the original encoder is not aware. This will result in a drift between the video signal received by the transcoder and that output from the transcoder.

Advantageously therefore the transcoder includes drift compensation means. The drift compensation means preferably comprises means for forming a signal representing the drift

between the output of the decoder and that of the encoder, means for storing the drift signal and means for adding the drift signal to the output of the decoder.

In a preferred embodiment, the drift signal is added to the output of the decoder after a delay, preferably of one picture period. Such an arrangement compensates for the drift without introducing a delay in the encoded signal.

The drift signal may be subjected to a threshold such that the drift signal is added to the output of the decoder if it exceeds such a threshold.

Preferably the decoder includes an inverse quantiser and the encoder includes a quantiser of different quantisation step size from that of the inverse quantiser.

The invention will now be further described by way of example only with reference to the accompanying drawings in which:

Figure 1 shows a schematic drawing of a known transcoder;

Figure 2 shows a schematic drawing of a transcoder according to one embodiment of the invention; and

Figure 3 shows a schematic drawing of a transcoder according to a second embodiment of the invention.

Figure 4 shows a schematic drawing of a transcoder according to a third embodiment of the invention.

A known transcoder as shown in Figure 1 can be perceived as comprising a decoder 28 and an encoder 30. The decoder 28 comprises a variable length decoder 2 which receives a video signal encoded according to a first coding scheme employing motion compensation and DCT coding of the difference signals, say a 64 kbit/s signal conforming to CCITT H.261 standard. The decoder 2 detects and converts the received data into quantised DCT coefficients, quantisation indexes and motion vectors. The DCT coefficients are passed through an inverse quantiser 4 and an inverse DCT processor 6 which converts the DCT coefficients into pixel difference values.

The motion vectors are passed to a motion compensator

8 which calculates the address of the prediction pixel block in the previous frame. This block is then retrieved from a previous frame store 12 and added in adder 10 to the output of the inverse DCT processor 6 to produce a decoded data stream for the current block. The decoded data stream is stored in the previous frame store 12 as a reference for the next frame.

The decoded data stream also passes into the encoder 30 of the transcoder and a motion estimator 14 searches a previous frame buffer 16 for an offset block of pixels that closely resembles the current block. The motion vector for this best-match block is calculated and the block retrieved from the previous frame buffer 16 and subtracted by means 15 from the decoded data stream to form a difference signal. This difference signal for the current block is then transformed into the frequency domain by a DCT processor 18. The frequency coefficients thus generated are then quantised in a quantiser 20 having a step size suitable for the bit rate desired at the transcoder's output. A variable length coder 22 converts the output of the quantiser 20 and the motion vectors from the motion estimator 14 into variable length codes and then outputs the data in the new format.

The encoder 30 of the transcoder also includes a local decoder which comprises an inverse quantiser 24 and an inverse DCT processor 26. The output of the inverse DCT processor 26 and the motion estimator and compensator 14 are input to an adder 27 to produce an updated predicted frame which is stored in the previous frame store 16.

A transcoder according to one embodiment of the invention is shown in Figure 2. The transcoder comprises a variable length decoder 40, for decoding incoming signals encoded according to a first format, for instance in accordance with CCITT standard H.261 at 64kbit/s. The decoder 40 detects and converts the variable length codes into DCT coefficients and motion vectors and the latter are passed through the transcoder without any further processing as indicated by numeral 42. Such a transcoder is suitable

for use with coding schemes having the same picture resolution, transform block size and motion compensation block size. The DCT coefficients are then input to an inverse quantiser 44 and the resulting data requantised by quantiser 46 with a different quantisation step size appropriate to the output format, for instance 32kbit/s. The new DCT coefficients are encoded by a variable length coder 48 and then recombined with the motion vectors 42 in a multiplexer 50.

Figure 3 shows a transcoder according to a second embodiment of the invention which is suitable for use with coding schemes having different picture resolutions, for instance a first coding scheme having a picture resolution of, say, 388x288 pixels and a second coding scheme having a picture resolution of, say, 176x144 pixels. A motion vector scalar 45 scales the incoming motion vectors 42 by a factor of 0.5 and the resulting motion vectors 42a are multiplexed with the output of the VLC, as described with reference to Figure 2.

The quantiser 46 introduces quantisation error into the output of the transcoder which is not foreseen by the original encoder. This error will build up over time unless this drift is compensated for. The transcoder according to Figure 3 also includes drift compensation means. The output from the inverse quantiser 44 is fed to an inverse DCT processor 52 and the output of quantiser 46 is fed to an inverse DCT processor 54. The resulting pixel difference values are passed, via adders 56,58 respectively, into frame stores 60,62 respectively, the contents of which are compensated by the original motion vectors 42 and the scaled motion vectors 42a respectively. After a delay of one frame the contents of the frame stores 60,62 are subtracted by subtractor 63 to form a drift signal between the received data (stored in frame store 60) and the transmitted data (stored in frame store 62). This drift signal is then converted back into the frequency domain by a DCT processor 64 and added to the output of the inverse quantiser 44 by

adder 65. The drift is thus compensated for after a delay of one frame. The motion compensated contents of the frame stores 60, 62 also form the second inputs to the adders 56, 58 respectively.

Figure 4 shows an alternative embodiment of a transcoder according to the invention, which is suitable for coding schemes having the same picture resolution, transform block size and motion compensation block size. Similar components are indicated by the same reference numerals. In this embodiment the drift signal is formed in the frequency domain as opposed to the pixel domain. The outputs of the inverse quantiser 44 and the quantiser 46 are input to a subtractor 70 to form an drift signal between the DCT coefficients of the received and transmitted signal. This drift signal is then converted to the pixel domain by inverse DCT processor 72. The output from the inverse DCT processor 72 forms one input to an adder 74, the output of which is passed to a frame store 76. As before, after a delay of one frame, the contents of the frame store are transformed back into the frequency domain by a DCT processor 78. The contents of the frame store also form the second input to the adder 74.

Figure 5 shows a further embodiment of a transcoder according to the invention which is suitable for use with coding schemes that do not employ motion compensation techniques. Such a transcoder is suitable for use with signals other than video signals. As before, similar components are indicated by the same reference numbers. The transcoder of Figure 5 operates in a manner similar to that shown in Figure 3.

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CLAIMS

1. A transcoder comprising a decoder for decoding a video signal encoded according to a first coding scheme employing motion compensation techniques and an encoder for encoding the decoded video signal according to a second coding scheme characterised in that the decoder extracts the motion compensation information from the video signal and transfers the motion compensation information to the encoded video signal output from the encoder.

2. A transcoder according to Claim 1 further comprising drift compensation means.

3. A transcoder according to Claim 2 wherein the drift compensation means comprises means for forming a signal representing the drift between the output of the decoder and that of the encoder, means for storing the drift signal and means for adding the drift signal to the output of the decoder.

4. A transcoder according to Claim 3 wherein the drift signal is added to the output of the decoder after a delay.

5. A transcoder according to Claim 4 wherein the drift signal is added to the output of the decoder after a delay of one picture period.

6. A transcoder according to either Claim 4 or 5 wherein the drift signal forming means forms the drift signal in the frequency domain, and the transcoder further includes means for converting the drift signal into the pixel domain and means for transforming the drift signal back to the frequency domain.

7. A transcoder according to either Claim 4 or 5 wherein the drift compensation means comprises means for storing the output of the decoder and encoder in the pixel domain and for forming the drift signal in the pixel domain and means for transforming the drift signal back to the frequency domain.

8. A transcoder according to any one of Claims 3 to 7 wherein the drift signal is added to the output of the decoder only if the drift signal exceeds a threshold.

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9. A transcoder according to any preceding Claim wherein the decoder includes an inverse quantiser and the encoder includes a quantiser of different quantisation step size from that of the inverse quantiser.

10. A transcoder comprising a decoder for decoding a video signal encoded according to a first coding scheme and an encoder for encoding the decoded video signal according to a second coding scheme characterised in that compensation means are provided to compensate for the drift between the output from the decoder and the input to the encoder.

11. A transcoder substantially as described herein with reference to Figures 2, 3 or 4 of the accompanying drawings.

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