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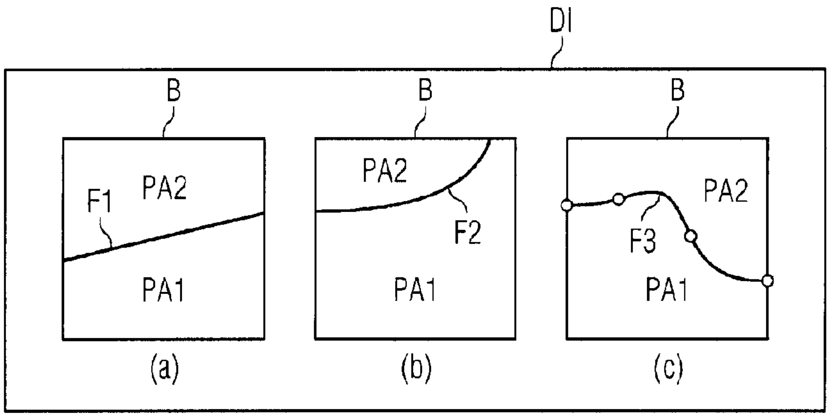


(57) Abrégé/Abstract:
The invention relates to a method for coding a sequence of digitalised images (I) that consist of a plurality of pixels. For each of the images, a signal (S) is coded that is dependent on the image content of the images in question, the uncoded signal being reconstructed and reconstructed images being derived therefrom in the course of the coding process. Said reconstructed images (RI) undergo filtering (LF) wherein a particular reconstructed image (RI) is divided into partitions (PA1, PA2) with one or more filter parameters (FP) being defined for each partition (PA1, PA2). According to the invention, at least some of the partitions (PI1, PI2) are respectively described using one or more parameters of a function (F1, F2, F3) that describes the curve of pixels within a predetermined image region (B), said pixel curve dividing the predetermined image region into at least two partitions (PA1, PA2).

Abstract

The invention relates to a method for coding a sequence of digitalised images (I) that consist of a plurality of pixels. For each of the images, a signal (S) is coded that is dependent on the image content of the images in question, the uncoded signal being reconstructed and reconstructed images being derived therefrom in the course of the coding process. Said reconstructed images (RI) undergo filtering (LF) wherein a particular reconstructed image (RI) is divided into partitions (PA1, PA2) with one or more filter parameters (FP) being defined for each partition (PA1, PA2). According to the invention, at least some of the partitions (PI1, PI2) are respectively described using one or more parameters of a function (F1, F2, F3) that describes the curve of pixels within a predetermined image region (B), said pixel curve dividing the predetermined image region into at least two partitions (PA1, PA2).

Description

METHOD AND DEVICE FOR FILTERING CODED IMAGE PARTITIONS

The invention relates to a method for coding a series of digitized images, together with a corresponding decoding method. Over and above this, the invention relates to a coding device and a decoding device for carrying out respectively the coding and decoding method.

The invention is in the field of video coding. In this, appropriate compression methods are used to compress the contents of temporally consecutive digital images comprising a plurality of pixels, in doing which similarities between temporally neighboring images are generally taken into consideration in a suitable way in order to reduce the size of the compressed image stream.

For the purpose of improving the image quality of a coded image stream after it has been coded, various filtering methods are known from the prior art. In these, images in the image stream which have already been coded are reconstructed again, and appropriate filtering is applied to them, analogous to that used in the decoding. In present-day coding methods, use is made in particular of deblocking filters and Wiener filters. In the case of deblocking filtering, artifacts produced by the compression at the boundaries of coded image blocks are reduced. In the case of Wiener filtering, a comparison is made between the reconstructed images and the original images, and corresponding filter coefficients are determined in such a way that the mean square of the errors between the reconstructed and original images is minimized.

Modern coding methods incorporate a prediction loop in which the temporally next image is predicted, by means of appropriate movement estimation, from one or more temporally preceding reconstructed images. In doing so, the prediction error between the image which is to be coded and the predicted image is coded as a signal. Frequently, the filters mentioned above are used within the prediction loop. In this case, the filters are also referred to as loop filters.

From the prior art, the use of so-called adaptive loop filtering is known, whereby only certain image regions of the image are subject to filtering. In the publication [1], an image block is subdivided for this purpose into ever smaller image blocks, by initially splitting up the original image block into four smaller equal-sized image blocks and then hierarchically splitting up the smaller image blocks repeatedly in the same way into ever smaller image blocks. In doing this, a signal is given for each image block as to whether or not filtering of the image block should take place. The filtering described in the publication [1] has the disadvantage that it is necessary to signal for each individual block whether or not filtering is used, so that when there is a large number of subdivided blocks it is necessary to communicate much additional data in the coded image stream.

It is the object of the invention to produce a method of respectively coding or decoding an image stream, which achieves simple and flexibly adaptable filtering of the images in the image stream.

According to another aspect of the present invention, there is provided a method for coding a series of digitized images (I) comprising a plurality of pixels, by which a signal (S) which depends on their image content is coded for each of the images (I) concerned, by which as part of the coding a reconstruction of the uncoded signal is carried out, and from this are derived reconstructed images (RI), by which the reconstructed images (RI) are subject to filtering (LF), whereby a respective reconstructed image (RI) is split up into partitions (PA1, PA2) and for each partition (PA1, PA2) one or more filter parameters (FP) are defined, wherein a predefined image region (B) is split up by a hierarchical subdivision of the corresponding image (I) into ever smaller image regions (B) into several partitions, and at least some of the partitions (PI1, PI2), which are not further reduced by the hierarchical subdivision, are each described by one or more parameters of a function (F1, F2, F3) that specifies the path of pixels within the at least some partitions, which are not further reduced by the hierarchical subdivision, into two partitions.

According to still another aspect of the present invention, there is provided a method for the decoding of a series of digitized images which have been coded using a method as described above, so that for the images (I) concerned a coded signal (S) is obtained which depends on their image content, whereby as part of the decoding a reconstruction of the uncoded signal (RS) is carried out, and from this are derived reconstructed images, where the reconstructed images (RI) are subject to a filtering which corresponds to the filtering used in the coding, by which during the filtering each particular reconstructed image (RI) is split up into partitions and for each partition one or more filter parameters (FP) are defined, wherein a predefined image region (B) is split up by a hierarchical subdivision of the corresponding image (I) into ever smaller image regions (B) into several partitions, and at least some of the partitions (PI1, PI2), which are not further reduced by the hierarchical subdivision, are each described by one or more parameters of a function (F1, F2, F3) that specifies the path of pixels within the at least some partitions, which are not further reduced by the hierarchical subdivision, into two partitions.

According to yet another aspect of the present invention, there is provided a method for coding and decoding a series of digitized images (I), where the images (I) in the series are coded using a method as described above; the coded images are decoded using a method as described above.

According to a further aspect of the present invention, there is provided a device for coding a series of digitized images (I) comprising a plurality of pixels, having a coding unit (CM) for coding a signal (S) which, for each of the images concerned, depends on their image content, where the coding unit includes: a reconstruction unit (M1), with which a reconstruction of the uncoded signal (RS) is carried out as part of the coding, and from this are derived reconstructed images (RI); a filtering unit (M2), which subjects the reconstructed images (RI) to filtering, by which a respective reconstructed image (RI) is split up into partitions, and for each partition one or more filter parameters (FP) are defined; wherein a predefined image region (B) is split up by a hierarchical subdivision of the corresponding image (I) into ever smaller image regions (B) into several partitions, and at least some of the partitions, which are not further reduced by the hierarchical subdivision, are each described by one or more parameters of a function (F1, F2, F3) that specifies the path of pixels within the at least some partitions, which are not further reduced by the hierarchical subdivision, into two partitions.

According to still a further aspect of the present invention, there is provided a device for decoding a series of digitized images which was coded using a method as described above whereby, in operation, the device uses a decoding unit (DM) to process a coded signal (S'), which depends on the image content of each of the images concerned, where the decoding unit (DM) includes: a reconstruction unit (M3), with which a reconstruction of the uncoded signal (RS) is carried out as part of the decoding, and from this are derived reconstructed images; a filtering unit (M4) which subjects the reconstructed images (RI) to filtering, which corresponds to the filtering used during the coding, by which in the filtering any particular reconstructed image (RI) is split up into partitions and for each partition (PA1, PA2) one or more filter parameters are defined, wherein a predefined image region (B) is split up by a hierarchical subdivision of the corresponding image (I) into ever smaller image regions (B) into several partitions, and at least some of the partitions, which are not further reduced by the hierarchical subdivision, are each described by one or more parameters of a function (F1, F2, F3) that specifies the path of pixels within the at least some partitions, which are not further reduced by the hierarchical subdivision, into two partitions.

The inventive method serves to code a series of digitized images comprising a plurality of pixels, whereby a signal which depends on their image content is coded for each of the images concerned. As part of the coding, a reconstruction of the uncoded signal is carried out, and from this are derived reconstructed images which are preferably used as part of a temporal prediction in the coding of subsequent images in the series. The reconstructed images are subject to filtering, by which each of the reconstructed images concerned is split up into partitions and for each partition one or more filter parameters are defined.

The inventive method is distinguished by the fact that at least some of the partitions are each specified by one or more parameters of a function which specifies a path of pixels within a predefined image region, where the path of pixels splits up the predefined image region into at least two partitions. The predefined image region represents in particular the individual image subregions which, as part of the coding, are processed separately in the form, as applicable, of so-called coding units or on the other hand as image subregions of these coding units.

The inventive method is based on the idea that it is possible to specify, by means of an appropriately parameterized function, various pixel paths within an image region, and it is possible thereby to create partitions of various shapes, to each of which suitable filter parameters can be assigned. By this means, a very flexible coding of the images in an image stream is achieved. The inventive method can be utilized for any required coding method. In particular, the method can be used in the HEVC (High Efficiency Video Coding) video coding standard, which is still under development.

In a preferred variant, the inventive filtering is utilized in a predictive video coding method. In this case a prediction error, between the image currently to be coded and one or more reconstructed and predicted images, is coded as the signal, with the prediction error being determined within a prediction loop from one or more earlier reconstructed images which are subject to movement compensation making use of movement vectors determined through movement estimation. Here and in what follows, the expression reconstruction of an uncoded image refers in particular to the regeneration by approximation of the original image from the coded signal. An exact reconstruction is not generally possible because of image losses evoked by the coding. Here, the reconstructed image(s) after the movement compensation is/are used within the prediction loop for the reconstruction of one or more subsequent images. In doing this, the inventive filtering will preferably be used within the prediction loop for loop filtering before or after the movement compensation. That is to say, within the prediction loop the reconstructed images used for the purpose of determining the prediction error are subject to the inventive filtering in addition to the movement compensation. This notwithstanding, there is also the possibility that the reconstructed images used for the purpose of determining the prediction error are unfiltered, and the filtering of the reconstructed images takes place outside the prediction loop.

In a particularly preferred variant, the coding makes use of a method in which the coded image is produced by a transformation and a quantization, and for the reconstruction of the uncoded signal a corresponding inverse quantization and inverse transformation are applied to the coded signal, where the coded signal, after the quantization and transformation, preferably undergoes a further entropy coding. The entropy coding increases yet further the coding efficiency, without any further loss of information from the image. Then, as part of the decoding, a corresponding entropy decoding is initially applied, before being followed by the application of inverse quantization and inverse transformation to the coded signal.

As part of the inventive filtering, it is possible to use any arbitrary filters used in the prior art. In particular, use can be made of the Wiener filter, already mentioned above, or alternatively or additionally even a deblocking filter.

In a further particularly preferred embodiment, each of the predefined image regions, which are split up into at least two partitions by the path of pixels, are rectangular image regions and preferably square image regions in the form of image blocks. As already mentioned above, the image regions are here, in particular, appropriate coding units or sub-regions of these coding units, as appropriate.

The function which specifies the path of pixels within the predefined image region can be selected as required, depending on the application situation. In one particularly preferred embodiment, a straight line is used. Preferably, the straight line then runs obliquely in an appropriate rectangular image region, i.e. at the points where the straight line intersects an applicable edge of the image region the straight line is not perpendicular to the border of the image region. Alternatively or additionally, the appropriate path of pixels in the predefined image region can also be specified by other functions, such as for example by a polynomial and/or a spline (in particular a B-spline) which represents a piecewise compilation of polynomials.

The appropriate filter parameters, which are defined for the individual partitions in the image, can be in any desired form. In one variant of the invention, the filter parameters specify solely whether or not filtering is effected in the partition concerned. Equally, it is also possible to use the filter parameters to specify which type of filter is used in the predetermined image region. In particular, it is possible to define specific filters for the different partitions, such as for example the Wiener filter or deblocking filter described above, or other specific filter types or special filter characteristics.

In a further embodiment, the inventive subdivision of partitions on the basis of parameters of a function is combined with hierarchical block subdivision. That is to say, the predefined image regions, which are split up into at least two partitions, are each produced by a hierarchical subdivision of the corresponding image into ever smaller image regions. Here, hierarchical splitting of an image means that an image region is subdivided on the basis of a rule into a predefined number of smaller image regions, which can in turn be subdivided in an analogous way on the basis of the same rule into further smaller image regions, and so on. An example of such a hierarchical image subdivision will be found in publication [1] mentioned in the introduction, where an image block is subdivided in steps into four smaller image blocks of equal size.

In a further embodiment of the inventive method, the filter parameter(s) for the partitions concerned and/or the parameter(s) of the function which specifies the path of pixels within the predefined image regions concerned is/are contained in the coded image sequence. Alternatively or in addition, there is also the possibility that the filter parameters or the parameters of the appropriate function, as applicable, can be deduced from one or more predefined coding parameters. For example, the nature of the function (linear, polynomial, spline etc.) can be implied by an appropriate profile, which specifies the coding.

In another preferred embodiment of the inventive method, in which a prediction is made with the aid of movement estimation, partitions, which are defined as part of the movement estimation and which in each case use movement vectors to show image regions which have moved, are used at least in part as partitions for the filtering. In particular, it is possible here to use the movement estimation described in publication [2], in which the partitions which have moved are defined by the splitting up of a block on the basis of the appropriate parameters of a straight line.

Apart from the coding method described above, the invention relates in addition to a method for the decoding of a series of digitized images which have been coded using the inventive method so that for each of the images a coded signal is obtained which depends on their image content. As part of the coding, a reconstruction of the uncoded signal is carried out, and from this are derived reconstructed images which are, preferably, used in the decoding of subsequent images in the series. The reconstructed images are subject to a filtering which corresponds to the filtering used in the coding, by which during the filtering each of the reconstructed images is split up into partitions and for each partition one or more filter parameters are defined. Just as in the coding, at least some of the partitions are each specified by one or more parameters of a function which defines the path of pixels within a predefined image region, where the path of pixels splits up the image region into at least two partitions. The inventive decoding method is preferably arranged in such a way that it is possible to decode a series of digitized images which was coded on the basis of one or more preferred variants of the coding method. I.e. the decoding method also covers the decoding of a series of digitized images which was coded using embodiments of the coding as claimed in the dependent claims.

The invention relates in addition to a method for coding and decoding a series of digitized images, where the images in the series are coded using the coding method described above and the coded images in the series are decoded using the decoding method described above.

The invention relates further to a device for coding a series of digitized images comprising a plurality of pixels, having a coding facility for coding a signal which, for each of the images, depends on their image content, where the coding facility includes:

- a reconstruction facility, with which a reconstruction of the uncoded signal is carried out as part of the coding, and from this are derived reconstructed images which are used, in particular, in the coding of subsequent images in the series;
- a filtering facility which subjects the reconstructed images to filtering by which any particular reconstructed image is split up into partitions, and for each partition one or more filter parameters are defined, where at least some of the partitions are, in each case, specified by one

or more parameters of a function which specifies the path of pixels within a predefined image region, where the path of pixels splits up the predefined image region into at least two partitions.

Over and above this, the invention relates to a corresponding decoding device for decoding a series of digitized images which was coded using the inventive coding method. In operation, the device uses a decoding facility to process a coded signal, which depends on the image content of each of the images concerned, where the decoding facility includes:

- a reconstruction facility, with which a reconstruction of the uncoded signal is carried out as part of the decoding, and from this are derived reconstructed images which are used, in particular, in the decoding of subsequent images in the series;
- a filtering facility which subjects the reconstructed images to filtering, which corresponds to the filtering used during the coding, by which in the filtering each of the reconstructed images is split up into partitions, and for each partition one or more filter parameters are defined, where at least some of the partitions are, in each case, specified by one or more parameters of a function which specifies the path of pixels within a predefined image region, where the path of pixels splits up the predefined image region into at least two partitions.

Over and above this, the invention relates to a codec, for coding and decoding a series of digitized images, which includes a coding device in accordance with the invention and a decoding device in accordance with the invention.

Exemplary embodiments of the invention are described in detail below by reference to the attached figures.

These show:

Fig. 1 a schematic representation of coding and decoding based on an embodiment of the inventive method;

Fig. 2 the representation of an image region which has been filtered on the basis of adaptive loop filtering in accordance with the prior art;

Fig. 3 a diagram showing different variants of a partitioning of image regions, used as part of the inventive filtering;

Fig. 4 an image region which has been partitioned on the basis of one embodiment of the inventive filtering; and

Fig. 5 a schematic diagram of a coding device and a decoding device for carrying out the inventive method.

The embodiment of the inventive method described below is based on the architecture shown in Fig. 1 for hybrid video coding, where the components shown are known per se from the prior art. The difference between the inventive method and the prior art consists in the carrying out of filtering on the basis of the loop filter LF shown in Fig. 1, as described in yet more detail below.

The architecture in Fig. 1 shows coding COD for a stream of video images I from which is determined, with the help of the differentiator DI, a prediction error signal S which is subject to a transformation (in particular a DCT Transformation; DCT = Discrete Cosine Transformation), which is known per se, and then a quantization Q which is also known per se, by which means a compressed prediction error signal CS is obtained. This signal undergoes lossless entropy coding EC. The signal S' thereby obtained is then decoded using appropriate decoding DEC.

For the purpose of determining the prediction error signal S which is to be coded, appropriate video images for previous points in time are taken into consideration. In order to obtain these video images, error signals CS which have already been coded are subject to an inverse quantization IQ and inverse transformation IT. The reconstructed prediction error RS obtained from this is then combined with a movement-compensated signal using the adder AD. The reconstructed image BI which results from this is subject to filtering LF and is stored in a memory FB. As part of the movement compensation, movement estimation ME, which is known per se, is carried out using the original images I, from which are obtained movement vectors MV which specify the displacement of image blocks between the current image and the temporally preceding image. The movement vectors are used as part of the movement compensation MC to predict from the temporally preceding image a current image, which is then fed to the differentiator DI, which outputs the corresponding prediction error S. In addition, via the adder AD the movement-compensated image is combined with the corresponding reconstructed prediction error RS and stored in the memory FB, thus creating a prediction loop.

As already mentioned above, the reconstructed images RI are subject to filtering LF before they are stored in the memory FB. This filtering is effected within the prediction loop, and is therefore also referred to as loop filtering. In doing this, a Wiener filter is utilized, this being known per se from the prior art. This filter minimizes the mean squared error between the current image I and the reconstructed image RI. As the result of the filtering one obtains filter coefficients FC, which are transmitted as page data to the decoder used for the decoding. As part of the inventive filtering, the filtering is effected separately for different image regions, i.e. the appropriate parameters for the filtering can be defined differently for the various image regions. These filter parameters FP are also transmitted to the decoder used for decoding, as page data. In addition to this, the movement vectors MV determined by the movement estimation are communicated to the decoder.

As part of the decoding DEC, the coded signal S′ is initially subject to entropy decoding, from which the coded prediction error CS is obtained. This is subject to an inverse quantization IQ and inverse transformation IT. The reconstructed error signal RS which this produces is combined via the adder AD′ with a corresponding reconstructed image from the memory FB, which has undergone filtering LF and movement compensation MC. By this means, the decoded series of images I′ is obtained, and this can be accessed after the filtering LF. As part of the reconstruction of the images in the memory FB, account is taken of the movement vectors MV, together with the filter parameters FP and filter coefficients FC, which have been communicated. Analog filtering is effected as for the coding, on the basis of the filter parameters and filter coefficients, together with analog movement compensation using the movement vectors MV which have been communicated.

Before giving details of an embodiment of the inventive loop filtering, a description is first given of an adaptive loop filter which is known per se, which can if necessary be combined with the inventive filtering. A description of this adaptive loop filter will be found in publication [1]. With this filter, a coding unit in the form of an appropriate image block is divided up on the basis of a hierarchical block partitioning into smaller square image regions. This is represented in Fig. 2. The image block B illustrated is initially subdivided into four smaller image blocks, and after this the individual image blocks are again divided up if necessary into four smaller image blocks and these are if necessary divided again into smaller image blocks, and so on. In this way, a hierarchical subdivision into smaller image blocks is achieved, with a decision being made at each hierarchical level as to whether a division into smaller blocks should be effected or the block should be retained as one whole. Thus, in accordance with this subdivision four smaller sub-blocks are produced from the block which is currently being processed, these being half as large in the horizontal and vertical directions as the original block. For each node of this quad-tree (i.e. the sub-block for which no further subdivision is effected) the binary data is then stored, indicating whether or not filtering is to be effected for the sub-block. According to Fig. 1, filtering is to be provided for all the blocks which are labeled with 1, whereas the other blocks which are labeled with a zero will not be filtered.

The inventive filtering also assumes a subdivision of an appropriate image block into smaller image regions, but the partitioning is not, or only optionally, carried out on the basis of hierarchical blocks which get ever smaller. Instead, use is made of parametric partitioning, this being indicated in Fig. 3 for different variants of the invention.

Fig. 3 shows a diagram DI, which clarifies variants (a), (b) and (c) of an inventive partitioning of an image block B. Here, a critical aspect of the invention is that, for the purpose of the partitioning, account is taken of one or more parameters of a function which specifies the path of pixels within the image block B which is to be appropriately partitioned. Variant (a) shows this partitioning based on a straight line which passes obliquely through the image block B concerned and divides it into the two partitions PA1 and PA2. In this case, the straight line is specified, in particular, by its slope and offset. For each partition it is specified, in a way analogous to the method shown in Fig. 2, whether or not filtering should be effected. Here, the position of the straight line can be arbitrary. In particular, it is possible that the straight line runs obliquely through the image block, this also being indicated in variant (a). Appropriate criteria, which determine the parameters of the straight lines and hence the splitting up into partitions, can be arbitrarily defined. The parameters of the straight lines will preferably be determined using suitable heuristics or recursive methods, as appropriate, in such a way that the squared error which results from the partitioning is minimized.

Instead of a partitioning based on a linear function, it is also possible to use other functions for the purpose of specifying the partitioning. Variant (b) in Fig. 3 represents this situation, with a partitioning based on a suitable polynomial. Further, the partitioning can be effected on the basis of a piecewise compilation of several polynomials, in the form of a spline, as indicated in variant (c). If necessary, other arbitrary functions can also be used for the purpose of the subdivision.

Fig. 4 shows a variant of the inventive partitioning, which is combined with the hierarchical block subdivision shown in Fig. 2. In this case, the image block B is first subdivided in a suitable way into several sub-blocks. After this, for at least some of the sub-blocks in the quad-tree, which will not be further reduced in size as part of the hierarchical subdivision, a subdivision is undertaken on the basis of the inventive partitioning, using a parametric specification of a pixel path in the form of a straight line. In Fig. 4, the inventive partitioning is applied to the upper left-hand block together with two blocks lying diagonally opposite each other within the lower right-hand block. The digit 1 again indicates the performance of filtering in the corresponding image region, whereas the digit 0 signals that no filtering is applied in the image region.

The filtering indicated in Fig. 4 can if necessary also be achieved purely by quad-tree partitioning, in that subdivision into smaller blocks continues until this models an appropriate straight line as the pixel path. However, this requires a significantly larger number of partitions than is the case for subdivision by means of a linear function. Consequently, the use of filtering in accordance with the invention leads to a significantly lower data rate for the compressed bit stream than pure quad-tree-based filtering.

In the embodiments of the inventive method explained above, as part of the filtering a determination is made for the partitions concerned as to whether or not filtering is to be effected in the partitions concerned. If necessary, there is also the possibility of defining the filter parameters in a more differentiated way. For example, for different partitions it is possible to define different filters or different filter types, e.g. separable filters, non-separable filters, diamond filters and the like. In other variants there is the further possibility that the filtering is effected not as part of a loop filter within the prediction loop, but by an appropriate filter outside the prediction loop. Equally, the filter in Fig. 1 can be arranged at another position within the prediction loop, for example the filtering can be effected after the movement compensation MC.

The appropriate parameters, by which the function for partitioning a block is specified, can be signaled in various ways. For example, the type of the partitioning (linear, polynomial, spline and the like) together with appropriate parameters or coefficients for the type of partition used, such as the slope, points on the function which are known in advance, and the like, can be specified as parameters. The parameters can here be signaled explicitly in the compressed bitstream as filter parameters FP, as is also shown in Fig. 1. Equally, it is possible that the parameters are deduced from other coding parameters. For example, in the case of movement estimation use can be made of the method described in publication [2], by which image blocks are partitioned using the parameters of a straight line just as in the inventive method, where the partitions formed in this way are used for movement estimation. The corresponding parameters of the movement estimation can also be used, at least in part, for the purpose of filtering, so that appropriate filter parameters are also defined via the coding parameters for the movement estimation. Appropriate filter parameters can if necessary also be implied by the specification of the profile used for the purpose of coding. For example, it may be specified for a predefined profile that only a linear partitioning is permitted.

The inventive method described above has a range of advantages. In particular, the filter which is used can be more precisely adjusted and controlled, which is of advantage particularly for complex scenes with several objects in the image. Furthermore, as already mentioned above, data rates can be cut down by comparison with a representation of the filter by means of hierarchical block subdivision. Over and above this, there is also the possibility of combining the inventive filtering in a suitable way with hierarchical block subdivision, which leads to a very flexible partitioning schema for the filter.

Fig. 5 shows a schematic representation of a specific embodiment of a system with a coding device in accordance with the invention and a decoding device in accordance with the invention. The individual components of the system can here be realized in the form of hardware or software or a combination of hardware and software, as appropriate. The coding device includes a coding facility CM, which receives the stream of digitized images I which is to be coded. In this case, a coding of the prediction error takes place within the coding facility, as shown in Fig. 1, i.e. among other items appropriate units are provided for the transformation, quantization, inverse transformation, inverse quantization and entropy coding. In particular, the coding facility CM incorporates in this case a first facility M1 in the form of a reconstruction facility, with which a reconstruction of the uncoded prediction error RS is carried out as part of the coding, and on the basis of this reconstructed images RI are derived. Over and above this, a second facility M2 is provided in the form of a filtering facility, with which the reconstructed images RI are subject to filtering in accordance with the invention, during which the inventive partitioning of the images into sub-regions is effected.

The coded signal S', which is obtained in the form of the coded prediction error as part of the coding, is transmitted to an appropriate decoding unit with a decoding facility DM which by analogy with Fig. 1 contains, among other items, appropriate components for entropy decoding, inverse quantization, inverse transformation and movement estimation. In particular, a third facility M3 is provided here, in the form of a reconstruction facility, which carries out a reconstruction of the uncoded signal RS during the decoding, and from this are derived the reconstructed images RI. Further, a fourth facility M4 is provided, in the form of a filter facility M4, with which the reconstructed images are subject to a filtering which corresponds to the filtering used during the coding, and subdivides the image blocks into suitable partitions. After the decoding has been concluded, the correspondingly decoded image stream, comprising a plurality of decoded images I', is output.

List of references

[1] T. Chujoh, N. Wada and G. Yasuda, "Quadtree-based Adaptive Loop Filter", ITU-T SG 16, document C181, Geneva, January 2009.

[2] P. Chen, W. Chien, R. Panchal, M. Karczewicz, "Geometry motion partition" JCT-VC of ISO/IEC SG29 WG11 (MPEG) and ITU-T SG16 Q.6(VCEG), document JCTVC-B049 , Geneva, Switzerland, July 2010.

CLAIMS:

1. A method for coding a series of digitized images (I) comprising a plurality of pixels, by which a signal (S) which depends on their image content is coded for each of the images (I) concerned, by which as part of the coding a reconstruction of the uncoded signal is carried out, and from this are derived reconstructed images (RI), by which the reconstructed images (RI) are subject to filtering (LF), whereby a respective reconstructed image (RI) is split up into partitions (PA1, PA2) and for each partition (PA1, PA2) one or more filter parameters (FP) are defined, wherein a predefined image region (B) is split up by a hierarchical subdivision of the corresponding image (I) into ever smaller image regions (B) into several partitions, and

at least some of the partitions (PI1, PI2), which are not further reduced by the hierarchical subdivision, are each described by one or more parameters of a function (F1, F2, F3) that specifies the path of pixels within the at least some partitions, which are not further reduced by the hierarchical subdivision, into two partitions.

2. The method as claimed in claim 1, wherein a prediction error, between the image (I) currently to be coded and one or more reconstructed and predicted images (RI), is coded as the signal (S), with the prediction error being determined, by means of a prediction loop, from one or more earlier reconstructed images (RI) which are subject to motion compensation (MC), making use of motion vectors (MV) determined through motion estimation (ME), the reconstructed image or images (RI) being used, after the motion compensation within

the prediction loop, for the purpose of reconstructing one or more subsequent images (RI).

3. The method as claimed in claim 2, wherein within the prediction loop the reconstructed images (RI) used for the purpose of determining the prediction error are subject to filtering (LF) in addition to the motion compensation (MC).

4. The method as claimed in claim 2 or 3, wherein the reconstructed images (RI) used for the purpose of determining the prediction error (S) are unfiltered, and the filtering of the reconstructed images (RI) takes place outside the prediction loop.

5. The method as claimed in any one of claims 1 to 3, wherein the coded signal (CS) is produced by a transformation (T) and a quantization (Q) and for the reconstruction of the uncoded signal (RS) a corresponding inverse quantization (IQ) and inverse transformation (IT) are applied to the coded signal (CS).

6. The method as claimed in claim 5, wherein the coded signal (CS) is applied to a further enropie coding after quantization (Q) and transformation (T).

7. The method as claimed in any one of claims 1 to 3, wherein the filtering of the reconstructed images (RI) is carried out on the basis of a Wiener filter and/or a deblocking filter.

8. The method as claimed in any one of claims 1 to 3, wherein the respective predefined image regions (B), which are split up into at least two partitions (PA1, PA2) by the path of

pixels, are rectangular image regions in the form of image blocks.

9. The method as claimed in any one of claims 1 to 3, wherein the respective predefined image regions (B), which are split up into at least two partitions (PA1, PA2) by the path of pixels, are square image regions in the form of image blocks.

10. The method as claimed in any one of claims 1 to 3, wherein the function (Fl, F2, F3) which specifies the path of pixels within the predefined image region (B), is a straight line.

11. The method as claimed in claim 10, wherein the straight line runs obliquely through the rectangular image region (B).

12. The method as claimed in any one of claims 1 to 3, wherein the function (Fl, F2, F3) which defines the path of pixels within the predefined image region (B) is a polynomial and/or a spline.

13. The method as claimed in any one of claims 1 to 3, wherein the filter parameter or filter parameters (FP) specifies / specify whether filtering is carried out in the partition (PA1, PA2), which are further reduced by the hierarchical subdivision, and/or which type of filter is used in the partition (PA1, PA2)), which are further reduced by the hierarchical subdivision.

14. The method as claimed in any one of claims 1 to 3, wherein the filter parameter or filter parameters (FP) for the partitions (PA1, PA2), which are further reduced by the hierarchical subdivision, and/or the parameter(s) of the

function (F1, F2, F3), which specifies the path of pixels within each of the predefined image regions (B), is/are contained in the coded image sequence and/or can be deduced from one or more predefined coding parameters.

15. The method as claimed in claim 2, wherein partitions (PA1, PA2), which are defined as part of the motion estimation (ME) and which represent image regions moved via relevant motion vectors (MV), are used at least in part as partitions (PA1, PA2) for the filtering.

16. A method for the decoding of a series of digitized images which have been coded using a method as claimed in any one of claims 1 to 15, so that for the images (I) concerned a coded signal (S) is obtained which depends on their image content, whereby as part of the decoding a reconstruction of the uncoded signal (RS) is carried out, and from this are derived reconstructed images, where the reconstructed images (RI) are subject to a filtering which corresponds to the filtering used in the coding, by which during the filtering each particular reconstructed image (RI) is split up into partitions and for each partition one or more filter parameters (FP) are defined,

wherein a predefined image region (B) is split up by a hierarchical subdivision of the corresponding image (I) into ever smaller image regions (B) into several partitions, and

at least some of the partitions (PI1, PI2), which are not further reduced by the hierarchical subdivision, are each described by one or more parameters of a function (F1, F2, F3) that specifies the path of pixels within the at least some

partitions, which are not further reduced by the hierarchical subdivision, into two partitions.

17. A method for coding and decoding a series of digitized images (I), where

- the images (I) in the series are coded using a method as claimed in one of the claims 1 to 15;

- the coded images are decoded using a method as claimed in claim 16.

18. A device for coding a series of digitized images (I) comprising a plurality of pixels, having a coding unit (CM) for coding a signal (S) which, for each of the images concerned, depends on their image content, where the coding unit includes:

- a reconstruction unit (M1), with which a reconstruction of the uncoded signal (RS) is carried out as part of the coding, and from this are derived reconstructed images (RI);

- a filtering unit (M2), which subjects the reconstructed images (RI) to filtering, by which a respective reconstructed image (RI) is split up into partitions, and for each partition one or more filter parameters (FP) are defined;

wherein a predefined image region (B) is split up by a hierarchical subdivision of the corresponding image (I) into ever smaller image regions (B) into several partitions, and

at least some of the partitions, which are not further reduced by the hierarchical subdivision, are each described by one or more parameters of a function (F1, F2, F3) that specifies the path of pixels within the at least some

partitions, which are not further reduced by the hierarchical subdivision, into two partitions.

19. The device as claimed in claim 18, wherein the device incorporates one or more unit for carrying out a method as claimed in any one of claims 2 to 15.

20. A device for decoding a series of digitized images which was coded using a method as claimed in any one of claims 1 to 15 whereby, in operation, the device uses a decoding unit (DM) to process a coded signal (S'), which depends on the image content of each of the images concerned, where the decoding unit (DM) includes:

- a reconstruction unit (M3), with which a reconstruction of the uncoded signal (RS) is carried out as part of the decoding, and from this are derived reconstructed images;

- a filtering unit (M4) which subjects the reconstructed images (RI) to filtering, which corresponds to the filtering used during the coding, by which in the filtering any particular reconstructed image (RI) is split up into partitions and for each partition (PA1, PA2) one or more filter parameters are defined,

wherein a predefined image region (B) is split up by a hierarchical subdivision of the corresponding image (I) into ever smaller image regions (B) into several partitions, and

at least some of the partitions, which are not further reduced by the hierarchical subdivision, are each described by one or more parameters of a function (F1, F2, F3) that specifies the path of pixels within the at least some

partitions, which are not further reduced by the hierarchical subdivision, into two partitions.

21. A codec for coding and decoding a series of digitized images (I), incorporating an coding device as claimed in claim 18 or 19 and a decoding device as claimed in claim 20.

FIG 1

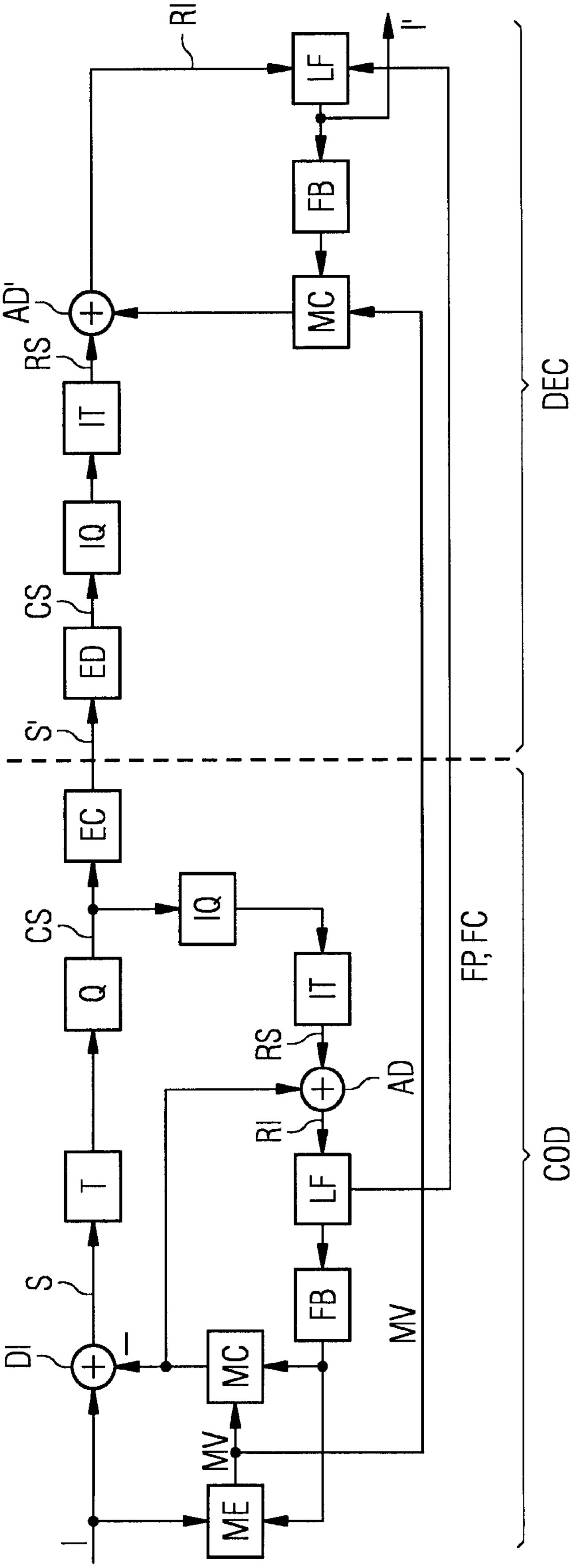

I
ME
MV
MC
DI
S
T
Q
CS
IQ
IT
RS
AD
RI
LF
FB
MV
FP, FC
EC
S'
ED
CS
IQ
IT
RS
AD'
MC
FB
LF
RI
I'
DEC
COD

FIG 2

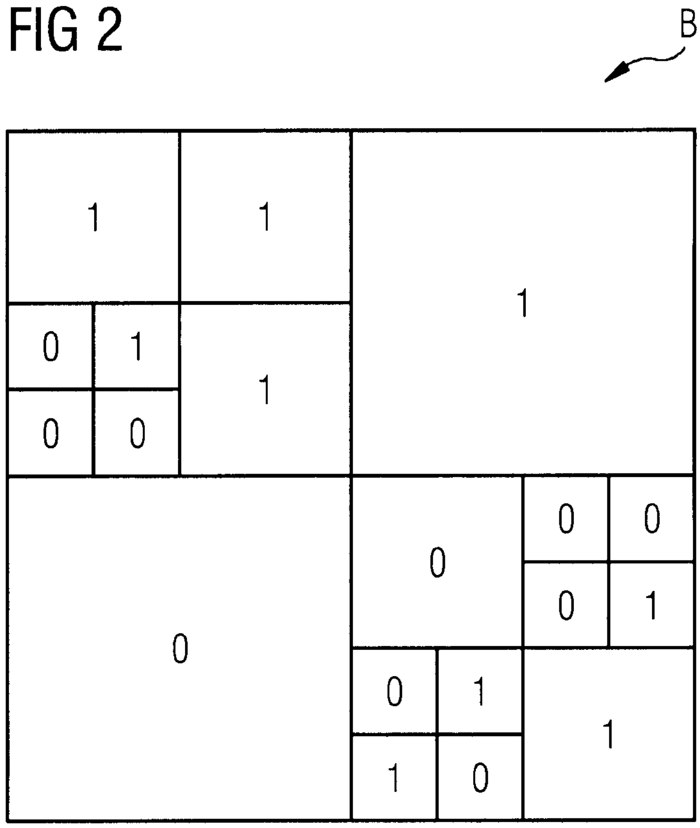

B
1
1
1
0
1
0
0
1
0
0
0
0
0
1
0
0
1
1
0
1

FIG 3

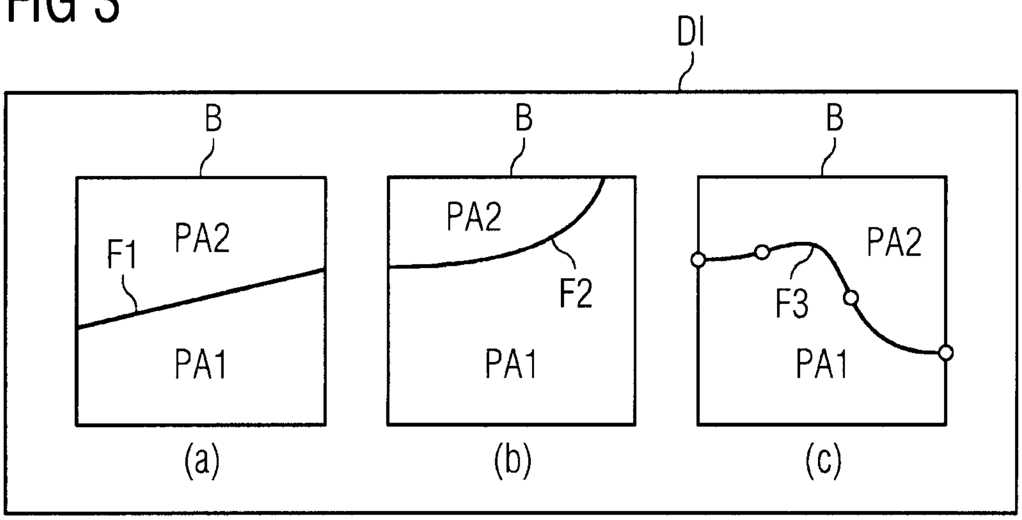

DI
B
F1
PA2
PA1
(a)
B
PA2
F2
PA1
(b)
B
PA2
F3
PA1
(c)

FIG 4

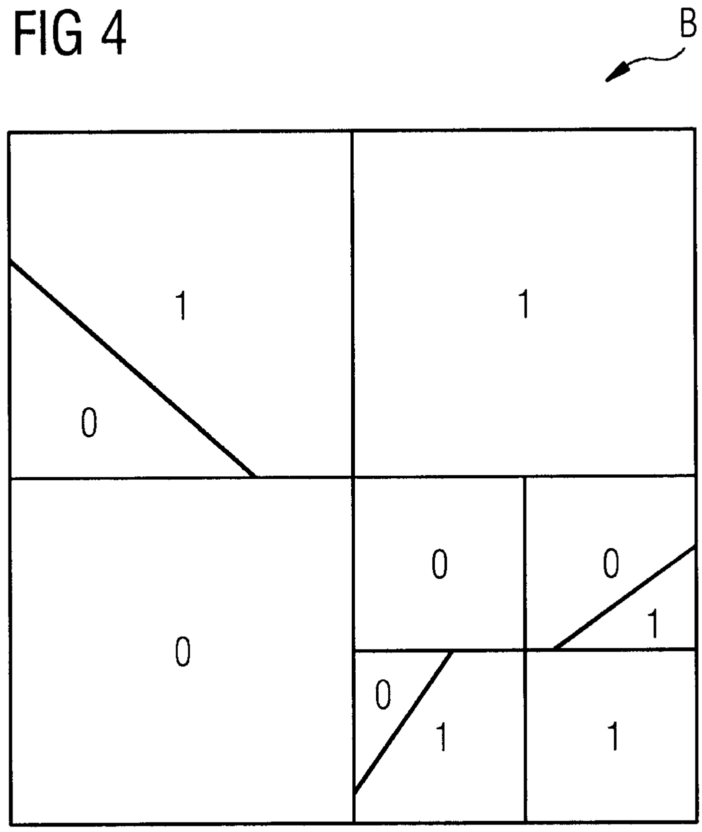
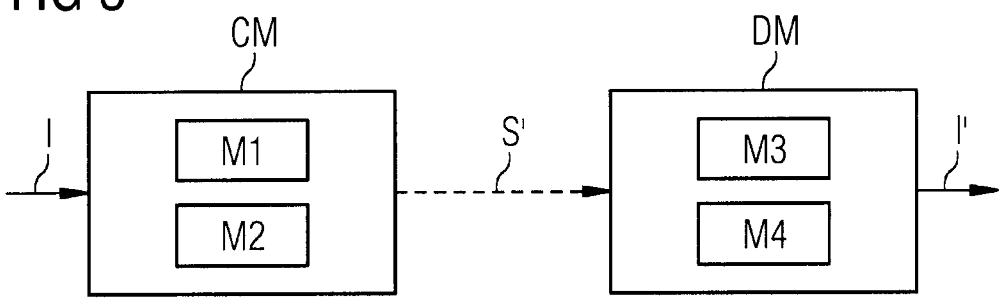
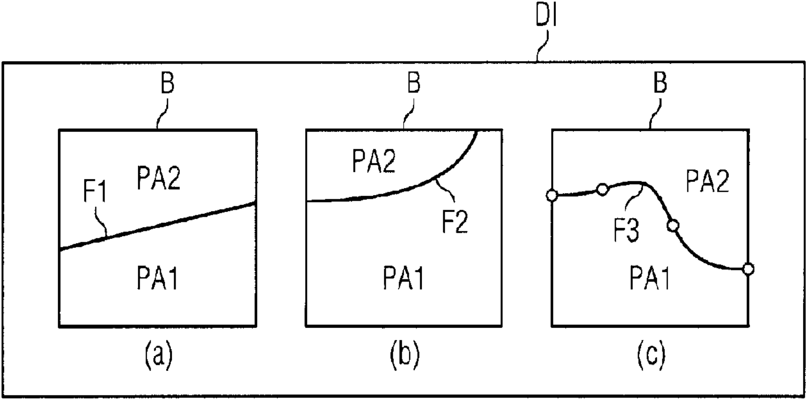


FIG 5




DI
B
PA2
F1
PA1
(a)
B
PA2
F2
PA1
(b)
B
PA2
F3
PA1
(c)