obtained, which corresponds to the differences obtained by subtracting the prediction signal from the signal input to the encoder in the case no quantization noise is introduced.

The prediction signal is obtained from either a temporal or a spatial prediction 260 and 270, respectively, which are switched 275 in accordance with a received information element signalizing the prediction applied at the encoder. The decoded information elements further include the information necessary for the prediction such as prediction type in the case of intra-prediction (a spatial intra-prediction mode information) and motion data in the case of motion compensated prediction. Depending on the current value of the motion vector, interpolation of pixel values may be needed in order to perform the motion compensated prediction. This interpolation is performed by an interpolation filter 250. The quantized prediction error signal in the spatial domain is then added by means of an adder 225 to the prediction signal obtained either from the motion compensated prediction 260 or intra-frame prediction 270. The reconstructed image may be passed through a deblocking filter 230 and the resulting decoded signal is stored in the memory 240 to be applied for temporal or spatial prediction of the following blocks. The post filter information is fed to a post filter 280, which sets up a post filter accordingly. The post filter is then applied to the decoded signal in order to further improve the image quality.

Directional intra prediction modes are very efficient to predict sharp edges, but are not adapted to predict smooth or out of focus regions. For such regions smoothing the references with a low pass filter is particularly appropriate and provides gains in terms of coding efficiency. Thus, applying a low pass filter on the reference pixels for intra prediction is a known technique to remove the quantization noise added to the reconstructed pixels and to improve intra prediction, especially when the region of the image to be predicted is blurred or out of focus.

SUMMARY OF THE INVENTION

The problem underlying the present invention is that if a low pass filter is applied to the references, sharp edges can not be predicted efficiently.

~~The aim~~Embodiments of the present invention ~~is to~~ provide an improved and more efficient intra prediction for encoding and decoding of an image.

~~This is achieved by the features of independent claims.~~

~~Further embodiments of the present invention are subject matter of the dependent claims.~~

According to a first aspect of the present invention, there is provided a method for decoding, on a block-by-block basis, encoded image data partitioned into a plurality of blocks, said method comprising: deriving characteristics between image data of each of a plurality of previously decoded blocks spatially adjacent to a current block, the previously decoded blocks being used for intra prediction of the current block; deciding on the basis of the derived characteristics whether first filtering is to be applied or not to the previously decoded blocks; predicting the current block from the image data of the previously decoded blocks by intra prediction, wherein in said predicting of the current block, intra prediction is performed using filtered image data of the previously decoded blocks to which the first filtering is applied, when said deciding decides that the first filtering is to be applied to the previously decoded blocks.

According to a second aspect of the present invention, there is provided an apparatus for decoding, on a block-by-block basis, encoded image data partitioned into a plurality of blocks, said apparatus comprising: a processor; and a non-transitory memory having stored thereon executable instructions, which when executed, cause the processor to perform: deriving characteristics between image data of each of a plurality of previously decoded blocks spatially adjacent to a current block, the previously decoded blocks being used for intra prediction of the current block; deciding on the basis of the derived characteristics whether first filtering is to be applied or not to the previously decoded blocks; predicting the current block from the image data of the previously decoded blocks, wherein in predicting of the current block, intra prediction is performed using filtered image data of the previously decoded blocks to which the first filtering is applied, when said deciding decides that the first filtering is to be applied to the previously decoded blocks.

~~It is a particular approach~~Embodiments of the present invention ~~to~~ distinguish whether a low-pass filter has to be applied to reference pixels or to prediction signal of a current image area or not. This distinguishing is based on characteristics of the image signal adjacent spatially to the current image area.

~~According to an aspect of the present invention, a method is provided~~ Disclosed herein is a method for decoding, on a block-by-block basis, encoded image data partitioned into a plurality of blocks, said method comprising the steps of: deriving statistics of previously decoded data spatially adjacent to the current block; deciding on the basis of the derived statistics whether filtering is to be applied or not during intra prediction; and predicting a current block from image data of previously decoded blocks.

~~According to another aspect of the present invention, a method is provided~~ Disclosed herein is a method for encoding, on a block-by-block basis, image data partitioned into a plurality of blocks, said method comprising the steps of: deriving statistics of previously decoded data spatially adjacent to the current block; deciding on the basis of the derived statistics whether filtering is to be applied or not during intra prediction; and predicting a current block from image data of previously decoded blocks.

~~According to another aspect of the present invention, an apparatus is provided~~ Disclosed herein is an apparatus for decoding, on a block-by-block basis, encoded image data partitioned into a plurality of blocks, said apparatus comprising: a calculation unit for deriving statistics of previously decoded data spatially adjacent to the current block; a judging unit for deciding on the basis of the derived statistics whether filtering is to be applied or not during intra prediction; and a directional prediction unit for predicting a current block from image data of previously decoded blocks.

~~According to another aspect of the present invention, an apparatus is provided~~Disclosed herein is a method for encoding, on a block-by-block basis, image data partitioned into a plurality of blocks, said apparatus comprising: a calculation unit for deriving statistics of previously decoded data spatially adjacent to the current block; a judging unit for deciding on the basis of the derived statistics whether filtering is to be applied or not during intra prediction; and a directional prediction unit for predicting a current block from image data of previously encoded and decoded blocks.

~~In accordance with still another aspect of the present invention.~~Disclosed herein is a computer program product ~~is provided~~ comprising a computer-readable medium having a computer-readable program code embodied thereon, wherein the program code is adapted to carry out the above ~~described~~disclosed method.

The above and other ~~objects~~aspects and features of the present invention will become more apparent from the following description and preferred embodiments given in conjunction with the accompanying drawings, in which:

Figure 1 is a block diagram illustrating an example of a conventional H.264/MPEG-4 AVC video encoder;

Figure 2 is a block diagram illustrating an example of a conventional H.264/MPEG-4 AVC video decoder;

Figure 3 is a block diagram illustrating an intra prediction unit in accordance with an embodiment of the present invention;

Figure 4 is a flow chart illustrating a method for intra prediction filtering according to a first embodiment of the present invention, using edge detection;

Figure 5 is a flowchart illustrating a method for intra prediction filtering according to a first embodiment of the present invention, using variance calculation;

Figure 6 is a flow chart illustrating a method for intra prediction filtering according to a second embodiment of the present invention employing a special prediction mode;

Figure 7 is a schematic drawing illustrating application of filtering according to a third embodiment of the present invention;

Figure 8 is a schematic drawing illustrating application of filtering according to a fourth embodiment of the present invention;

Figure 9 is a schematic drawing of an overall configuration of a content providing system for implementing content distribution services;

Figure 10 is a schematic drawing of an overall configuration of a digital broadcasting system;

Figure 11 is a block diagram illustrating an example of a configuration of a television;

Figure 12 is a block diagram illustrating an example of a configuration of an information reproducing/recording unit that reads and writes information from or on a recording medium that is an optical disk;

CLAIMS

1. A method for decoding, on a block-by-block basis, encoded image data partitioned into a plurality of blocks, said method comprising the steps of:

   deriving statistics of previously decoded data spatially adjacent to the current block;

   deciding on the basis of the derived statistics whether filtering is to be applied or not during intra prediction; and

   predicting a current block from image data of previously decoded blocks.

2. A method for encoding, on a block-by-block basis, image data partitioned into a plurality of blocks, said method comprising the steps of:

   deriving statistics of previously decoded data spatially adjacent to the current block;

   deciding on the basis of the derived statistics whether filtering is to be applied or not during intra prediction; and

   predicting a current block from image data of previously decoded blocks.

3. The method according to claim 1, further comprising the step of, when decided that the filtering is to be applied, filtering during the intra prediction, wherein the filtering is applied to the already decoded reference pixels used for the prediction.

4. The method according to claim 1, further comprising the step of, when decided that the filtering is to be applied, filtering during the intra prediction, wherein the filtering is applied to the predicted signal.

5. The method according to any of claims 1 to 4, wherein the derivation of statistics of the previously decoded signal is performed by calculating the variance of the signal of the surrounding blocks.

6. The method according to claim 5, wherein the filtering is applied when the variance of the signal of the surrounding blocks is below a predefined threshold; and

no filtering is applied when the variance of the signal of the surrounding blocks is above the predefined threshold.

7. The method according to any of claims 1 to 4, wherein the derivation of statistics of the previously decoded signal is performed by applying an edge detection method.

8. The method according to claim 7, wherein the filtering is applied when no edge is detected; and no filtering is applied when an edge is detected.

9. The method according to claim 8, wherein the filtering is applied only to already decoded reference pixels located in a predetermined distance from the line calculated by extending the detected edge.

10. The method according to claim 8, wherein different filters are applied to pixels in a line of reference pixels depending on their position relative to the line calculated by extending the detected edge.

11. A computer program product comprising a computer-readable medium having a computer-readable program code embodied thereon, the program code being adapted to carry out the method according to any of claims 1 to 10.

12. An apparatus for decoding, on a block-by-block basis, encoded image data partitioned into a plurality of blocks, said apparatus comprising:

a calculation unit for deriving statistics of previously decoded data spatially adjacent to the current block;

a judging unit for deciding on the basis of the derived statistics whether filtering is to be applied or not during intra prediction; and

a directional prediction unit for predicting a current block from image data of previously decoded blocks.

13. An apparatus for encoding, on a block-by-block basis, image data partitioned into a plurality of blocks, said apparatus comprising:

a calculation unit for deriving statistics of previously decoded data spatially adjacent to the current block;

a judging unit for deciding on the basis of the derived statistics whether filtering is to be applied or not during intra prediction; and

a directional prediction unit for predicting a current block from image data of previously decoded blocks.

14. The apparatus according to claim 12, further comprising a filter, wherein the apparatus is configured to apply the filter during the intra prediction to the already decoded reference pixels used for the prediction when the judging unit decides that the filtering is to be applied.

15. The apparatus according to claim 12, further comprising a filter, wherein the apparatus is configured to apply the filter during the intra prediction to the predicted signal when the judging unit decides that the filtering is to be applied,

16. The apparatus according to any of claims 1 to 15, wherein the calculation unit is configured to derive statistics of the previously decoded signal by calculating the variance of the signal of the surrounding blocks.

17. The apparatus according to claim 16, wherein the filtering is applied when the variance of the signal of the surrounding blocks derived by the calculation unit is below a predefined threshold; and

no filtering is applied when the variance of the signal of the surrounding blocks is above the predefined threshold.

18. The apparatus according to any of claims 12 to 15, wherein the calculation unit is configured to derive statistics of the previously decoded signal by applying an edge detection method.

19. The apparatus according to claim 18, wherein the filtering is applied when no edge is detected by the calculation unit; and no filtering is applied when an edge is detected by the calculation unit.

20. The apparatus according to claim 19, wherein the filtering is applied only to already decoded reference pixels located in a predetermined distance from the line calculated by extending the detected edge.

21. The apparatus according to claim 19, wherein different filters are applied to pixels in a line of reference pixels depending on their position relative to the line calculated by extending the detected edge.

CLAIMS

1. A method for decoding, on a block-by-block basis, encoded image data partitioned into a plurality of blocks, said method comprising:

deriving characteristics between image data of each of a plurality of previously decoded blocks spatially adjacent to a current block, the previously decoded blocks being used for intra prediction of the current block;

deciding on the basis of the derived characteristics whether first filtering is to be applied or not to the previously decoded blocks;

predicting the current block from the image data of the previously decoded blocks by intra prediction,

wherein in said predicting of the current block, intra prediction is performed using filtered image data of the previously decoded blocks to which the first filtering is applied, when said deciding decides that the first filtering is to be applied to the previously decoded blocks.

2. The method according to claim 1, wherein said deriving of the characteristics includes calculating a variance between the image data of each of the plurality of the previously decoded blocks.

3. The method according to claim 2, wherein said deciding decides that the first filtering is to be applied to the previously decoded blocks when the variance is below a predefined threshold; and

wherein said deciding decides that no filtering is to be applied to the previously decoded blocks when the variance is above the predefined threshold.

4. The method according to claim 1, wherein in said predicting of the current block, intra prediction is performed using filtered image data of the previously decoded blocks to which second filtering is applied, when said deciding decides that no filtering is to be applied to the previously decoded blocks.

5. The method according to claim 1, further comprising detecting an edge,

wherein said deciding includes deciding, according to the detected edge and a position of a pixel, which one of the first filtering and a second filtering is to be applied to the previously decoded blocks, and

wherein in said predicting of the current block, intra prediction is performed using the filtered image data of the previously decoded blocks to which the decided one of the first filtering and the second filtering is applied.

6. A computer program adapted to carry out the method according to any one of claims 1 to 5.

7. An apparatus for decoding, on a block-by-block basis, encoded image data partitioned into a plurality of blocks, said apparatus comprising:

a processor; and

a non-transitory memory having stored thereon executable instructions, which when executed, cause the processor to perform:

deriving characteristics between image data of each of a plurality of previously decoded blocks spatially adjacent to a current block, the previously decoded blocks being used for intra prediction of the current block;

deciding on the basis of the derived characteristics whether first filtering is to be applied or not to the previously decoded blocks;

predicting the current block from the image data of the previously decoded blocks,

wherein in predicting of the current block, intra prediction is performed using filtered image data of the previously decoded blocks to which the first filtering is applied, when said deciding decides that the first filtering is to be applied to the previously decoded blocks.

8. The apparatus according to claim 7, wherein the deriving of the characteristics includes calculating a variance between the image data of each of the plurality of the previously decoded blocks.

9. The apparatus according to claim 8, wherein the deciding decides that the first filtering is to be applied to the previously decoded blocks when the variance is below a predefined threshold, and

wherein the decoding decides that no filtering is to be applied to the previously decoded blocks when the variance is above the predefined threshold.

10. The apparatus according to claim 7, wherein in the predicting of the current block, intra prediction is performed using filtered image data of the previously decoded blocks to which second filtering is applied, when the deciding decides that no filtering is to be applied to the previously decoded blocks.

11. The apparatus according to claim 7,

wherein the executable instructions, when executed, further cause the processor to perform detecting an edge,

wherein the deciding includes deciding, according to the detected edge and a position of a pixel, which one of the first filtering and a second filtering is to be applied to the previously decoded blocks, and

wherein in the predicting of the current block, intra prediction is performed using the filtered image data of the previously decoded blocks to which the decided one of the first filtering and the second filtering is applied.