CLAIMS:

1. A method of encoding video data, the method comprising:

selecting an intra-prediction mode to use to encode a block of video data;

determining whether the block includes a sub-block of a size for which multiple transforms are possible based on the size of the sub-block and the selected intra-prediction mode;

when the block includes the sub-block of the size for which multiple transforms are possible based on the size of the sub-block and the selected intra-prediction mode:

selecting one of the multiple possible transforms;

transforming the sub-block using the selected one of the multiple possible transforms; and

providing an indication of the selected one of the multiple possible transforms for the size of the block.

2. The method of claim 1, further comprising, when the block does not include the sub-block of the size for which multiple transforms are possible, transforming the block using a transform associated with the intra-prediction mode selected for the block.

3. The method of claim 1, further comprising transforming all sub-blocks of the block having the size for which multiple transforms are possible using the selected one of the multiple possible transforms.

4. The method of claim 1, wherein the intra-prediction mode comprises a first intra-prediction mode, and wherein the sub-block comprises a first sub-block, the method further comprising:

determining whether the block includes a second sub-block of a size for which the first intra-prediction mode is not available;

when the block includes the second sub-block of the size for which the first intra-prediction mode is not available:

determining a second intra-prediction mode to which the first intra-prediction mode is mapped; and

predicting the second sub-block using the second intra-prediction mode.

5. The method of claim 4, wherein the first sub-block and the second sub-block are the same sub-block.

6. The method of claim 4, further comprising, when the first intra-prediction mode is available for all sub-blocks of the block, predicting all sub-blocks using the first intra-prediction mode.

7. The method of claim 1, wherein providing the indication comprises providing the indication in a root node of a quadtree data structure corresponding to the block of video data.

8. An apparatus for encoding video data, the apparatus comprising a video encoder configured to select an intra-prediction mode to use to encode a block of video data, determine whether the block includes a sub-block of a size for which multiple transforms are possible based on the size of the sub-block and the selected intra-prediction mode, when the block includes the sub-block of the size for which multiple transforms are possible based on the size of the sub-block and the selected intra-prediction mode, select one of the multiple possible transforms, transform the sub-block using the selected one of the multiple possible transforms, and provide an indication of the selected one of the multiple possible transforms for the size of the block.

9. The apparatus of claim 8, wherein when the block does not include the sub-block of the size for which multiple transforms are possible, the video encoder is configured to transform the block using a transform associated with the intra-prediction mode selected for the block.

10. The apparatus of claim 8, wherein the video encoder is configured to transform all sub-blocks of the block having the size for which multiple transforms are possible using the selected one of the multiple possible transforms.

11. The apparatus of claim 8, wherein the intra-prediction mode comprises a first intra-prediction mode, wherein the sub-block comprises a first sub-block, and wherein the video encoder is further configured to determine whether the block includes a second sub-block of a size for which the first intra-prediction mode is not available, and when the block includes the second sub-block of the size for which the first intra-prediction mode is not available, determine a second intra-prediction mode to which the first intra-prediction mode is mapped, and predict the second sub-block using the second intra-prediction mode.

12. The apparatus of claim 11, wherein when the first intra-prediction mode is available for all sub-blocks of the block, the video encoder is configured to predict all sub-blocks using the first intra-prediction mode.

13. The apparatus of claim 8, wherein the video encoder is configured to provide the indication of the selected one of the multiple possible transforms in a root node of a quadtree data structure corresponding to the block of video data.

14. The apparatus of claim 8, wherein the apparatus comprises at least one of:

an integrated circuit;

a microprocessor; and

a wireless communication device that includes the video encoder.

15. An apparatus for encoding video data, the apparatus comprising:

means for selecting an intra-prediction mode to use to encode a block of video data;

means for determining whether the block includes a sub-block of a size for which multiple transforms are possible based on the size of the sub-block and the selected intra-prediction mode;

means for selecting one of the multiple possible transforms when the block includes the sub-block of the size for which multiple transforms are possible based on the size of the sub-block and the selected intra-prediction mode;

means for transforming the sub-block using the selected one of the multiple possible transforms when the block includes the sub-block of the size for which multiple transforms are possible based on the size of the sub-block and the selected intra-prediction mode; and

means for providing an indication of the selected one of the multiple possible transforms for the size of the block when the block includes the sub-block of the size for which multiple transforms are possible based on the size of the sub-block and the selected intra-prediction mode.

16. The apparatus of claim 15, wherein the intra-prediction mode comprises a first intra-prediction mode, and wherein the sub-block comprises a first sub-block, further comprising:

means for determining whether the block includes a second sub-block of a size for which the first intra-prediction mode is not available;

means for determining a second intra-prediction mode to which the first intra-prediction mode is mapped when the block includes the second sub-block of the size for which the first intra-prediction mode is not available; and

means for predicting the second sub-block using the second intra-prediction mode when the block includes the second sub-block of the size for which the first intra-prediction mode is not available.

17. A computer program product comprising a computer-readable storage medium having stored thereon instructions that, when executed, cause a processor of a device for encoding video data to:

select an intra-prediction mode to use to encode a block of video data;

determine whether the block includes a sub-block of a size for which multiple transforms are possible based on the size of the sub-block and the selected intra-prediction mode;

when the block includes the sub-block of the size for which multiple transforms are possible based on the size of the sub-block and the selected intra-prediction mode:

select one of the multiple possible transforms;

transform the sub-block using the selected one of the multiple possible transforms; and

provide an indication of the selected one of the multiple possible transforms for the size of the block.

18. The computer program product of claim 17, wherein the intra-prediction mode comprises a first intra-prediction mode, and wherein the sub-block comprises a first sub-block, further comprising instructions that cause the processor to:

determine whether the block includes a second sub-block of a size for which the first intra-prediction mode is not available;

when the block includes the second sub-block of the size for which the first intra-prediction mode is not available:

determine a second intra-prediction mode to which the first intra-prediction mode is mapped; and

predict the second sub-block using the second intra-prediction mode.

19. A method of decoding video data, the method comprising:

receiving a first indication of an intra-prediction mode to use to decode a block of video data;

determining whether the block includes a sub-block of a size for which multiple transforms are possible based on the size of the sub-block and the indicated intra-prediction mode;

when the block includes the sub-block of the size for which multiple inverse transforms are possible based on the size of the sub-block and the indicated intra-prediction mode:

receiving a second indication of one of the multiple possible inverse transforms; and

inverse transforming the sub-block using the indicated one of the multiple possible inverse transforms.

20. The method of claim 19, further comprising, when the block does not include the sub-block of the size for which multiple inverse transforms are possible, inverse transforming the block using an inverse transform associated with the intra-prediction mode indicated for the block.

21. The method of claim 19, further comprising inverse transforming all sub-blocks of the block having the size for which multiple inverse transforms are possible using the indicated one of the multiple possible transforms.

22. The method of claim 19, wherein the intra-prediction mode comprises a first intra-prediction mode, and wherein the sub-block comprises a first sub-block, the method further comprising:

determining whether the block includes a second sub-block of a size for which the first intra-prediction mode is not available;

when the block includes the second sub-block of the size for which the first intra-prediction mode is not available:

determining a second intra-prediction mode to which the first intra-prediction mode is mapped; and

predicting the second sub-block using the second intra-prediction mode.

23. The method of claim 22, further comprising, when the first intra-prediction mode is available for all sub-blocks of the block, predicting all sub-blocks using the first intra-prediction mode.

24. The method of claim 19, wherein receiving the first indication comprises receiving the first indication in a root node of a quadtree data structure corresponding to the block of video data.

25. An apparatus for decoding video data, the apparatus comprising a video decoder configured to receive a first indication of an intra-prediction mode to use to decode a block of video data, determine whether the block includes a sub-block of a size for which multiple transforms are possible based on the size of the sub-block and the indicated intra-prediction mode, when the block includes the sub-block of the size for which multiple inverse transforms are possible based on the size of the sub-block and the indicated intra-prediction mode, receive a second indication of one of the multiple possible inverse transforms, and inverse transform the sub-block using the indicated one of the multiple possible inverse transforms.

26. The apparatus of claim 25, wherein when the block does not include the sub-block of the size for which multiple inverse transforms are possible, the video decoder is configured to inverse transform the block using an inverse transform associated with the intra-prediction mode indicated for the block.

27. The apparatus of claim 25, wherein the video decoder is configured to inverse transform all sub-blocks of the block having the size for which multiple inverse transforms are possible using the indicated one of the multiple possible transforms.

28. The apparatus of claim 25, wherein the intra-prediction mode comprises a first intra-prediction mode, wherein the sub-block comprises a first sub-block, and wherein the video decoder is configured to determine whether the block includes a second sub-block of a size for which the first intra-prediction mode is not available, when the block includes the second sub-block of the size for which the first intra-prediction mode is not available, determine a second intra-prediction mode to which the first intra-prediction mode is mapped, and predict the second sub-block using the second intra-prediction mode.

29. The apparatus of claim 28, wherein when the first intra-prediction mode is available for all sub-blocks of the block, the video decoder is configured to predict all sub-blocks using the first intra-prediction mode.

30. The apparatus of claim 25, wherein the video decoder is configured to receive the first indication in a root node of a quadtree data structure corresponding to the block of video data.

31. The apparatus of claim 25, wherein the apparatus comprises at least one of:

an integrated circuit;

a microprocessor; and

a wireless communication device that includes the video decoder.

32. An apparatus for decoding video data, the apparatus comprising:

means for receiving a first indication of an intra-prediction mode to use to decode a block of video data;

means for determining whether the block includes a sub-block of a size for which multiple transforms are possible based on the size of the sub-block and the indicated intra-prediction mode;

means for receiving a second indication of one of the multiple possible inverse transforms when the block includes the sub-block of the size for which multiple inverse transforms are possible based on the size of the sub-block and the indicated intra-prediction mode; and

means for inverse transforming the sub-block using the indicated one of the multiple possible inverse transforms when the block includes the sub-block of the size for which multiple inverse transforms are possible based on the size of the sub-block and the indicated intra-prediction mode.

33. The apparatus of claim 32, wherein the intra-prediction mode comprises a first intra-prediction mode, and wherein the sub-block comprises a first sub-block, further comprising:

means for determining whether the block includes a second sub-block of a size for which the first intra-prediction mode is not available;

means for determining a second intra-prediction mode to which the first intra-prediction mode is mapped when the block includes the second sub-block of the size for which the first intra-prediction mode is not available; and

means for predicting the second sub-block using the second intra-prediction mode when the block includes the second sub-block of the size for which the first intra-prediction mode is not available.

34. A computer program product comprising a computer-readable storage medium having stored thereon instructions that, when executed, cause a processor of a device for decoding video data to:

receive a first indication of an intra-prediction mode to use to decode a block of video data;

determine whether the block includes a sub-block of a size for which multiple transforms are possible based on the size of the sub-block and the indicated intra-prediction mode;

when the block includes the sub-block of the size for which multiple inverse transforms are possible based on the size of the sub-block and the indicated intra-prediction mode:

receive a second indication of one of the multiple possible inverse transforms; and

inverse transform the sub-block using the indicated one of the multiple possible inverse transforms.

35. The computer program product of claim 34, wherein the intra-prediction mode comprises a first intra-prediction mode, and wherein the sub-block comprises a first sub-block, further comprising instructions that cause the processor to:

determine whether the block includes a second sub-block of a size for which the first intra-prediction mode is not available;

when the block includes the second sub-block of the size for which the first intra-prediction mode is not available:

determine a second intra-prediction mode to which the first intra-prediction mode is mapped; and

predict the second sub-block using the second intra-prediction mode.

36. A method of decoding video data, the method comprising:

receiving information indicating that an intra-prediction mode for a block of video data is a DC intra-prediction mode;

determining whether an edge is present in the block of video data;

after determining that the edge is present in the block:

determining an angle for the edge; and

based on the information indicating that the intra-prediction mode is the DC intra-prediction mode and the determination that the edge is present in the block, inverse transforming the block using a directional inverse transform mapped from a directional intra-prediction mode having an angle that approximates the angle of the edge; and

decoding the inverse transformed block.

37. The method of claim 36, wherein the block comprises a current block, and wherein determining that the edge is present in the current block comprises:

analyzing pixels of one or more neighboring, previously coded blocks to the current block; and

based on the analysis, determining that the edge is present in the current block when an edge is present in a neighboring, previously coded block and that the edge in the neighboring, previously coded block intersects a border between the neighboring, previously coded block and the current block.

38. The method of claim 36, further comprising determining the directional inverse transform mapped from the directional intra-prediction mode as the directional inverse transform having an angle with a minimum difference relative to the angle of the edge.

39. The method of claim 36, wherein decoding the inverse transformed block comprises:

calculating a predicted value using an edge-based intra-prediction mode; and

adding the predicted value to the inverse transformed block.

40. An apparatus for decoding video data, the apparatus comprising a video decoder configured to receive information indicating that an intra-prediction mode for a block of video data is a DC intra-prediction mode, determine whether an edge is present in the block of video data, after determining that the edge is present in the block, determine an angle for the edge, based on the information indicating that the intra-prediction mode is the DC intra-prediction mode and the determination that the edge is present in the block, inverse transform the block using a directional inverse transform mapped from a directional intra-prediction mode having an angle that approximates the angle of the edge, and decode the inverse transformed block.

41. The apparatus of claim 40, wherein the block comprises a current block, and wherein to determine that the edge is present in the current block, the video decoder is configured to analyze pixels of one or more neighboring, previously coded blocks to the current block, and, based on the analysis, determine that the edge is present in the current block when an edge is present in a neighboring, previously coded block and that the edge in the neighboring, previously coded block intersects a border between the neighboring, previously coded block and the current block.

42. The apparatus of claim 40, wherein the video decoder is further configured to determine the directional inverse transform mapped from the directional intra-prediction mode as the directional inverse transform having an angle with a minimum difference relative to the angle of the edge.

43. The apparatus of claim 40, wherein to decode the inverse transformed block, the video decoder is configured to calculate a predicted value using an edge-based intra-prediction mode, and add the predicted value to the inverse transformed block.

44. The apparatus of claim 40, wherein the apparatus comprises at least one of:

an integrated circuit;

a microprocessor; and

a wireless communication device that includes the video decoder.

45. An apparatus for decoding video data, the apparatus comprising:

means for receiving information indicating that an intra-prediction mode for a block of video data is a DC intra-prediction mode;

means for determining whether an edge is present in the block of video data;

means for determining, after determining that the edge is present in the block, an angle for an edge in the block of video data based on the indication of the DC intra-prediction mode for the block;

means for inverse transforming, after determining the angle of the edge, the block using a directional inverse transform mapped from a directional intra-prediction mode having an angle that approximates the angle of the edge based on the information indicating that the intra-prediction mode is the DC intra-prediction mode and the determination that the edge is present in the block,; and

means for decoding the inverse transformed block.

46. A computer program product comprising a computer-readable medium having stored thereon instructions that, when executed, cause a processor to:

receive information indicating that an intra-prediction mode for a block of video data is a DC intra-prediction mode;

determine whether an edge is present in the block of video data;

after determining that the edge is present in the block:

determine an angle for an edge in the block of video data based on the indication of the DC intra-prediction mode for the block; and

based on the information indicating that the intra-prediction mode is the DC intra-prediction mode and the determination that the edge is present in the block, inverse transform the block using a directional inverse transform mapped from a directional intra-prediction mode having an angle that approximates the angle of the edge; and

decode the inverse transformed block.

47. A method of encoding video data, the method comprising:

determining that a block to be intra-prediction encoded contains an edge within the block;

selecting an edge-based intra-prediction mode to predict the block;

calculating a residual block for the block based on a prediction value calculated using the edge-based intra-prediction mode;

based on the determination that the edge is present in the block and the selection of the edge-based intra-prediction mode, transforming the residual block using a directional transform mapped from a directional intra-prediction mode having an angle that approximates an angle of the edge; and

outputting information representative of the transformed residual block and information indicating that the block was predicted using a DC intra-prediction mode.

48. The method of claim 47, wherein the block comprises a current block, and wherein determining that the edge is present in the current block comprises:

analyzing pixels of one or more neighboring, previously coded blocks to the current block; and

based on the analysis, determining that the edge is present in the current block when an edge is present in a neighboring, previously coded block and that the edge in the neighboring, previously coded block intersects a border between the neighboring, previously coded block and the current block.

49. The method of claim 47, further comprising determining the directional transform mapped from the directional intra-prediction mode as the directional transform having an angle with a minimum difference relative to the angle of the edge.

50. The method of claim 47, wherein calculating the residual block comprises:

calculating a predicted value for the block using the edge-based intra-prediction mode; and

subtracting the predicted value from an original value for the block.

51. An apparatus for encoding video data, the apparatus comprising a video encoder configured to determine that a block to be intra-prediction encoded contains an edge within the block, select an edge-based intra-prediction mode to predict the block, calculate a residual block for the block based on a prediction value calculated using the edge-based intra-prediction mode, based on the determination that the edge is present in the block and the selection of the edge-based intra-prediction mode, transform the residual block using a directional transform mapped from a directional intra-prediction mode having an angle that approximates an angle of the edge, and output information representative of the transformed residual block and information indicating that the block was predicted using a DC intra-prediction mode.

52. The apparatus of claim 51, wherein the block comprises a current block, and wherein to determine that the edge is present in the current block, the video encoder is configured to analyze pixels of one or more neighboring, previously coded blocks to the current block, and, based on the analysis, determine that the edge is present in the current block when an edge is present in a neighboring, previously coded block and that the edge in the neighboring, previously coded block intersects a border between the neighboring, previously coded block and the current block.

53. The apparatus of claim 51, wherein the video encoder is further configured to determine the directional transform mapped from the directional intra-prediction mode as the directional transform having an angle with a minimum difference relative to the angle of the edge.

54. The apparatus of claim 51, wherein to calculate the residual block, the video encoder is configured to calculate a predicted value for the block using the edge-based intra-prediction mode, and subtract the predicted value from an original value for the block.

55. The apparatus of claim 51, wherein the apparatus comprises at least one of:

an integrated circuit;

a microprocessor; and

a wireless communication device that includes the video encoder.

56. An apparatus for encoding video data, the apparatus comprising:

means for determining that a block to be intra-prediction encoded contains an edge within the block;

means for selecting an edge-based intra-prediction mode to predict the block;

means for calculating a residual block for the block based on a prediction value calculated using the edge-based intra-prediction mode;

means for transforming, based on the determination that the edge is present in the block and the selection of the edge-based intra-prediction mode, the residual block using a directional transform mapped from a directional intra-prediction mode having an angle that approximates an angle of the edge; and

means for outputting information representative of the transformed residual block and information indicating that the block was predicted using a DC intra-prediction mode.

57. A computer program product comprising a computer-readable storage medium having stored thereon instructions that, when executed, cause a processor to:

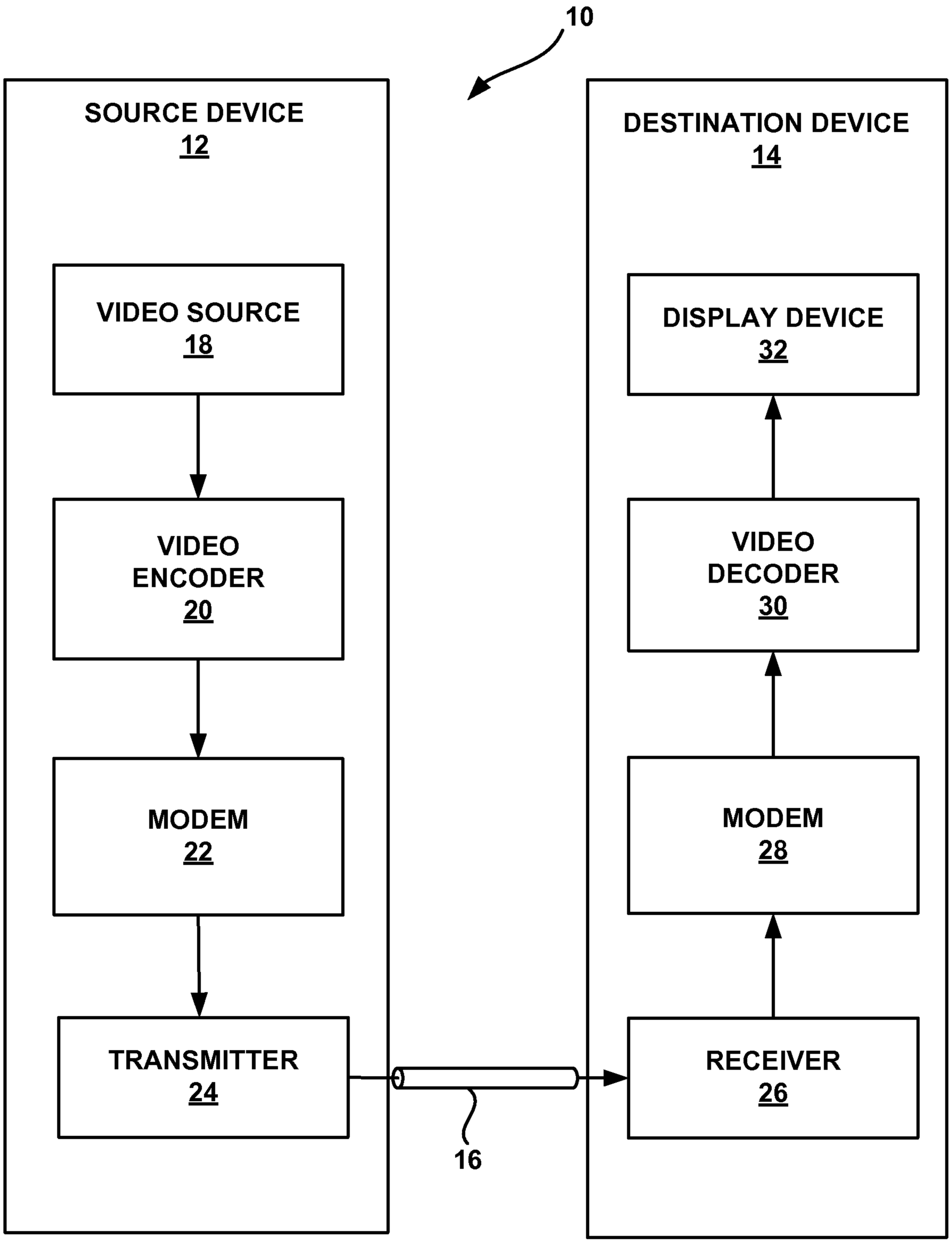
determine that a block to be intra-prediction encoded contains an edge within the block;

select an edge-based intra-prediction mode to predict the block;

calculate a residual block for the block based on a prediction value calculated using the edge-based intra-prediction mode;

based on the determination that the edge is present in the block and the selection of the edge-based intra-prediction mode, transform the residual block using a directional transform mapped from a directional intra-prediction mode having an angle that approximates an angle of the edge; and

output information representative of the transformed residual block and information indicating that the block was predicted using a DC intra-prediction mode.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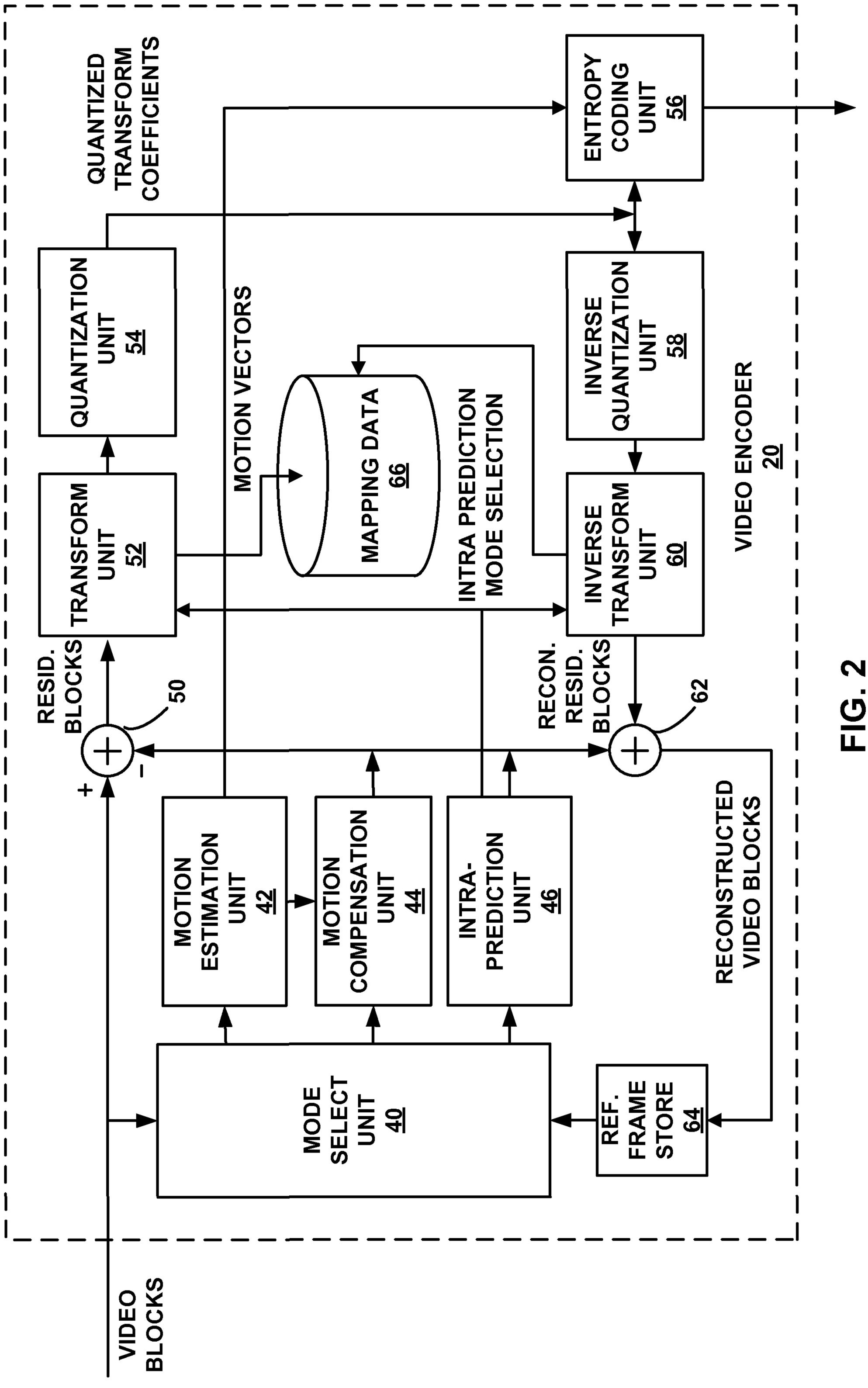
SOURCE DEVICE
12
VIDEO SOURCE
18
VIDEO
ENCODER
20
MODEM
22
TRANSMITTER
24
16
DESTINATION DEVICE
14
DISPLAY DEVICE
32
VIDEO
DECODER
30
MODEM
28
RECEIVER
26

FIG. 1


VIDEO ENCODER
20
QUANTIZED TRANSFORM COEFFICIENTS
ENTROPY CODING UNIT
56
QUANTIZATION UNIT
54
INVERSE QUANTIZATION UNIT
58
TRANSFORM UNIT
52
MOTION VECTORS
MAPPING DATA
66
INTRA PREDICTION MODE SELECTION
INVERSE TRANSFORM UNIT
60
RESID. BLOCKS
50
+
-
RECON. RESID. BLOCKS
62
MOTION ESTIMATION UNIT
42
MOTION COMPENSATION UNIT
44
INTRA-PREDICTION UNIT
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RECONSTRUCTED VIDEO BLOCKS
MODE SELECT UNIT
40
REF. FRAME STORE
64
VIDEO BLOCKS

FIG. 2

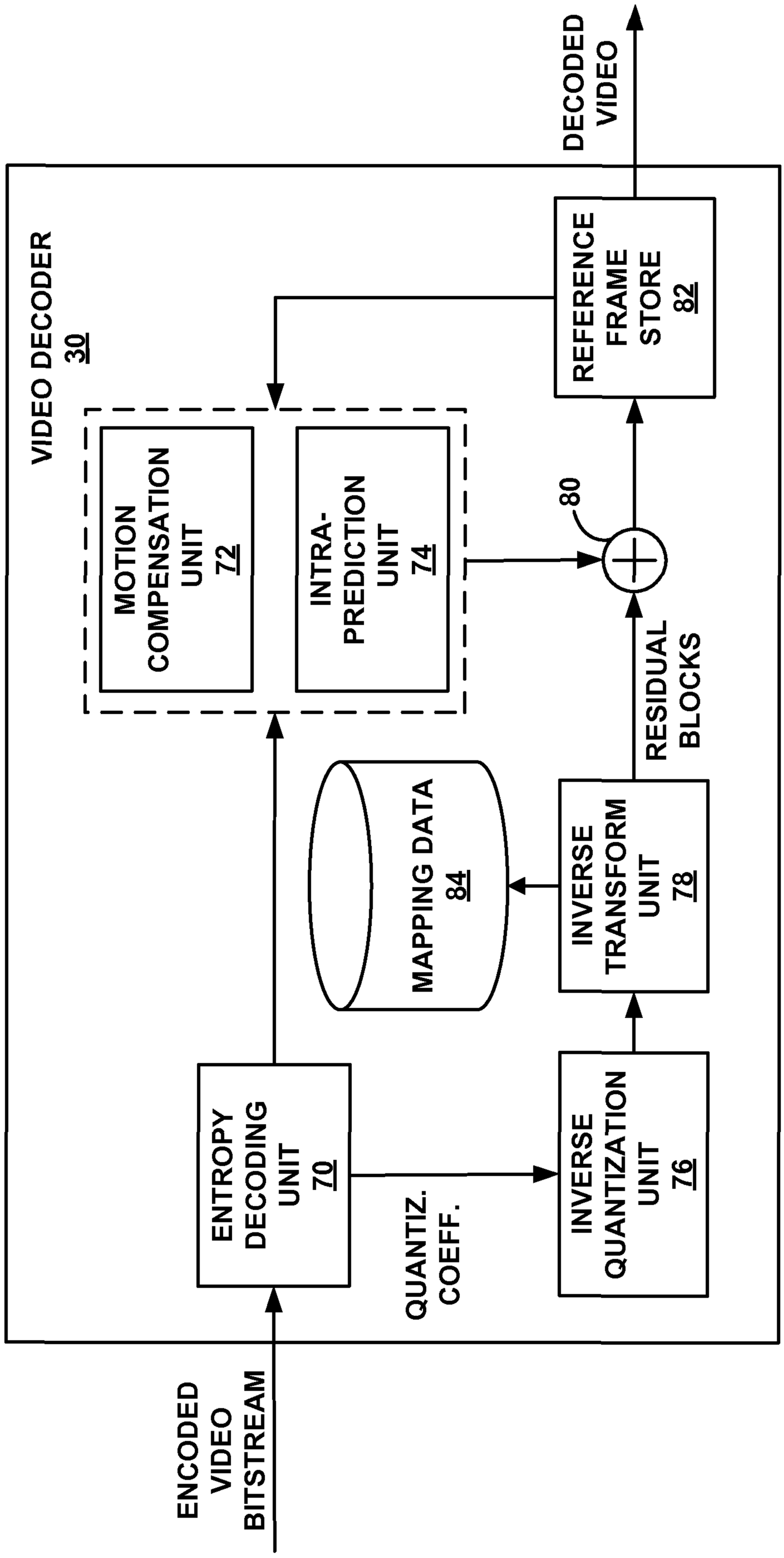
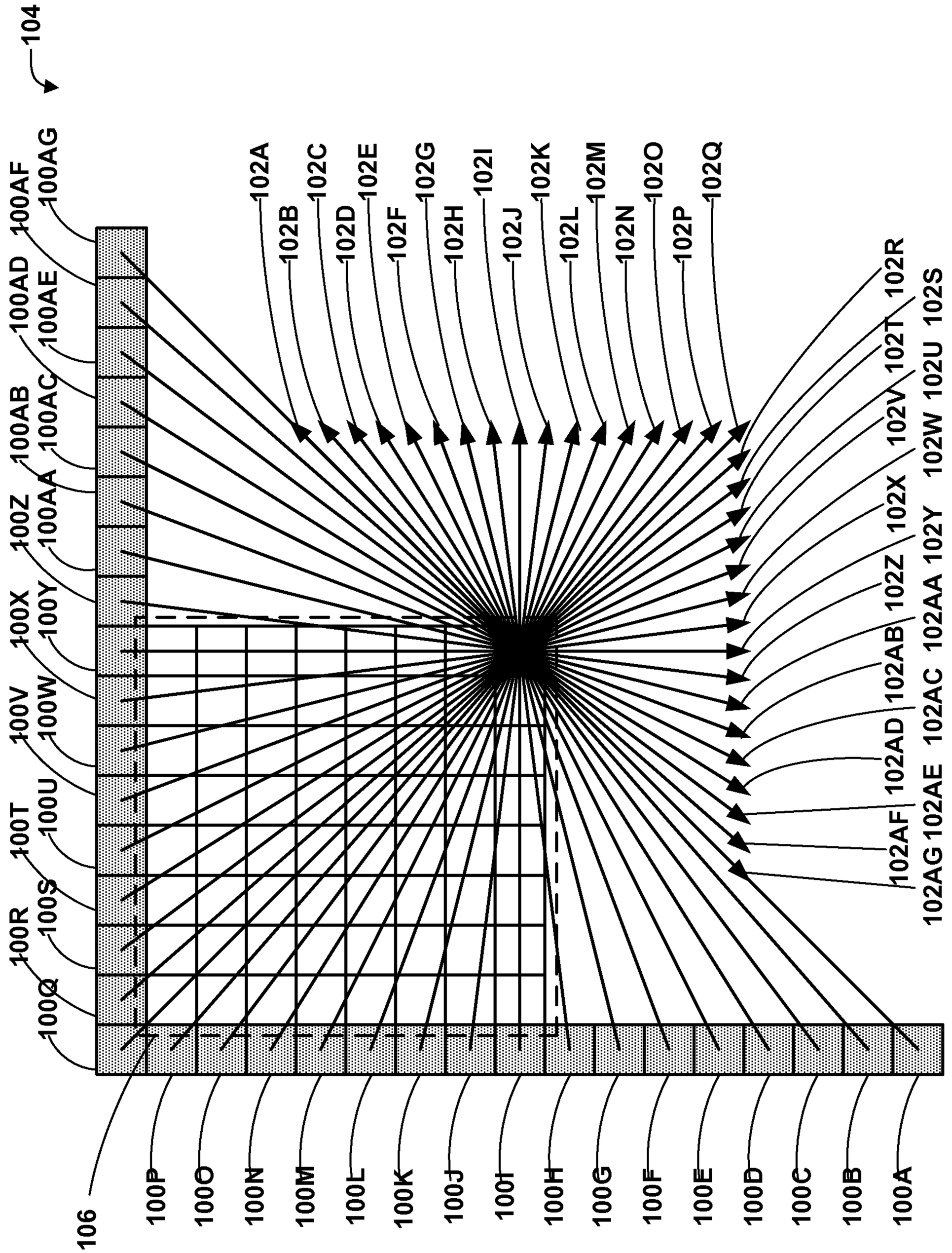

DECODED VIDEO
VIDEO DECODER 30
REFERENCE FRAME STORE 82
MOTION COMPENSATION UNIT 72
INTRA-PREDICTION UNIT 74
80
RESIDUAL BLOCKS
MAPPING DATA 84
INVERSE TRANSFORM UNIT 78
ENTROPY DECODING UNIT 70
QUANTIZ. COEFF.
INVERSE QUANTIZATION UNIT 76
ENCODED VIDEO BITSTREAM

FIG. 3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100AB
100AA
100Z
100Y
100X
100W
100V
100U
100T
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106
100P
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100N
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100I
100H
100G
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100D
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102Q
102R
102S
102T
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102AF
102AG

FIG. 4

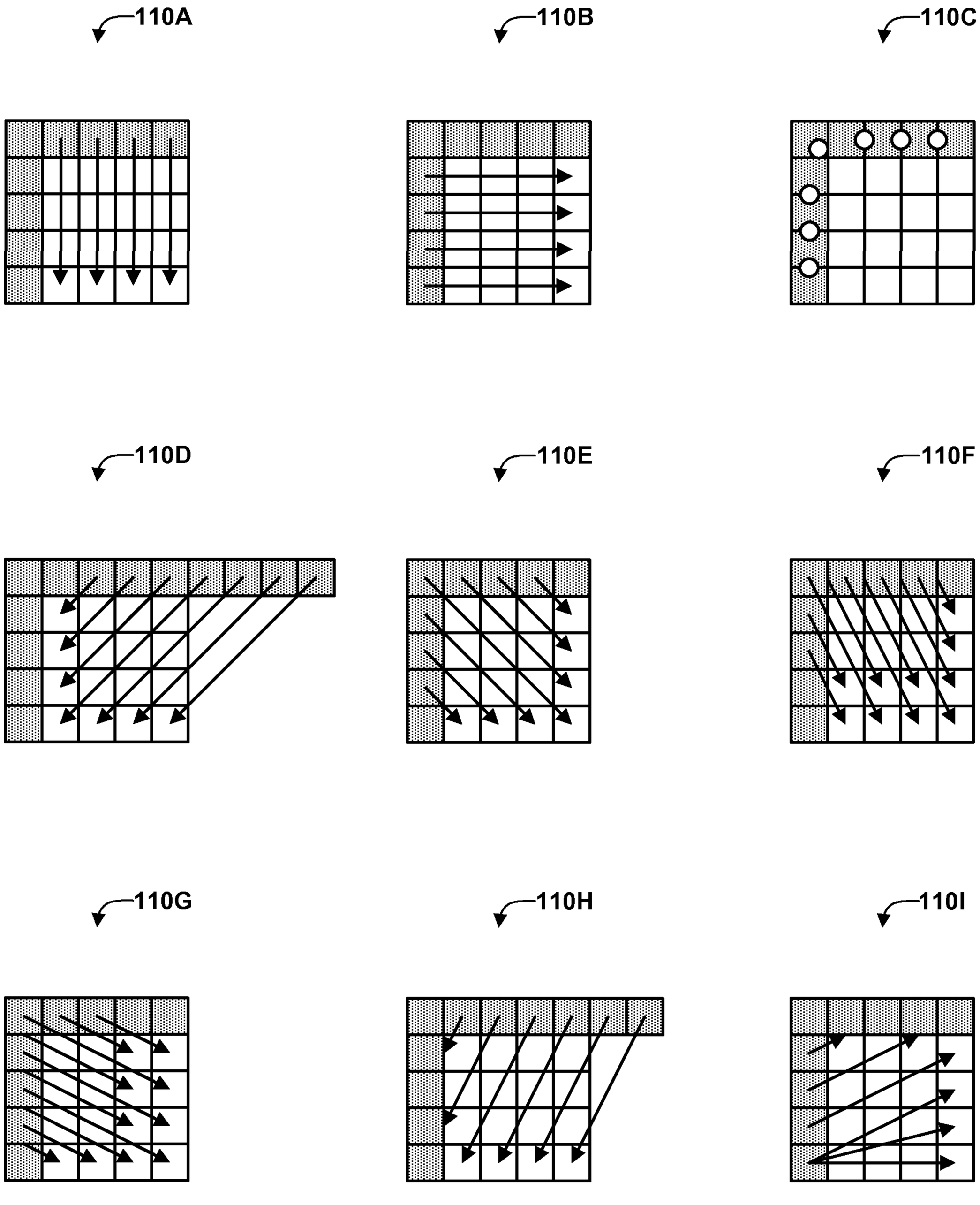
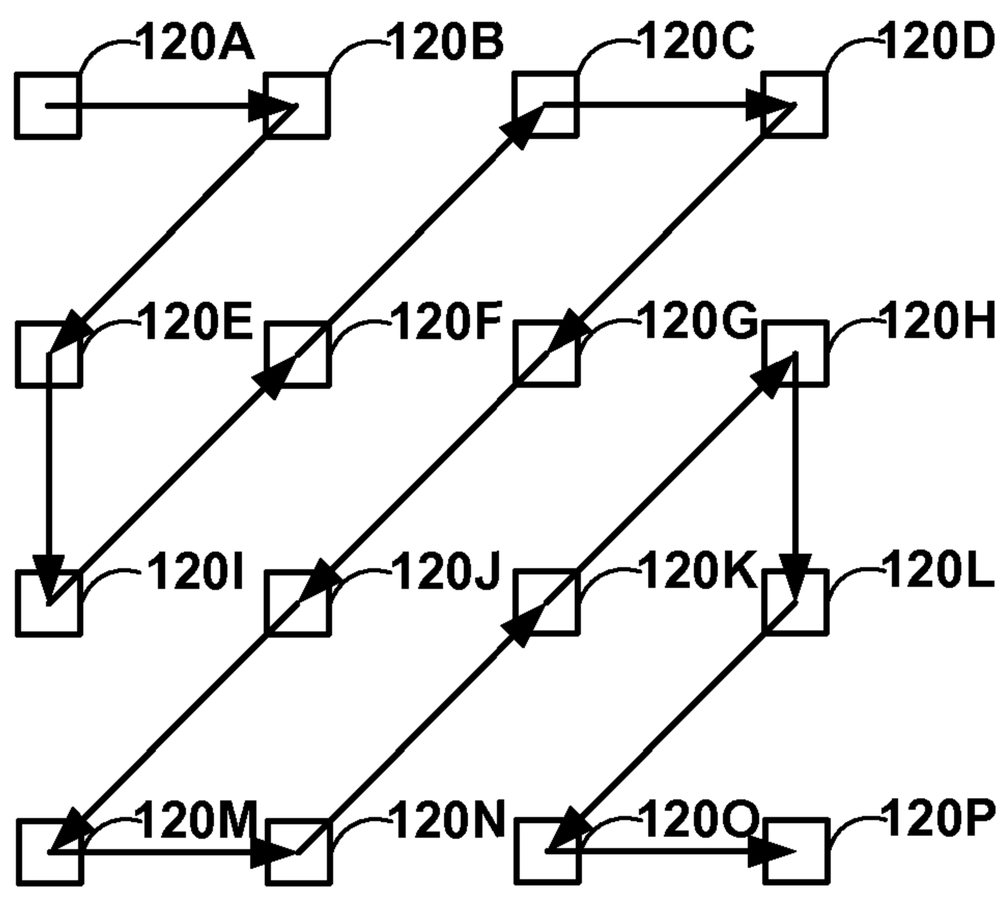


FIG. 5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120B
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120D
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120F
120G
120H
120I
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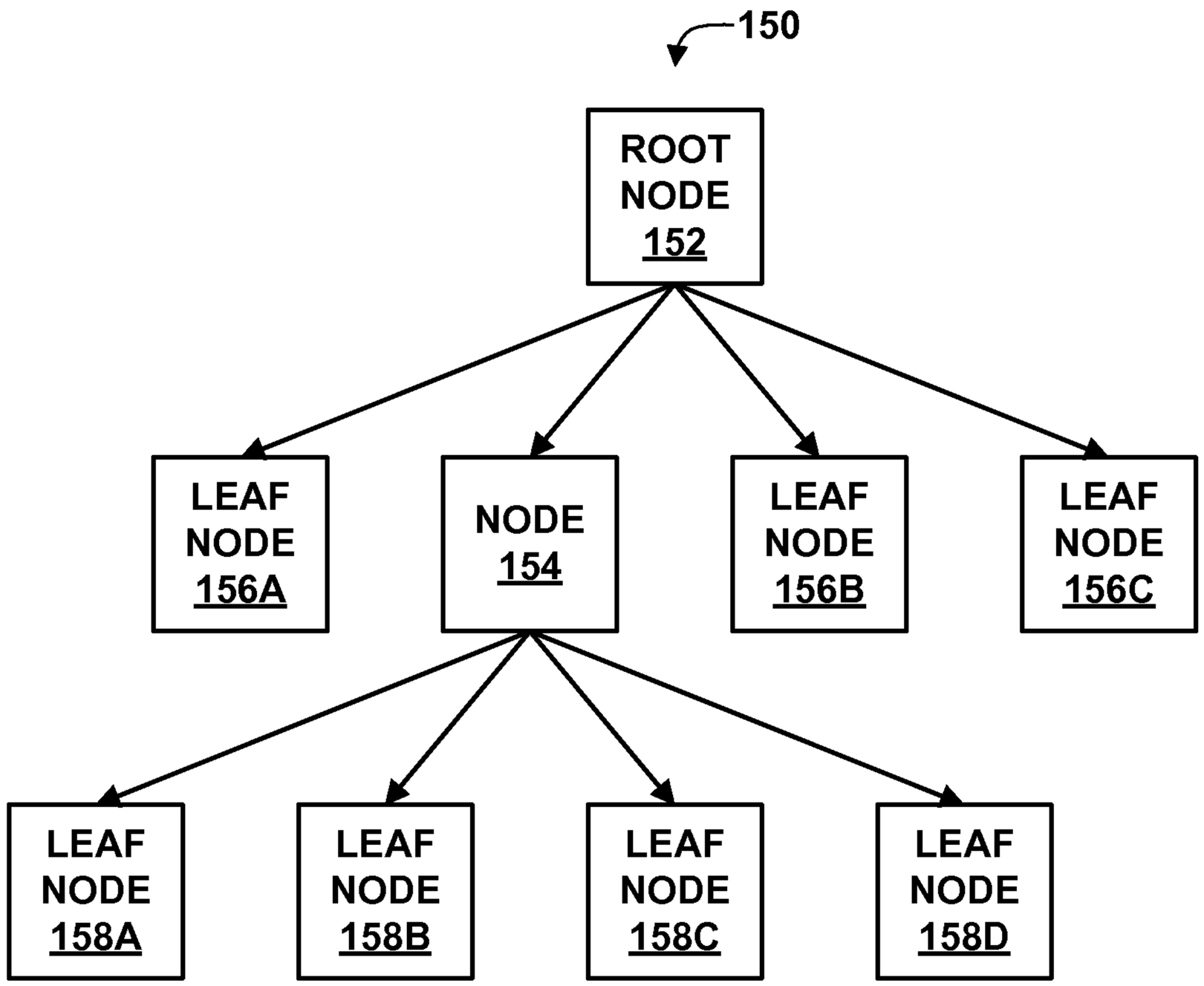
120O
120P

FIG. 6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ROOT NODE 152
LEAF NODE 156A
NODE 154
LEAF NODE 156B
LEAF NODE 156C
LEAF NODE 158A
LEAF NODE 158B
LEAF NODE 158C
LEAF NODE 158D

FIG. 7A

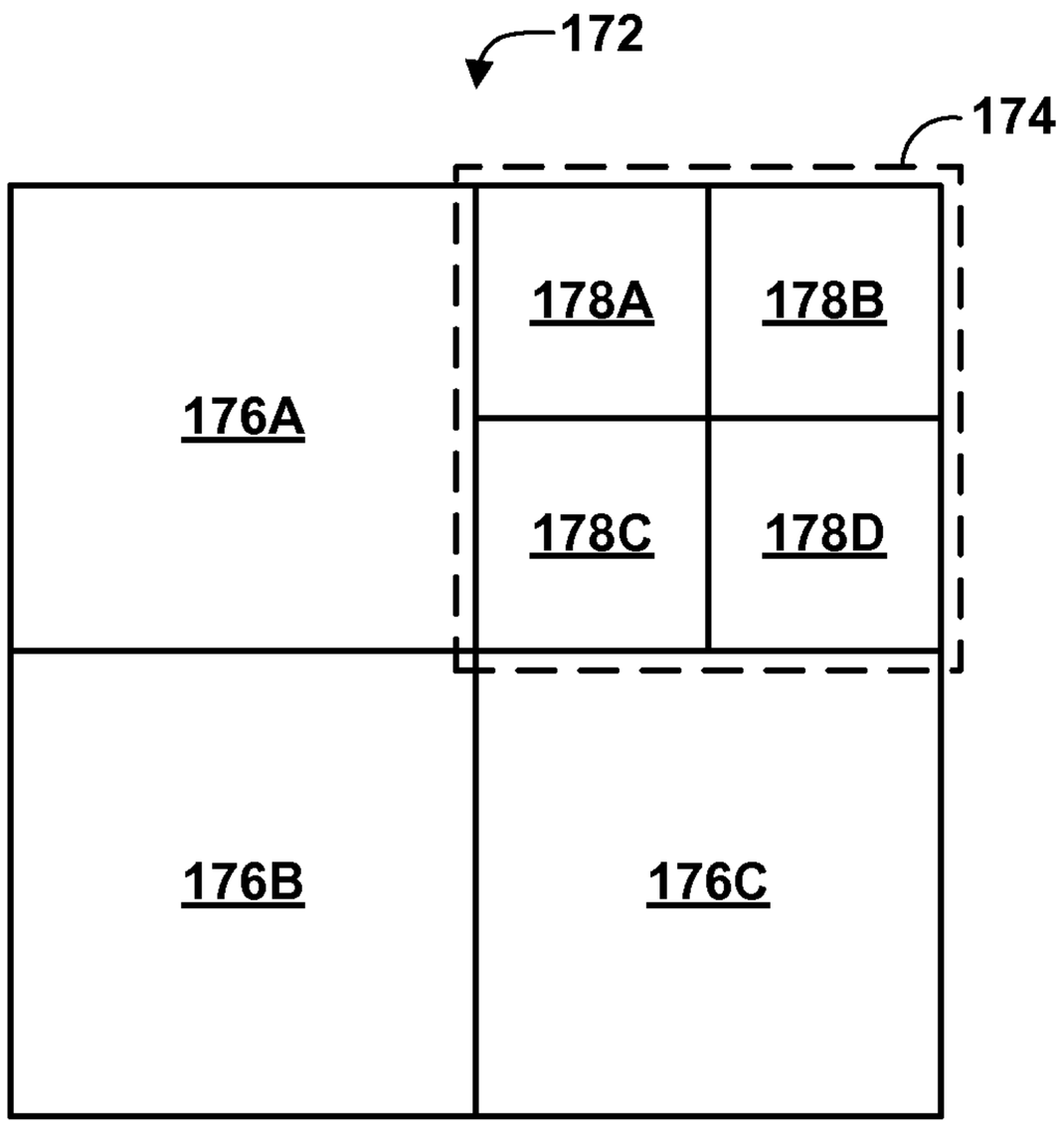
172
174
178A
178B
176A
178C
178D
176B
176C

FIG. 7B

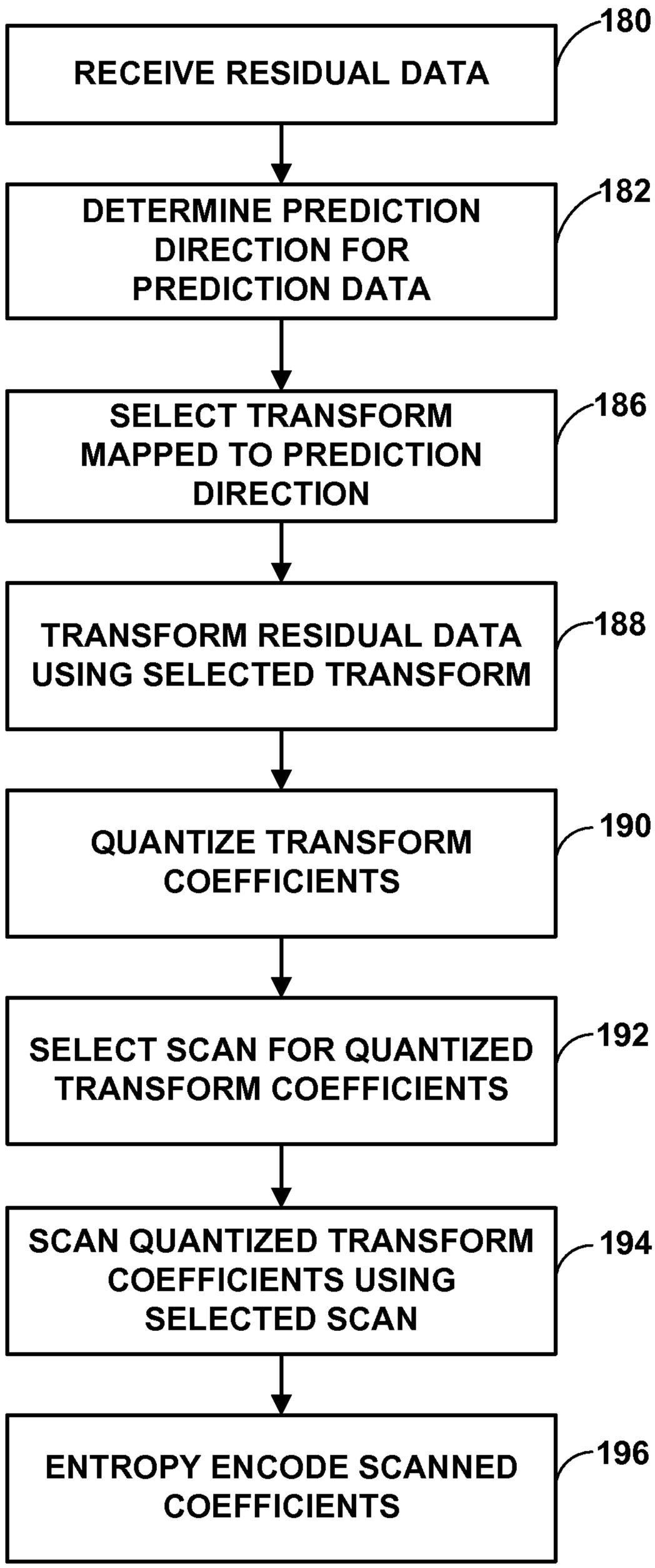
RECEIVE RESIDUAL DATA
180
DETERMINE PREDICTION DIRECTION FOR PREDICTION DATA
182
SELECT TRANSFORM MAPPED TO PREDICTION DIRECTION
186
TRANSFORM RESIDUAL DATA USING SELECTED TRANSFORM
188
QUANTIZE TRANSFORM COEFFICIENTS
190
SELECT SCAN FOR QUANTIZED TRANSFORM COEFFICIENTS
192
SCAN QUANTIZED TRANSFORM COEFFICIENTS USING SELECTED SCAN
194
ENTROPY ENCODE SCANNED COEFFICIENTS
196

FIG. 8

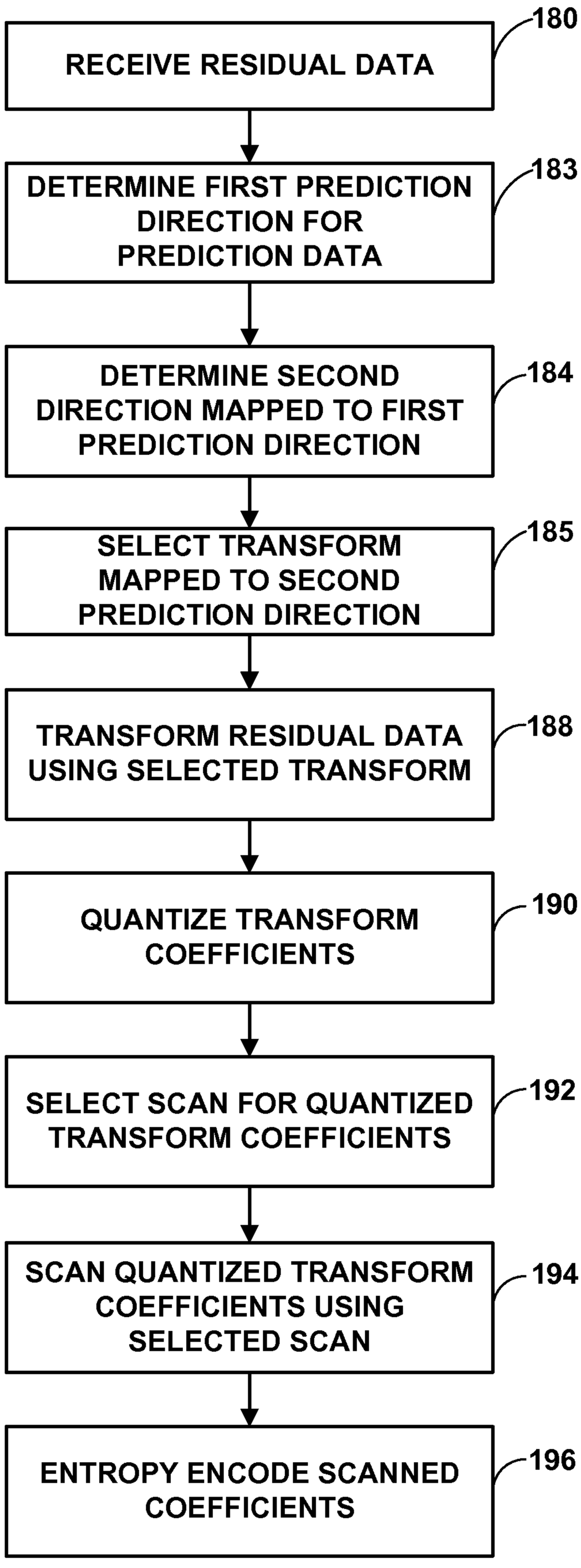
RECEIVE RESIDUAL DATA
180
DETERMINE FIRST PREDICTION DIRECTION FOR PREDICTION DATA
183
DETERMINE SECOND DIRECTION MAPPED TO FIRST PREDICTION DIRECTION
184
SELECT TRANSFORM MAPPED TO SECOND PREDICTION DIRECTION
185
TRANSFORM RESIDUAL DATA USING SELECTED TRANSFORM
188
QUANTIZE TRANSFORM COEFFICIENTS
190
SELECT SCAN FOR QUANTIZED TRANSFORM COEFFICIENTS
192
SCAN QUANTIZED TRANSFORM COEFFICIENTS USING SELECTED SCAN
194
ENTROPY ENCODE SCANNED COEFFICIENTS
196

FIG. 9

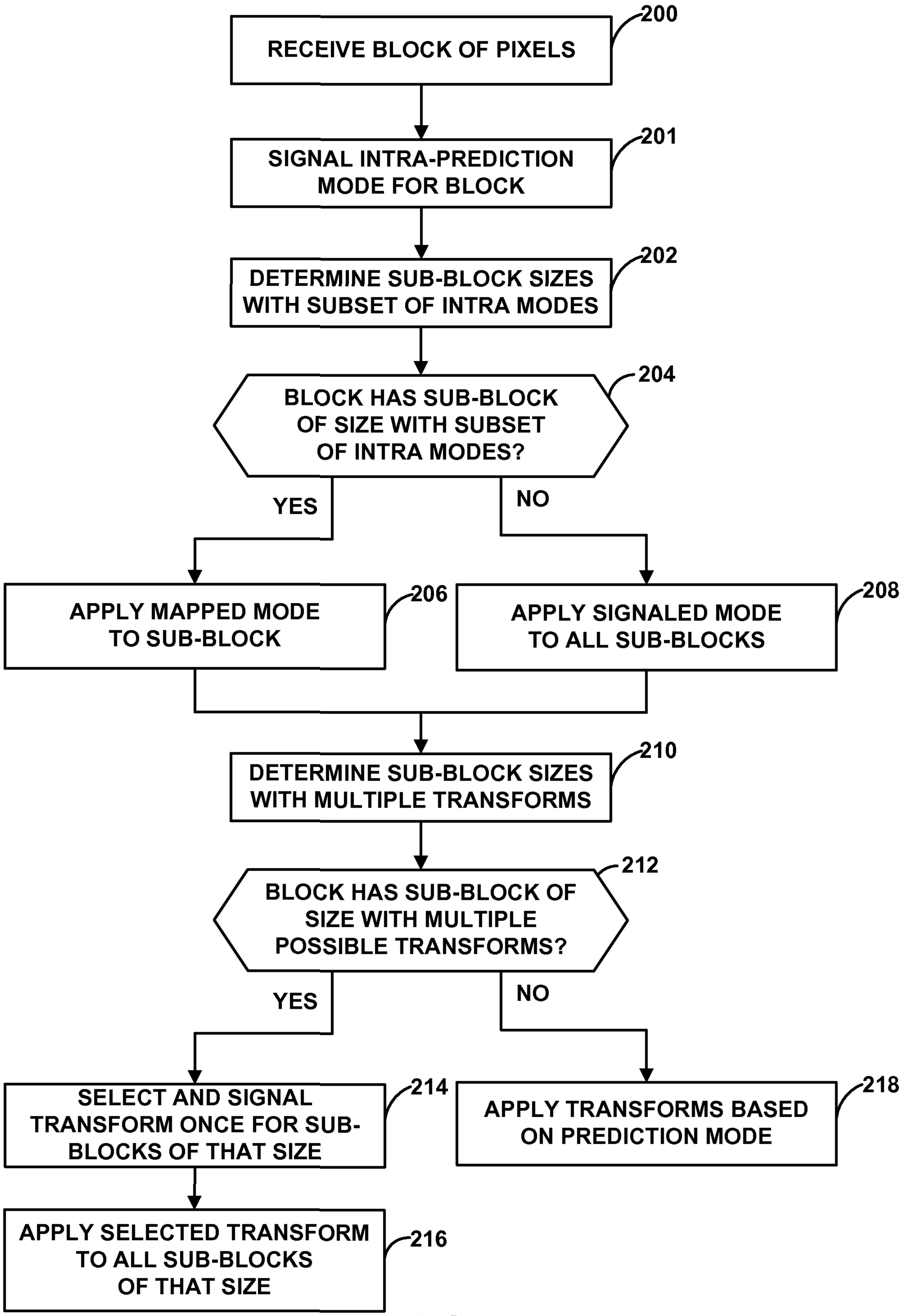
RECEIVE BLOCK OF PIXELS
200
SIGNAL INTRA-PREDICTION MODE FOR BLOCK
201
DETERMINE SUB-BLOCK SIZES WITH SUBSET OF INTRA MODES
202
BLOCK HAS SUB-BLOCK OF SIZE WITH SUBSET OF INTRA MODES?
204
YES
NO
APPLY MAPPED MODE TO SUB-BLOCK
206
APPLY SIGNALED MODE TO ALL SUB-BLOCKS
208
DETERMINE SUB-BLOCK SIZES WITH MULTIPLE TRANSFORMS
210
BLOCK HAS SUB-BLOCK OF SIZE WITH MULTIPLE POSSIBLE TRANSFORMS?
212
YES
NO
SELECT AND SIGNAL TRANSFORM ONCE FOR SUB-BLOCKS OF THAT SIZE
214
APPLY TRANSFORMS BASED ON PREDICTION MODE
218
APPLY SELECTED TRANSFORM TO ALL SUB-BLOCKS OF THAT SIZE
216

FIG. 10

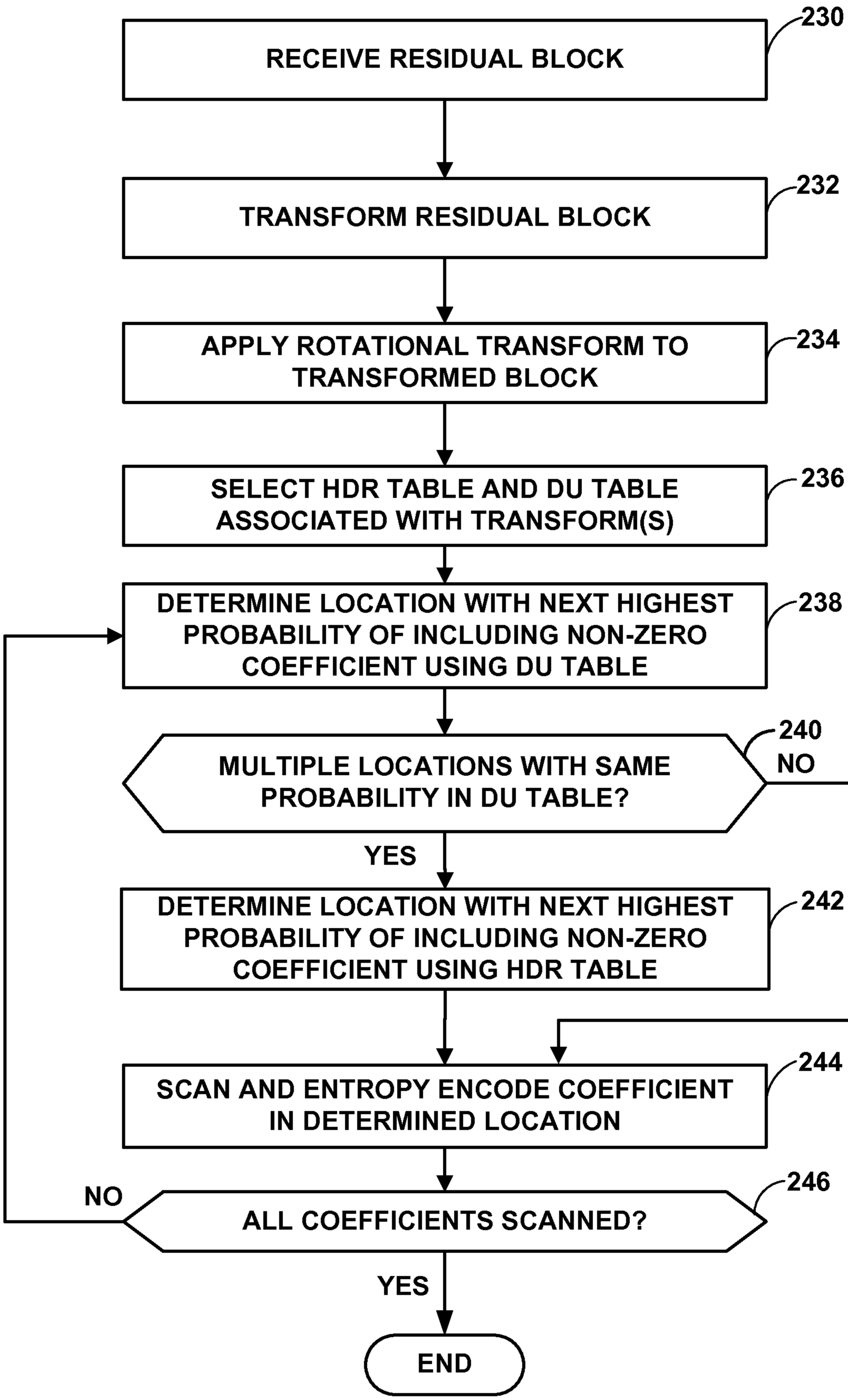
RECEIVE RESIDUAL BLOCK
230
TRANSFORM RESIDUAL BLOCK
232
APPLY ROTATIONAL TRANSFORM TO TRANSFORMED BLOCK
234
SELECT HDR TABLE AND DU TABLE ASSOCIATED WITH TRANSFORM(S)
236
DETERMINE LOCATION WITH NEXT HIGHEST PROBABILITY OF INCLUDING NON-ZERO COEFFICIENT USING DU TABLE
238
MULTIPLE LOCATIONS WITH SAME PROBABILITY IN DU TABLE?
240
NO
YES
DETERMINE LOCATION WITH NEXT HIGHEST PROBABILITY OF INCLUDING NON-ZERO COEFFICIENT USING HDR TABLE
242
SCAN AND ENTROPY ENCODE COEFFICIENT IN DETERMINED LOCATION
244
NO
ALL COEFFICIENTS SCANNED?
246
YES
END

FIG. 11

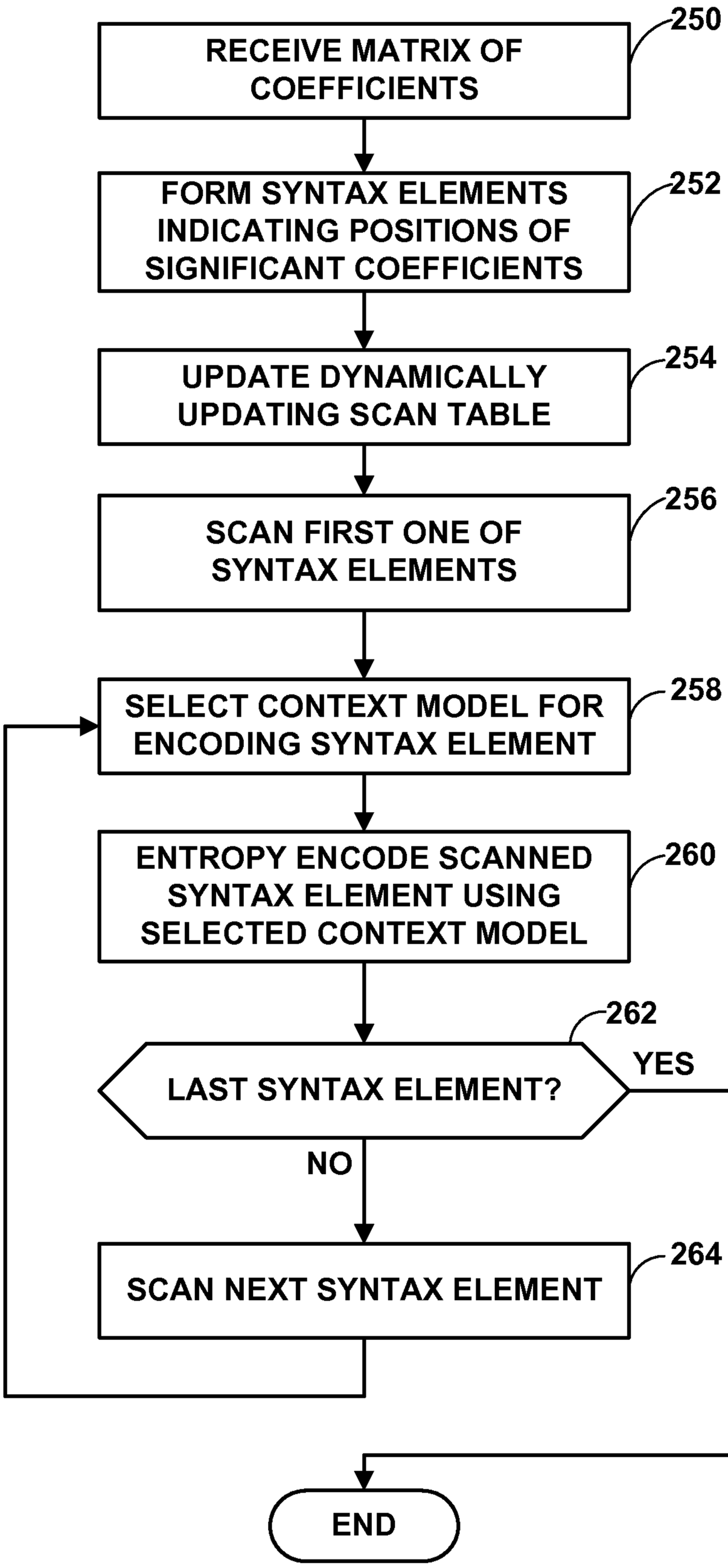
RECEIVE MATRIX OF COEFFICIENTS
250
FORM SYNTAX ELEMENTS INDICATING POSITIONS OF SIGNIFICANT COEFFICIENTS
252
UPDATE DYNAMICALLY UPDATING SCAN TABLE
254
SCAN FIRST ONE OF SYNTAX ELEMENTS
256
SELECT CONTEXT MODEL FOR ENCODING SYNTAX ELEMENT
258
ENTROPY ENCODE SCANNED SYNTAX ELEMENT USING SELECTED CONTEXT MODEL
260
LAST SYNTAX ELEMENT?
262
YES
NO
SCAN NEXT SYNTAX ELEMENT
264
END

FIG. 12

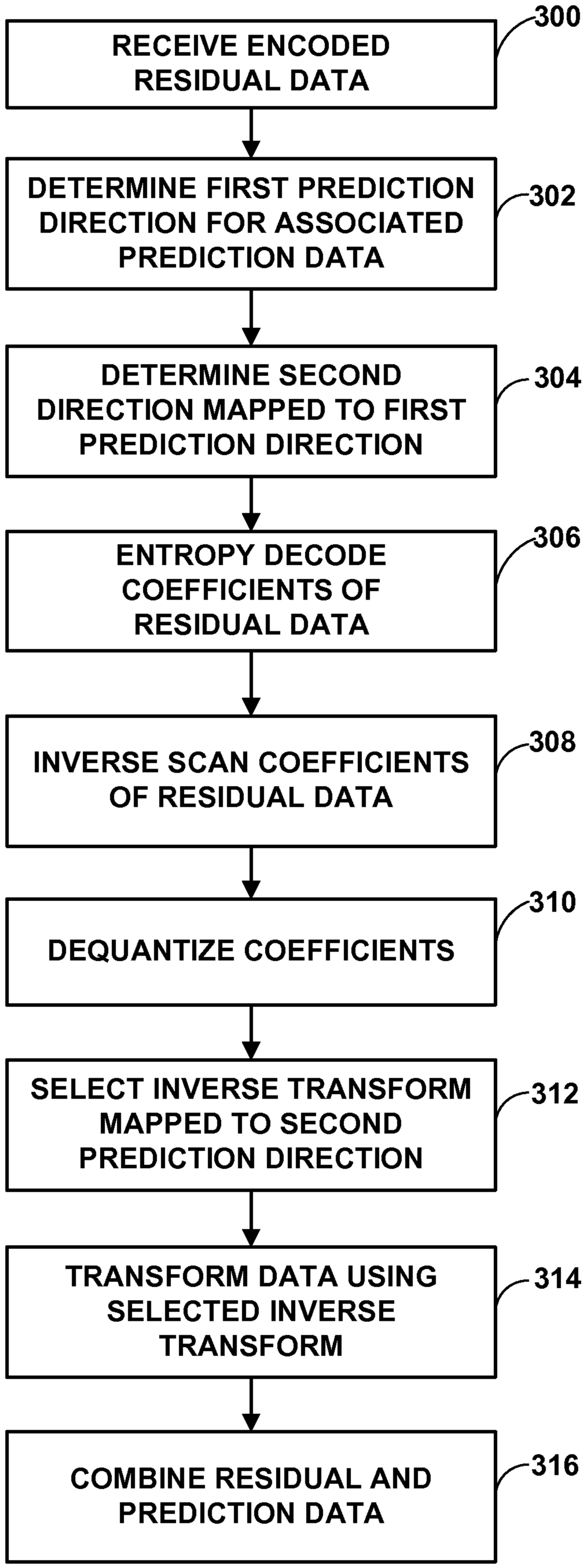
RECEIVE ENCODED RESIDUAL DATA
300
DETERMINE FIRST PREDICTION DIRECTION FOR ASSOCIATED PREDICTION DATA
302
DETERMINE SECOND DIRECTION MAPPED TO FIRST PREDICTION DIRECTION
304
ENTROPY DECODE COEFFICIENTS OF RESIDUAL DATA
306
INVERSE SCAN COEFFICIENTS OF RESIDUAL DATA
308
DEQUANTIZE COEFFICIENTS
310
SELECT INVERSE TRANSFORM MAPPED TO SECOND PREDICTION DIRECTION
312
TRANSFORM DATA USING SELECTED INVERSE TRANSFORM
314
COMBINE RESIDUAL AND PREDICTION DATA
316

FIG. 13

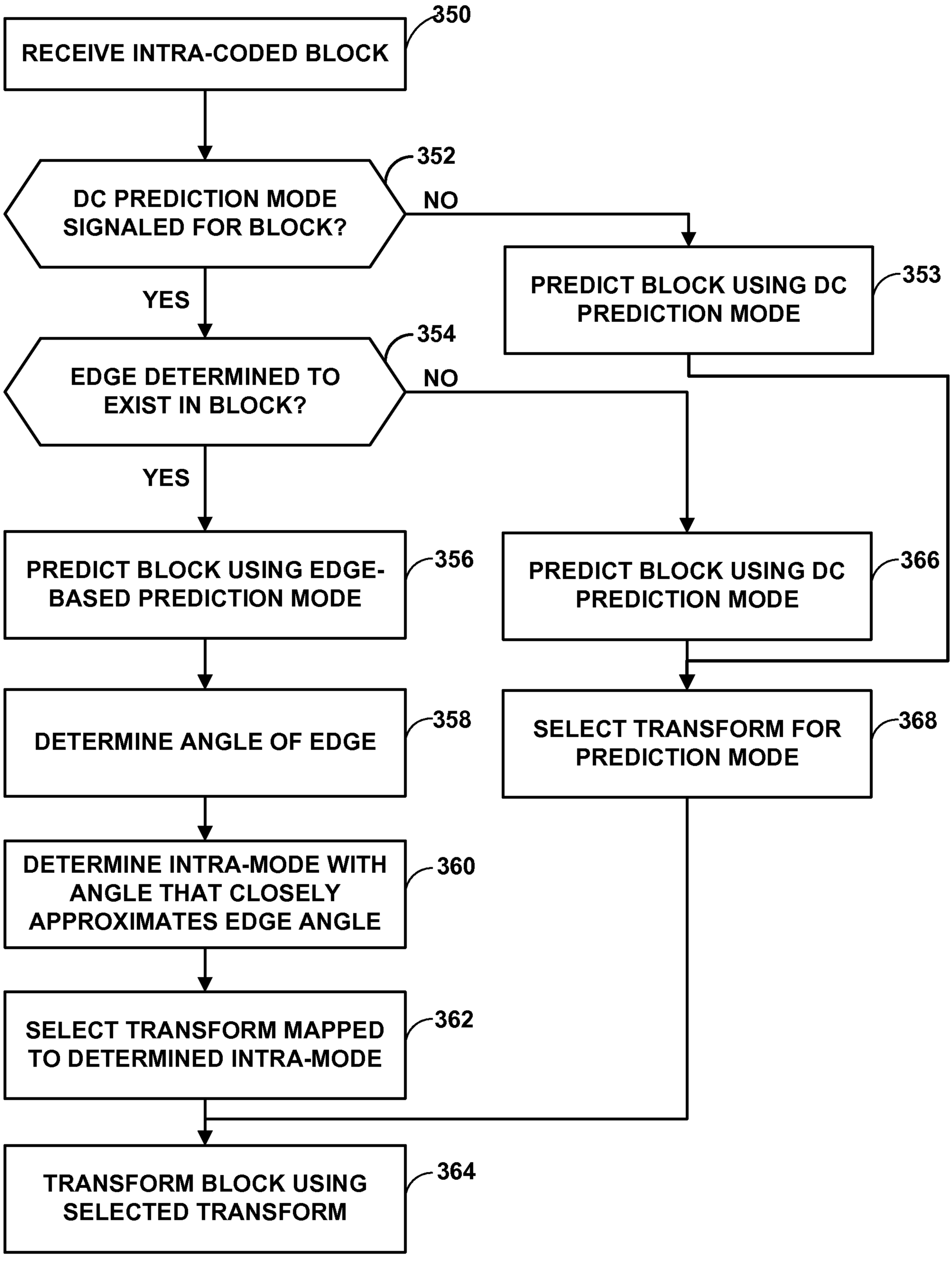
RECEIVE INTRA-CODED BLOCK
350
DC PREDICTION MODE SIGNALED FOR BLOCK?
352
NO
YES
PREDICT BLOCK USING DC PREDICTION MODE
353
EDGE DETERMINED TO EXIST IN BLOCK?
354
NO
YES
PREDICT BLOCK USING EDGE-BASED PREDICTION MODE
356
PREDICT BLOCK USING DC PREDICTION MODE
366
DETERMINE ANGLE OF EDGE
358
SELECT TRANSFORM FOR PREDICTION MODE
368
DETERMINE INTRA-MODE WITH ANGLE THAT CLOSELY APPROXIMATES EDGE ANGLE
360
SELECT TRANSFORM MAPPED TO DETERMINED INTRA-MODE
362
TRANSFORM BLOCK USING SELECTED TRANSFORM
364

FIG. 14

SIGNALING SELECTED DIRECTIONAL TRANSFORM FOR VIDEO CODING

TECHNICAL FIELD

[0001] This disclosure relates to video coding.

BACKGROUND

[0002] Digital video capabilities can be incorporated into a wide range of devices, including digital televisions, digital direct broadcast systems, wireless broadcast systems, personal digital assistants (PDAs), laptop or desktop computers, digital cameras, digital recording devices, digital media players, video gaming devices, video game consoles, cellular or satellite radio telephones, video teleconferencing devices, and the like. Digital video devices implement video compression techniques, such as those described in the standards defined by MPEG-2, MPEG-4, ITU-T H.263, ITU-T H.264/MPEG-4, Part 10, Advanced Video Coding (AVC), the upcoming High Efficiency Video Coding (HEVC) standard (also referred to as H.265), and extensions of such standards, to transmit and receive digital video information more efficiently.

[0003] Video compression techniques perform spatial prediction and/or temporal prediction to reduce or remove redundancy inherent in video sequences. For block-based video coding, a video frame or slice may be partitioned into macroblocks. Each macroblock can be further partitioned. Macroblocks in an intra-coded (I) frame or slice are encoded using spatial prediction with respect to neighboring macroblocks. Macroblocks in an inter-coded (P or B) frame or slice may use spatial prediction with respect to neighboring macroblocks in the same frame or slice or temporal prediction with respect to other reference frames.

SUMMARY

[0004] In general, this disclosure describes techniques for coding video data. This disclosure describes techniques for transforming residual video data and scanning transform coefficients during a video coding process. In general, blocks of a picture to be coded may be intra-mode encoded (e.g., encoded relative to other blocks of the same picture) or inter-mode encoded (e.g., encoded relative to blocks of a previously coded picture). In either case, a video encoder forms predictive data and residual data. The

video encoder may transform the residual value, using one or more various transforms, such as discrete sine transforms, discrete cosine transforms, directional transforms and/or rotational transforms. The video encoder may be configured to select one or more transforms to apply based on certain criteria such as, for example, a prediction direction used when intra-mode encoding the block.

[0005] The video encoder may calculate transform coefficients by transforming residual data for a block of video data, where the residual data corresponds to pixel difference values between an original block and a predicted block. The transform coefficients may correspond to a two-dimensional matrix having the same size (in terms of the number of coefficients) as the block that was transformed. The video encoder may scan the transform coefficients to convert the two-dimensional matrix into a one-dimensional array, thereby serializing the transform coefficients. In accordance with the techniques of this disclosure, the video encoder may apply a predetermined scan pattern selected based on the transform(s) used to transform the block. In some examples, in accordance with the techniques of this disclosure, the video encoder may apply an adaptive scan pattern, rather than a predetermined scan pattern, where the video encoder may periodically update the adaptive scan pattern. The scan pattern may be based on the transform(s) and/or intra-prediction mode used to predict the block, in some examples.

[0006] In one example, a method of encoding video data includes calculating a residual block for a block of video data based on a predicted block formed using an intra-prediction mode, and transforming the residual block using a transform mapped from the intra-prediction mode.

[0007] In another example, an apparatus for encoding video data, the apparatus comprising a video encoder configured to calculate a residual block for a block of video data based on a predicted block formed using an intra-prediction mode, and transform the residual block using a transform mapped from the intra-prediction mode.

[0008] In another example, an apparatus for encoding video data includes means for calculating a residual block for a block of video data based on a predicted block formed using an intra-prediction mode, and means for transforming the residual block using a transform mapped from the intra-prediction mode.

[0009] In another example, a computer program product includes a computer-readable storage medium having stored thereon instructions that, when executed, cause a processor of a device for encoding video data to calculate a residual block for a block of

video data based on a predicted block formed using an intra-prediction mode, and transform the residual block using a transform mapped from the intra-prediction mode.

[0010] In another example, a method of decoding video data includes determining an intra-prediction mode to be used to predict a block of video data, and inverse transforming transformed residual data of the block using an inverse transform mapped from the intra-prediction mode.

[0011] In another example, an apparatus for decoding video data includes a video decoder configured to determine an intra-prediction mode to be used to predict a block of video data, and to inverse transform transformed residual data of the block using an inverse transform mapped from the intra-prediction mode.

[0012] In another example, an apparatus for decoding video data includes means for determining an intra-prediction mode to be used to predict a block of video data, and means for inverse transforming transformed residual data of the block using an inverse transform mapped from the intra-prediction mode.

[0013] In another example, a computer program product comprising a computer-readable storage medium having stored thereon instructions that, when executed, cause a processor of a device for decoding video data to determine an intra-prediction mode to be used to predict a block of video data, and inverse transform transformed residual data of the block using an inverse transform mapped from the intra-prediction mode.

[0014] In another example, a method of encoding video data includes receiving an indication of a first intra-prediction mode in a first set of intra-prediction modes for a block of video data, determining a second intra-prediction mode from a second set of intra-prediction modes, smaller than the first set of intra-prediction modes, to which the first intra-prediction mode is mapped, determining a directional transform to which the second intra-prediction mode is mapped, and applying the directional transform to residual data of the block.

[0015] In another example, an apparatus for encoding video data includes a video encoder configured to receive an indication of a first intra-prediction mode in a first set of intra-prediction modes for a block of video data, determine a second intra-prediction mode from a second set of intra-prediction modes, smaller than the first set of intra-prediction modes, to which the first intra-prediction mode is mapped, determine a directional transform to which the second intra-prediction mode is mapped, and apply the directional transform to residual data of the block.