



US00RE46678E

(19) **United States**  
(12) **Reissued Patent**  
**Sim et al.**

(10) **Patent Number: US RE46,678 E**  
(45) **Date of Reissued Patent: Jan. 16, 2018**

(54) **METHOD AND APPARATUS FOR ADAPTIVELY ENCODING AND DECODING A QUANTIZATION PARAMETER BASED ON A QUADTREE STRUCTURE**

(58) **Field of Classification Search**  
CPC .... H04N 19/176; H04N 19/70; H04N 19/126; C08K 5/3435; C08L 97/00

(Continued)

(71) Applicant: **INTELLECTUAL DISCOVERY CO., LTD.**, Seoul (KR)

(56) **References Cited**

U.S. PATENT DOCUMENTS

(72) Inventors: **Dong Gyu Sim**, Seoul (KR); **Jung Hak Nam**, Seoul (KR); **Hyung Ho Jo**, Seoul (KR)

8,315,310 B2 \* 11/2012 Shi ..... H04N 19/52  
348/699  
8,340,188 B2 \* 12/2012 Shi ..... H04N 19/52  
348/407.1

(Continued)

(73) Assignee: **Intellectual Discovery Co., LTD.**, Seoul (KR)

FOREIGN PATENT DOCUMENTS

(21) Appl. No.: **14/815,532**

CN 101978697 A 2/2011  
EP 2506579 A2 10/2012

(22) Filed: **Jul. 31, 2015**

(Continued)

**Related U.S. Patent Documents**

**OTHER PUBLICATIONS**

Reissue of:

(64) Patent No.: **9,066,098**  
Issued: **Jun. 23, 2015**  
Appl. No.: **14/585,946**  
Filed: **Dec. 30, 2014**

Coban, Muhammed, et al. "CU-Level QP Prediction." *Proc. 5th JCT-VC Meeting*. Mar. 2011. (3 pages, in English).

(Continued)

U.S. Applications:

*Primary Examiner* — Linh M Nguyen

(63) Continuation of application No. 14/815,325, filed on Jul. 31, 2015, which is an application for the reissue  
(Continued)

(74) *Attorney, Agent, or Firm* — NSIP Law

(30) **Foreign Application Priority Data**

(57) **ABSTRACT**

Jun. 21, 2011 (KR) ..... 10-2011-0060058

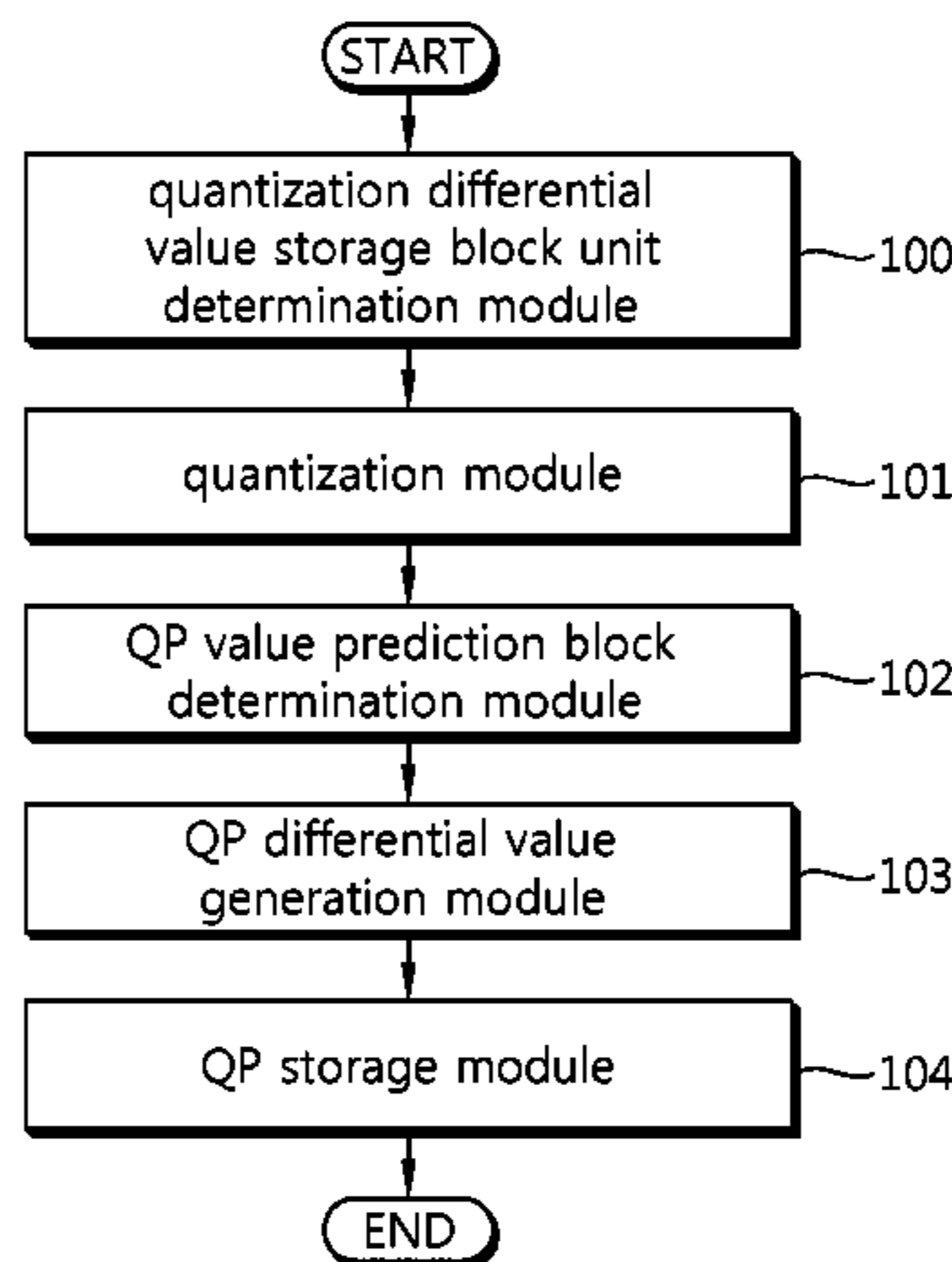
Disclosed are an apparatus and a method of encoding/decoding a video, particularly a method and an apparatus for storing a quantization parameter differential value in a largest coding unit (LCU) based on quadtree splitting and adaptively predicting a quantization parameter value based on context information on neighboring CUs. Quadtree-based quantization parameter encoding and decoding methods and apparatuses effectively show information on a block having a quantization parameter differential value based on splitting information on a CU and adaptively predict a quantization parameter value using context information including a block size, block partition and a quantization parameter of a neighboring CU.

(51) **Int. Cl.**  
*H04N 19/126* (2014.01)  
*H04N 19/463* (2014.01)

(Continued)

(52) **U.S. Cl.**  
CPC ..... *H04N 19/126* (2014.11); *H04N 19/176* (2014.11); *H04N 19/463* (2014.11);  
(Continued)

**2 Claims, 20 Drawing Sheets**



**Related U.S. Application Data**

of Pat. No. 9,066,098, which is a continuation of application No. 14/096,211, filed on Dec. 4, 2013, now Pat. No. 8,964,834, which is a continuation of application No. PCT/KR2012/004881, filed on Jun. 20, 2012.

- (51) **Int. Cl.**  
*H04N 19/96* (2014.01)  
*H04N 19/593* (2014.01)  
*H04N 19/50* (2014.01)  
*H04N 19/176* (2014.01)  
*H04N 19/70* (2014.01)
- (52) **U.S. Cl.**  
 CPC ..... *H04N 19/50* (2014.11); *H04N 19/593* (2014.11); *H04N 19/70* (2014.11); *H04N 19/96* (2014.11)
- (58) **Field of Classification Search**  
 USPC ..... 375/240.03  
 See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

8,358,698	B2 *	1/2013	Shi	.....	H04N 19/176 375/240.16
8,559,519	B2 *	10/2013	Shi	.....	H04N 19/52 375/240.12
8,989,256	B2 *	3/2015	Wilkins	.....	H04N 19/513 375/240
2005/0175093	A1 *	8/2005	Haskell et al.	.....	375/240.03
2005/0180502	A1 *	8/2005	Puri	.....	375/240.03
2008/0240250	A1 *	10/2008	Lin et al.	.....	375/240.18
2011/0274162	A1 *	11/2011	Zhou et al.	.....	375/240.03

FOREIGN PATENT DOCUMENTS

JP	2012-191294	A	10/2012
JP	2013-5111	A	1/2013
JP	2013-529021	A	7/2013
JP	2013-529045	A	7/2013
JP	2013-542689	A	11/2013
JP	2014-506752	A	3/2014
KR	10-2008-0004855	A	1/2008
KR	10-2010-0087600	A	8/2010
KR	10-2011-0015002	A	2/2011
WO	WO 2009/158113	A2	12/2009
WO	WO 2011/064926	A1	6/2011
WO	WO 2011/140211	A2	11/2011
WO	WO 2012/023806	A2	2/2012
WO	WO 2012/042890	A1	4/2012
WO	WO 2012/062161	A1	5/2012
WO	WO 2012/102867	A1	8/2012

OTHER PUBLICATIONS

Chuang, T. et al., "AhG quantization: Sub-LCU delta QP," Proceedings of the 5<sup>th</sup> Meeting of the Joint Collaborative Team on

Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, held in Geneva, CH on Mar. 16-23, 2011, document JCTVC-E051 (6 pages in English).

Kobayashi, M. et al., "Sub-LCU level delta QP signaling," Proceedings of the 5<sup>th</sup> Meeting of the Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, held in Geneva, CH on Mar. 16-23, 2011, document JCTVC-E198 (10 pages in English).

Hellman et al., "Changing cu\_qp\_delta parsing to enable CU-level processing," Proceedings of the 9<sup>th</sup> Joint Collaborative Team on Video Coding (JCT-VC), Broadcom Corporation, Document No. JCTVC-I0219v4, meeting held in Geneva, Switzerland, Apr. 27-May 7, 2012 (11 pages in English).

Wiegand, T., et al., "WD3: Working draft 3 of high-efficiency video coding.," JCT-VC 5th Meeting held in Geneva Switzerland on Mar. 16-23, 2011, document No. JCTVC-E603 (50 pages).

H. Aoki et al., "Prediction-based QP derivation," document JCTVC-E215 submitted at the 5th Meeting of the Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11 held at Geneva, Switzerland, Mar. 16-23, 2011, pp. 1-11.

M. Kobayashi et al., "Sub-LCU level delta QP signaling," document JCTVC-E198 submitted at the 5th Meeting of the Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11 held at Geneva, Switzerland, Mar. 16-23, 2011, pp. 1-9.

Japanese Office Action issued on Jan. 27, 2015, in counterpart Japanese Application No. 2014-516914 (6 pages, in Japanese, no English translation).

Search Report issued Dec. 18, 2012 in counterpart International Application No. PCT/KR2012/004881. (5 pages including English Translation).

Coban, Muhammed, et al. "CU-Level QP Prediction", Proceedings from the 5th Meeting of the Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, meeting held on Mar. 16-23, 2011, Geneva, Switzerland, (3 pages, in English).

K., Sato, et al. "Description of Core Experiment 4: Quantization", Proceedings from the 5th Meeting of the Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, meeting held on Mar. 16-23, 2011, Geneva, Switzerland, (9 pages, in English).

M. Budagavi et al., "Delta QP signaling at sub-LCU level," document JCTVC-D038 submitted at the 4th Meeting of the Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11 held at Daegu, Republic of Korea, Jan. 20-28, 2011, pp. 1-5.

T.-D. Chuang et al., "AhG Quantization: Sub-LCU Delta QP," document JCTVC-B-051 submitted at the 5th Meeting of the Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11 held at Geneva, Switzerland, Mar. 16-23, 2011, pp. 1-6.

C. Pang et al., "Sub-LCU QP representation," document JCTVC-B436 submitted at the 5th Meeting of the Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11 held at Geneva, Switzerland, Mar. 16-23, 2011, pp. 1-5.

\* cited by examiner

FIG. 1A

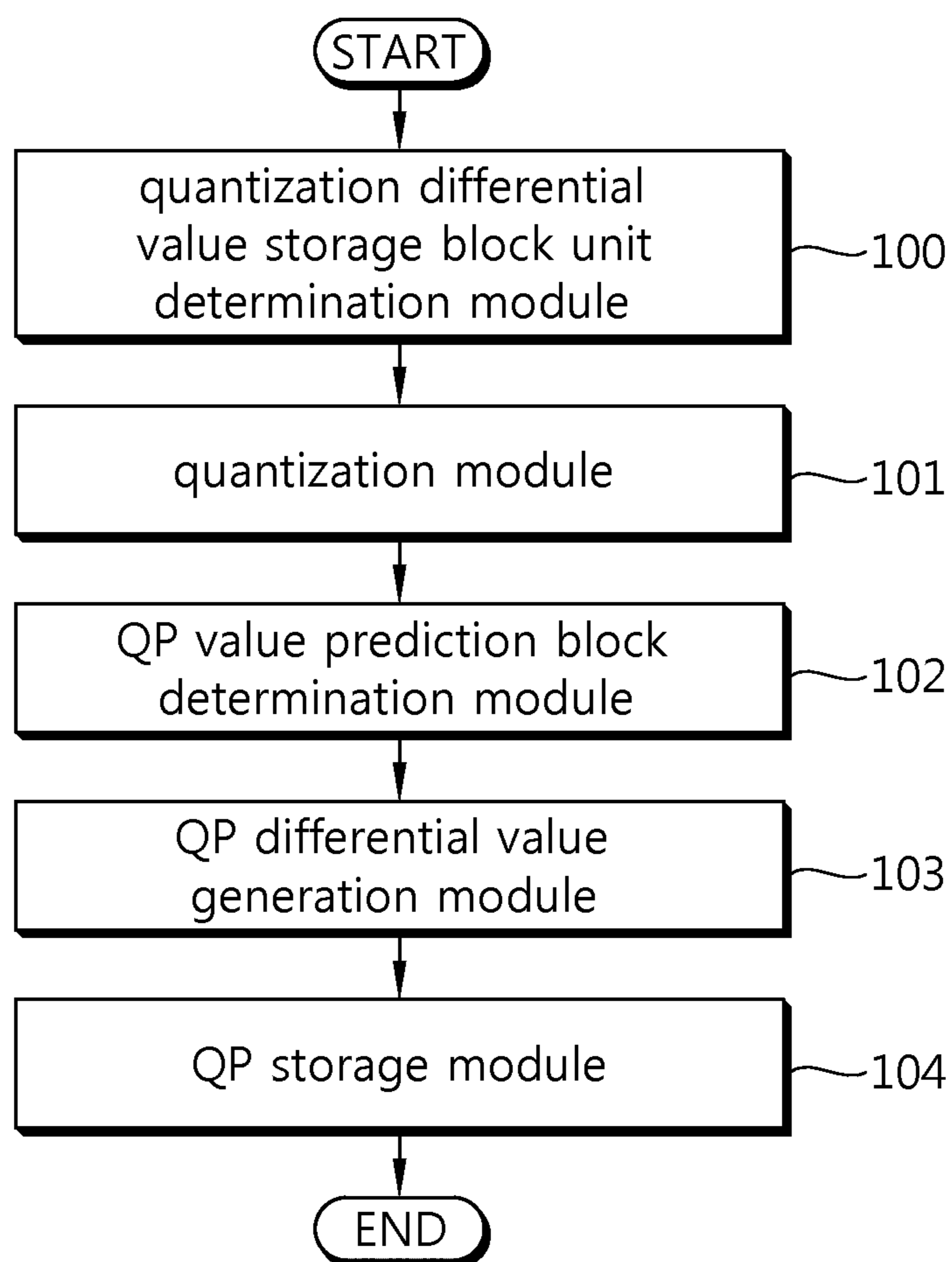


FIG. 1B

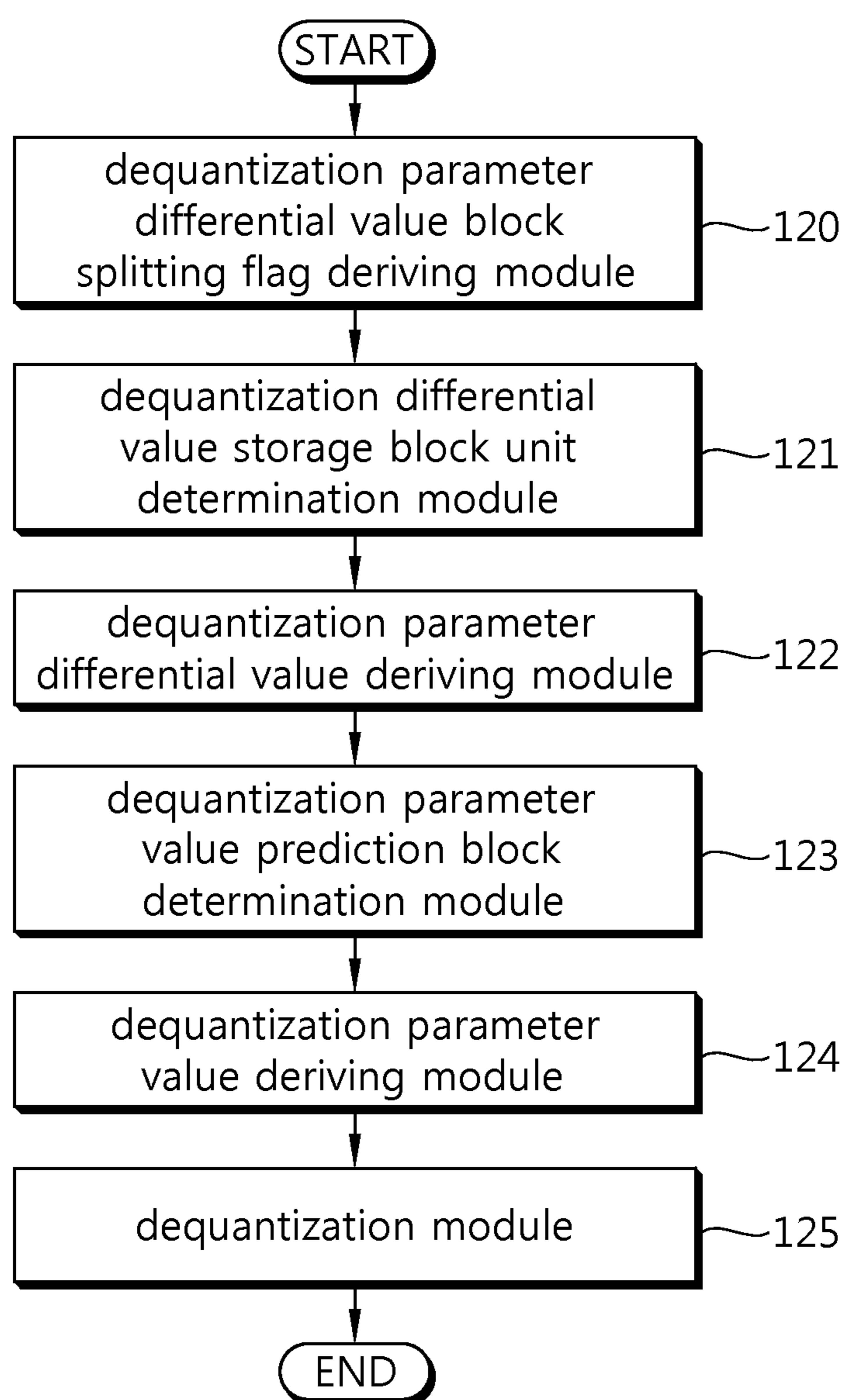


FIG. 2

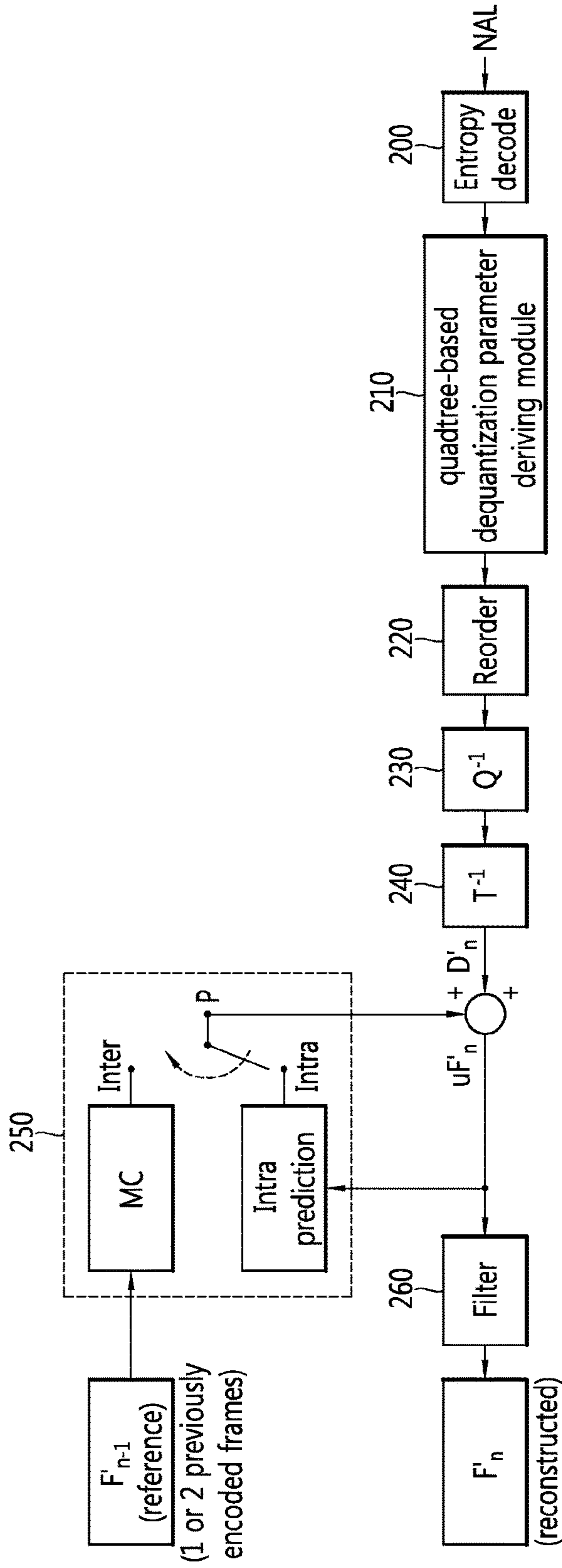


FIG. 3


seq_parameter_set_rbsp()	Descriptor
<b>cu_qp_delta_enabled_flag</b>	u(1)  300

FIG. 4A

slice_data()	Descriptor
<pre>CurrTbAddr=first_tb_in_slice do {   xCU=HorLumaLocation(CurrTbAddr)   yCU=VerLumaLocation(CurrTbAddr)    400— IsCuQpDeltaCoded=0   401— coding_tree(xCU, yCU, Log2TbSize, 1)   ...   CurrTbAddr=NextTbAddress(CurrTbAddr) } While(moreDataFlag)</pre>	

FIG. 4B

coding_tree(x0, y0, log2CUSize, cu_qp_delta_exist_flag)	Descriptor
<pre> ... split_coding_unit_flag[x0][y0] ... if(split_coding_unit_flag[x0][y0]) {   if(cu_qp_delta_enabled_flag&amp;&amp;cu_qp_delta_exist_flag)   {     <b>split_qp_delta_flag</b>     if(split_qp_delta_flag==0)       IsCuQpDeltaCoded=0;     cu_qp_delta_exist_flag=split_qp_delta_flag   }   x1=x0+((1&lt;&lt;log2CUSize)&gt;&gt;1)   y1=y0+((1&lt;&lt;log2CUSize)&gt;&gt;1)   coding_tree(x0, y0, log2CUSize-1, cu_qp_delta_exist_flag)   if(x1&lt;PicWidthInSamplesL)     coding_tree(x1, y0, log2CUSize-1, cu_qp_delta_exist_flag)   if(y1&lt;PicWidthInSamplesL)     coding_tree(x0, y1, log2CUSize-1, cu_qp_delta_exist_flag)   if(x1&lt;PicWidthInSamplesL &amp;&amp; y1&lt;PicHeightInSamplesL)     coding_tree(x1, y1, log2CUSize-1, cu_qp_delta_exist_flag) } else {   coding_unit(x0, y0, log2CUSize, cu_qp_delta_exist_flag) } </pre>	<p>421</p> <p>420</p> <p>u(1)   ae(v) 422</p>



FIG. 5

coding_tree(x0, y0, log2CUSize, cu_qp_delta_exist_flag)	Descriptor
<pre> If(skip_flag[x0][y0]) {   ... } else {   if((cu_qp_delta_enabled_flag&amp;&amp;cu_qp_delta_exist_flag)         (cu_qp_delta_enabled_flag&amp;&amp; ! IsCuQpDeltaCoded))   {     <b>cu_qp_delta</b>     IsCuQpDeltaCoded=1;   } } </pre>	se(v)   ae(v)

500

501

FIG. 6A

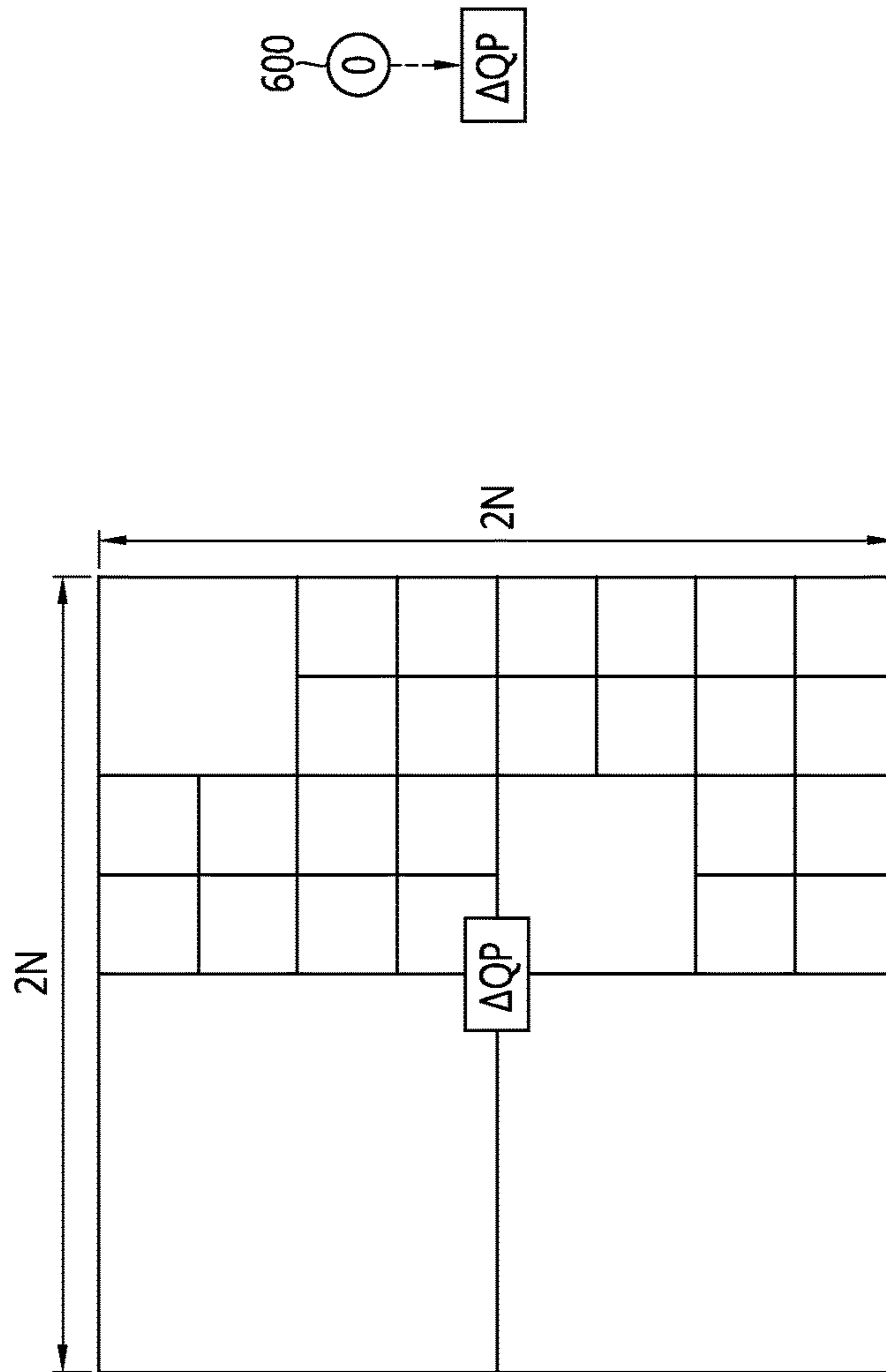


FIG. 6B

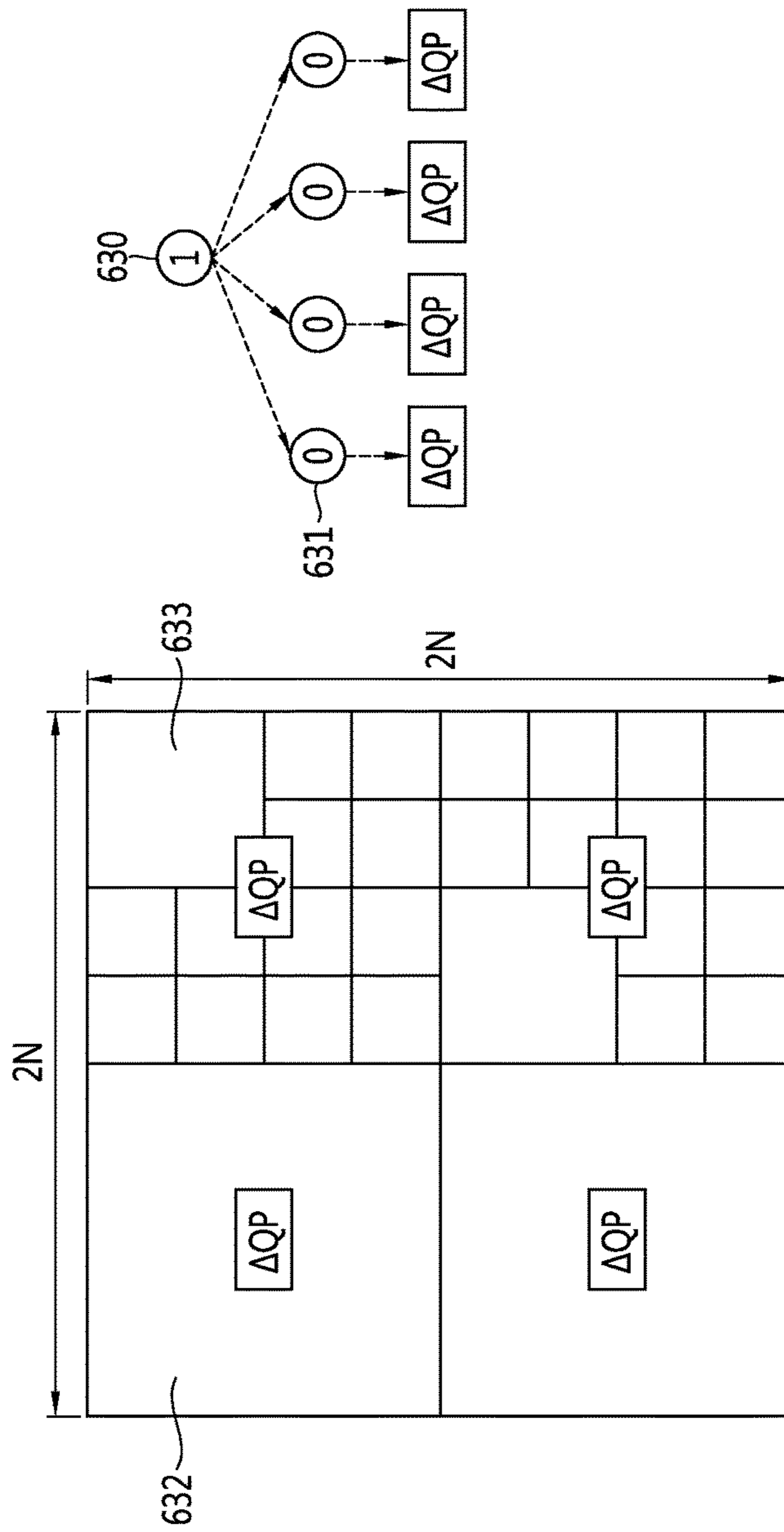


FIG. 6C

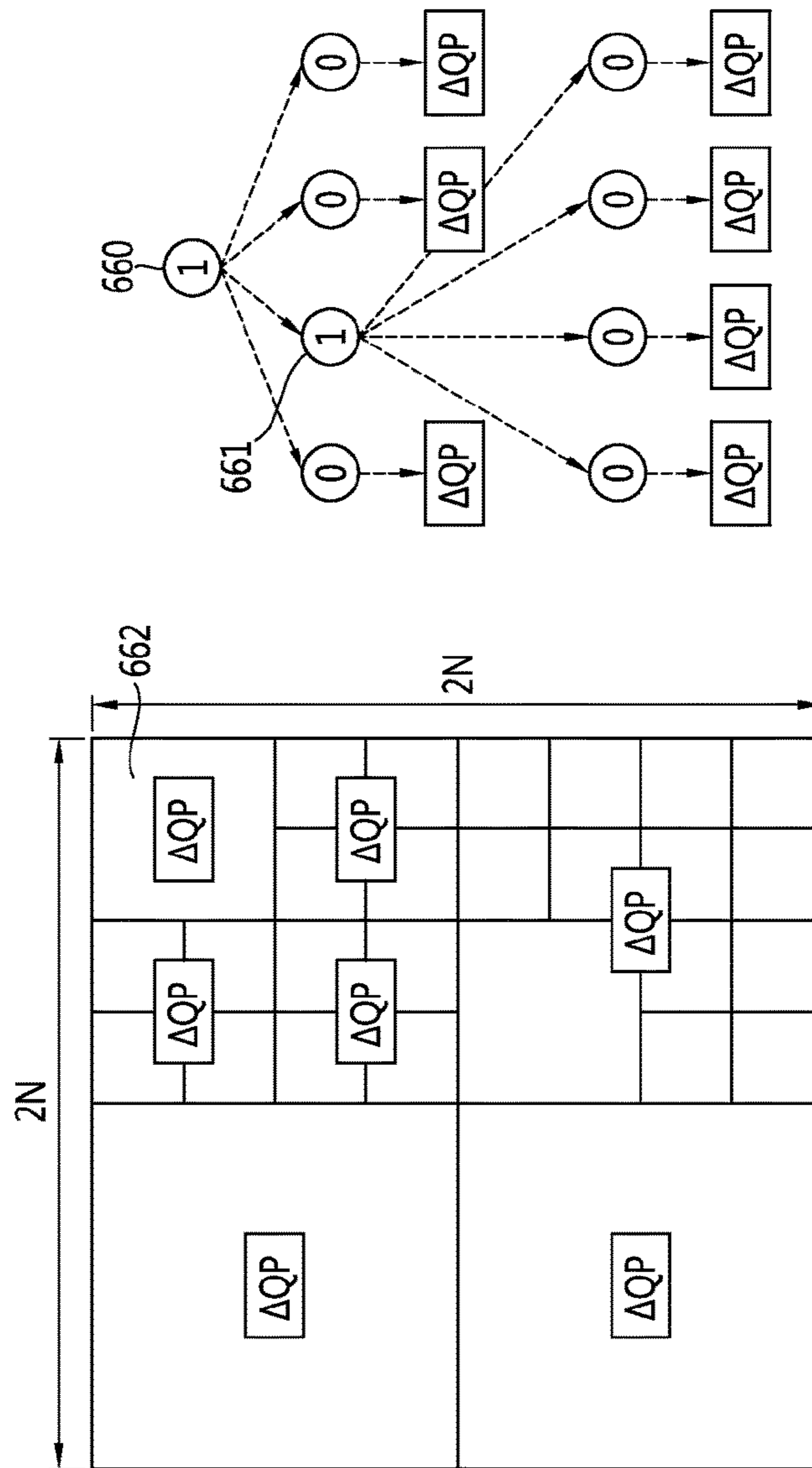




FIG. 7B

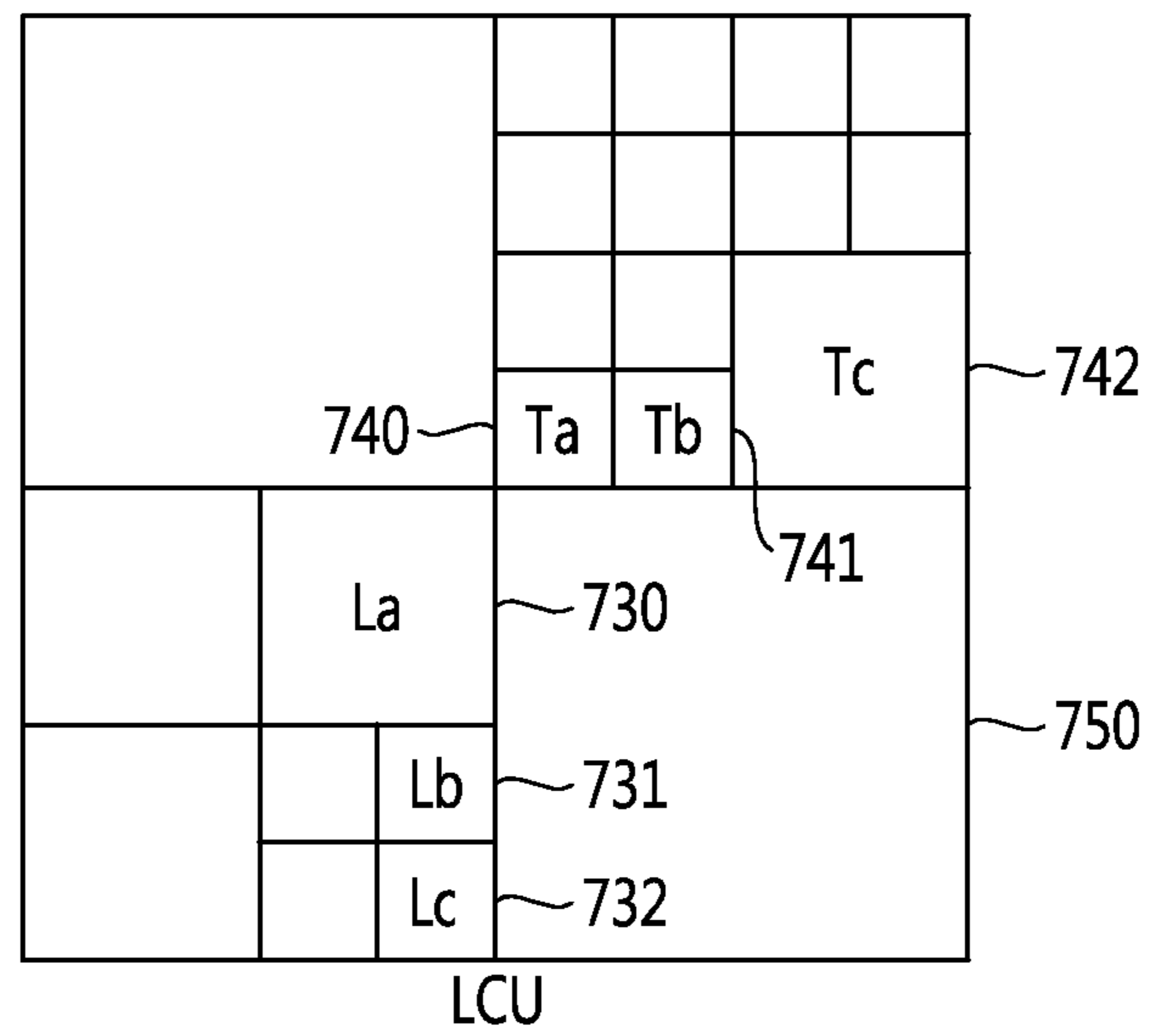


FIG. 8A

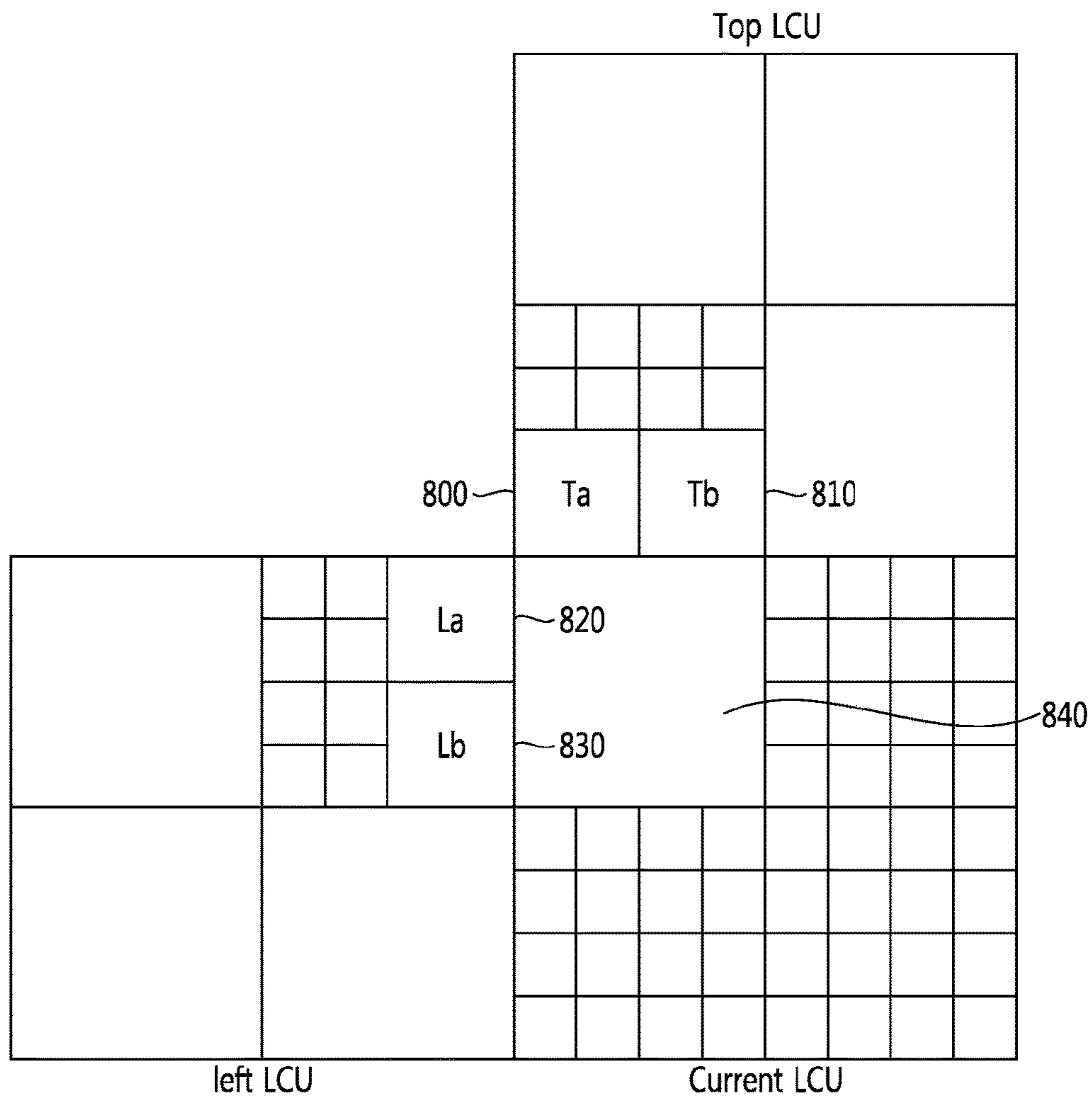


FIG. 8B

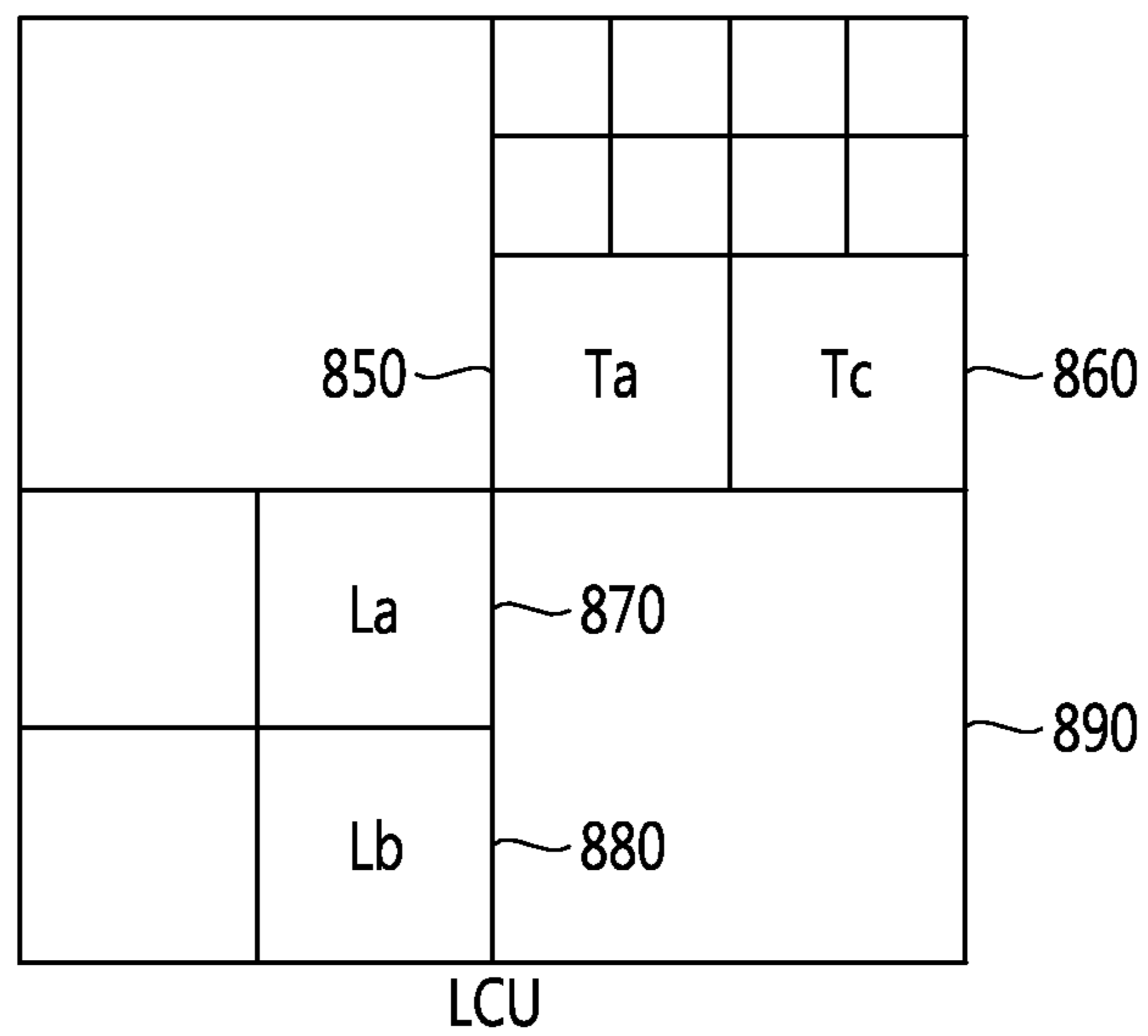




FIG. 9A

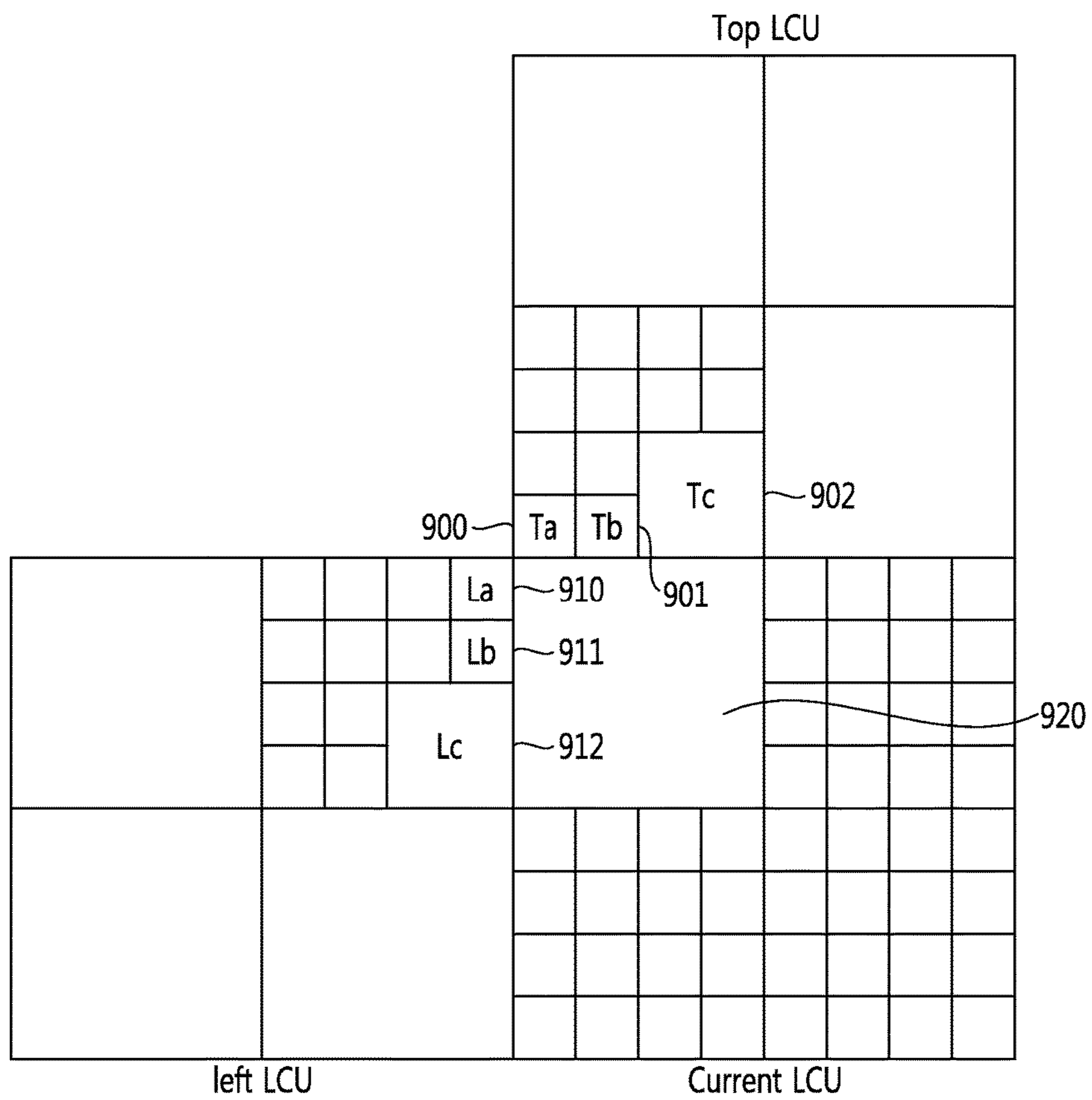


FIG. 9B

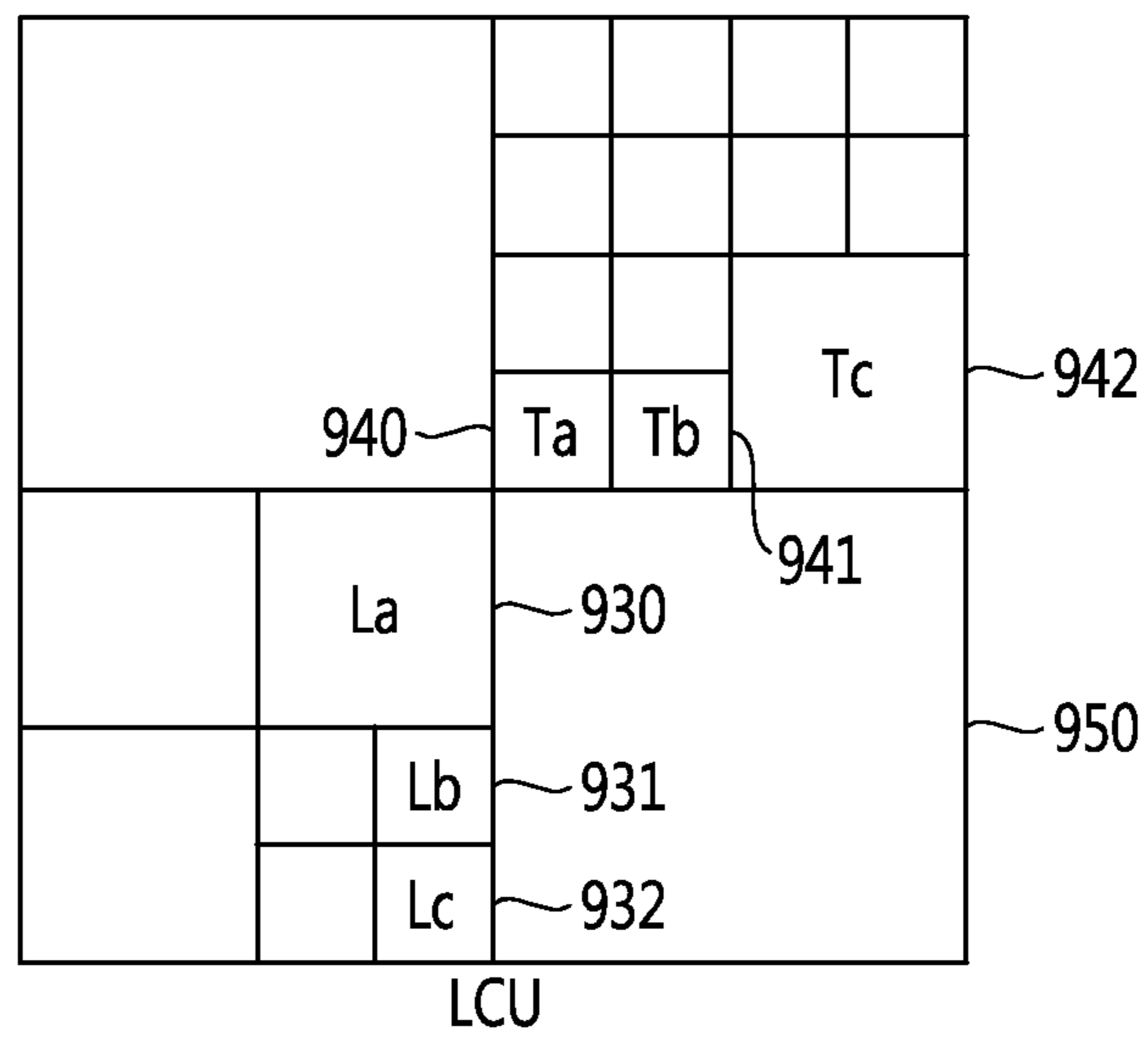


FIG. 10A

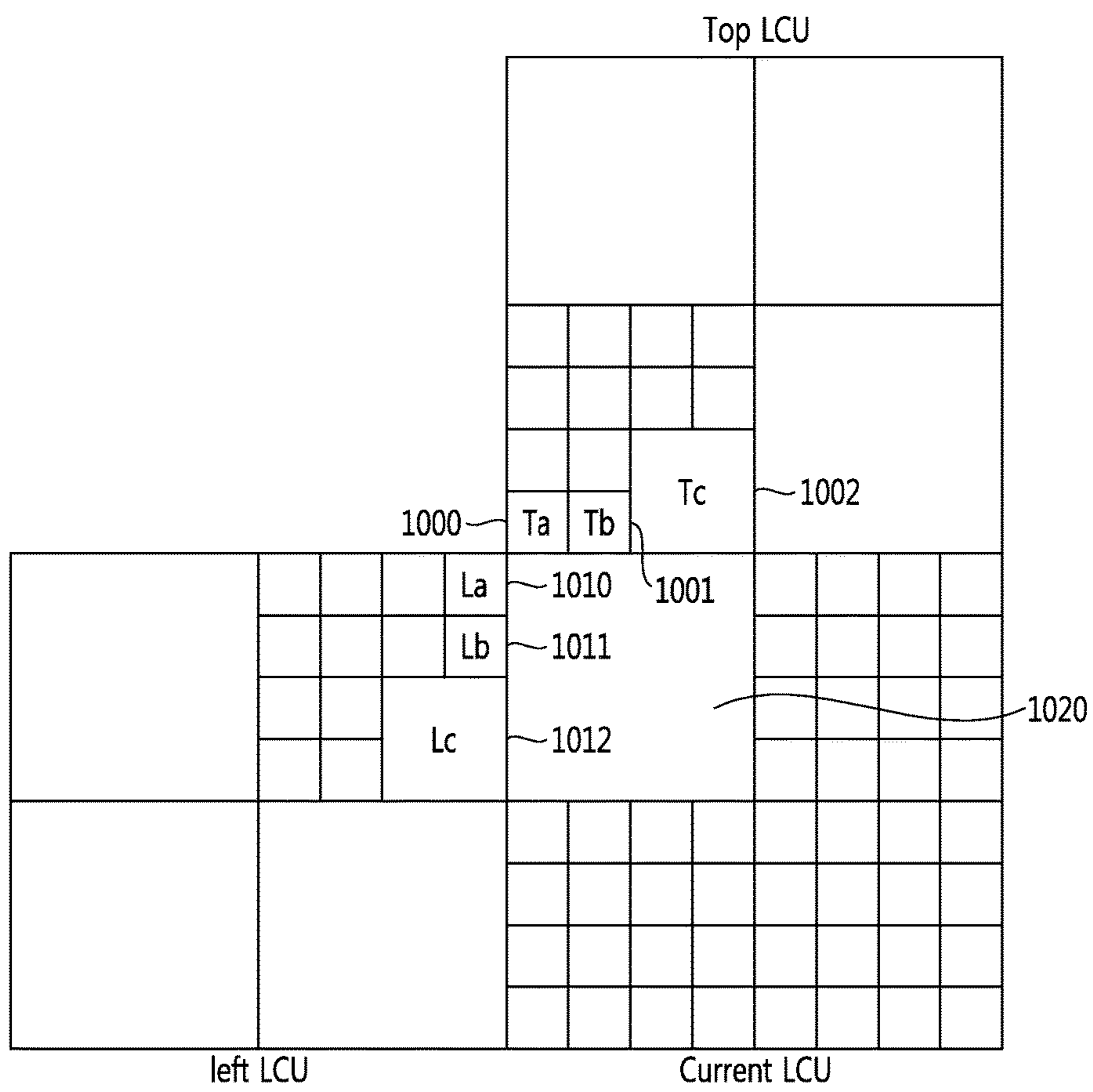


FIG. 10B

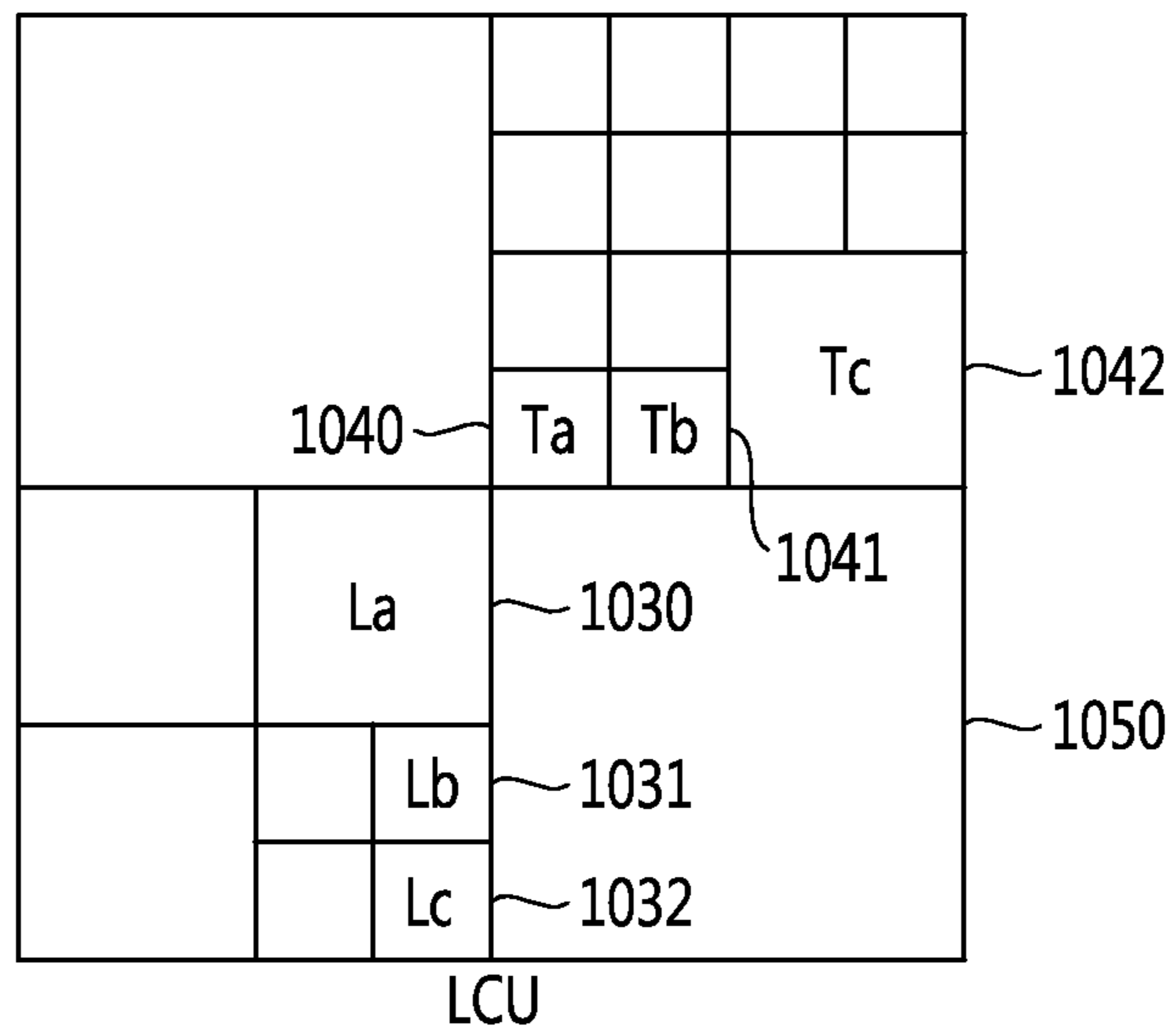


FIG. 11A

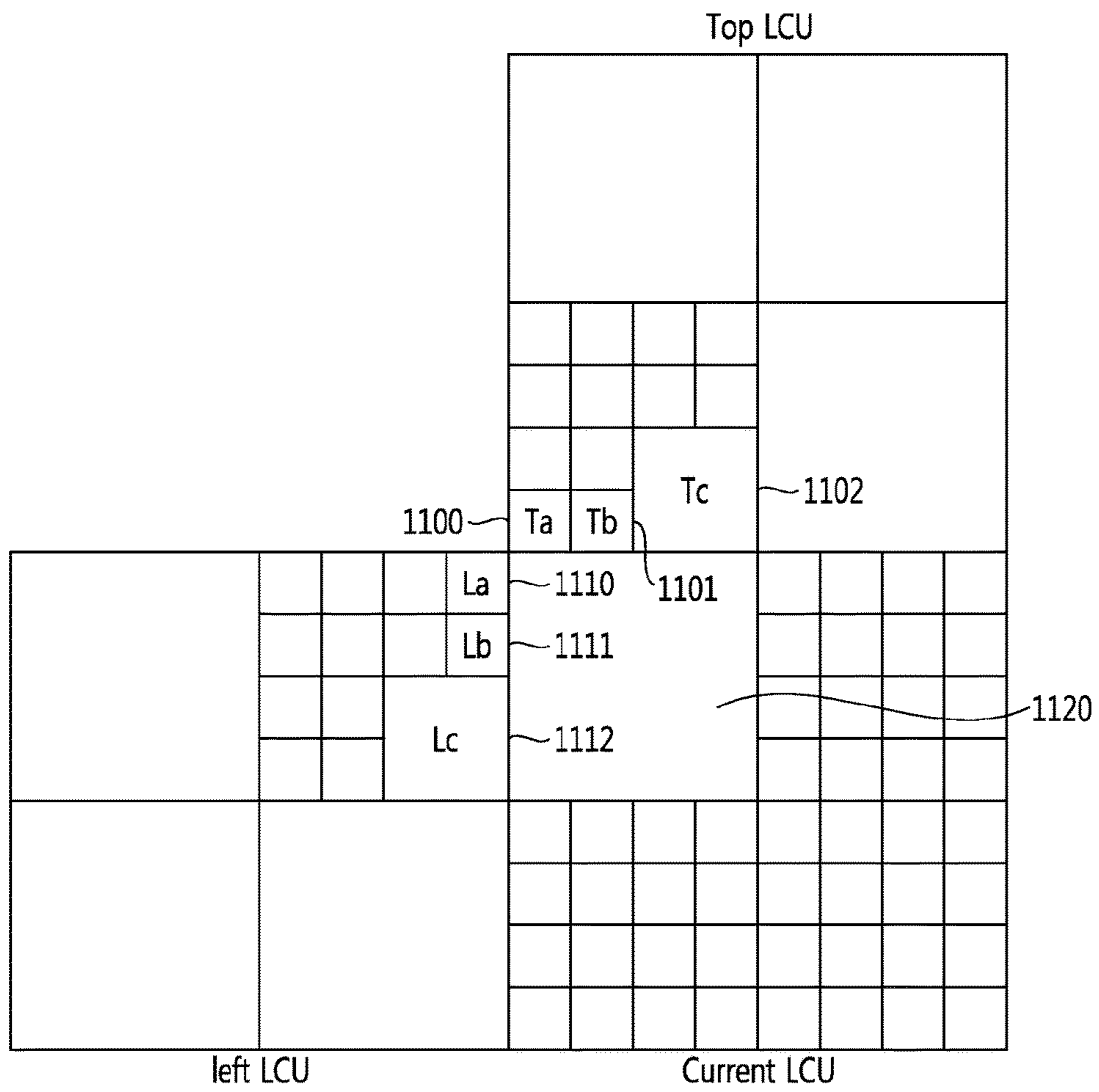
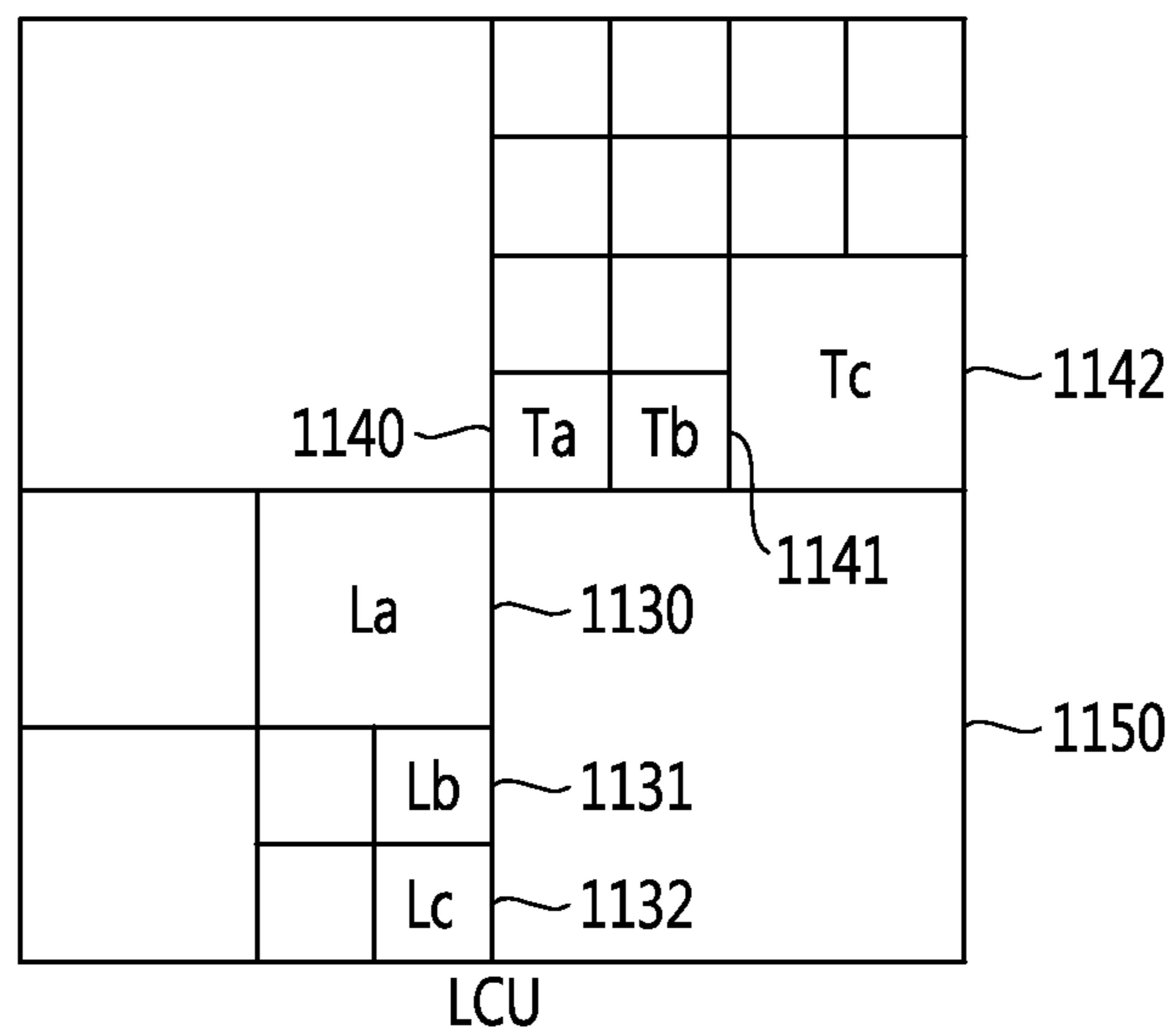


FIG. 11B



1

**METHOD AND APPARATUS FOR  
ADAPTIVELY ENCODING AND DECODING  
A QUANTIZATION PARAMETER BASED ON  
A QUADTREE STRUCTURE**

**Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue; a claim printed with strikethrough indicates that the claim was canceled, disclaimed, or held invalid by a prior post-patent action or proceeding.**

*CROSS-REFERENCE TO RELATED  
APPLICATIONS*

**[This]** *The present application is a Continuation Reissue Application of U.S. application Ser. No. 14/815,325, filed Jul. 31, 2015, which is a Reissue Application from U.S. Pat. No. 9,066,098 issued on Jun. 23, 2015 and filed Dec. 30, 2014, which is a Continuation Application of U.S. application Ser. No. 14/096,211, filed on Dec. 4, 2013, which is a Continuation Application of PCT Application No. PCT/KR2012/004881, filed on Jun. 20, 2012 and published as WO 2012/177051 on Dec. 27, 2012, which claims priority to Korean Patent Application No. 10-2011-0060058, filed on Jun. 21, 2011 in the Korean Intellectual Property Office, the entire disclosures of which are incorporated herein by reference for all purposes.*

TECHNICAL FIELD

The present invention relates to an apparatus and a method of encoding/decoding a video, and more particularly, to a video encoding/decoding method and apparatus which displays a block having a quantization/dequantization differential value based on a quadtree with respect to coding units (CUs) in a largest coding unit (LCU) and adaptively predicts/decodes a quantization/dequantization parameter value using context information on blocks neighboring to a block to encode/decode.

High Efficiency Video Coding (HEVC) encodes/decodes an input picture by a coding unit (CU). A CU with a largest size in a frame is referred to as a largest coding unit (LCU), which is split into a plurality of CUs based on quadtree splitting information for encoding/decoding. In HEVC, one quantization parameter value is allocated to an LCU, and a quantization parameter value for a current LCU to encode is predicted from a previous LCU according to raster scan order.

BACKGROUND ART

In H.265/AVC, encoding/decoding is carried out on a macroblock unit, and a quantization/dequantization value is allocated to each macroblock. A quantization parameter value allocated to each macroblock is predicted from a quantization parameter value of a macroblock located on the left in a frame. A differential value which is generated after prediction of the quantization parameter value is written in a macroblock to encode, thereby conducting encoding. A decoder decodes the quantization parameter value by adding the quantization parameter differential value decoded in entropy decoding and the quantization parameter value of the left macroblock.

However, when a large LCU is allocated as compared with a size of an input picture, a bit rate may not be

2

effectively controlled using a quantization parameter value stored by an LCU. Further, when a quantization parameter value is allocated by a CU, subjective deterioration in image quality may occur due to a difference in quantization parameter value from neighboring CUs. Thus, there is a need for a method of allocating quantization parameter values to various block sizes ranging from a CU to an LCU depending on an input picture and of optimally predicting a quantization parameter using context information on blocks neighboring to a block to encode.

DISCLOSURE

Technical Problem

An aspect of the present invention is to provide a method and an apparatus for encoding/decoding quadtree-based quantization/dequantization parameter values based on splitting information on a CU. The quantization/dequantization parameter encoding/decoding method and apparatus are capable of predicting quantization/dequantization parameter values in an effective manner using context information on neighboring blocks.

Technical problems of the present invention are not limited to those mentioned above, and those skilled in the art may understand additional problems not stated herein based on the following description.

Technical Solution

An embodiment of the present invention provides a video encoding apparatus which includes a quantization differential value storing block unit determination module to determine a block unit to store a quantization parameter (QP) differential value in splitting a largest coding unit (LCU) of a picture into a plurality of CUs in a quadtree or encoding into a single CU, a quantization module to perform quantization using a quantization value allocated to each block unit, a quantization prediction block determination module to adaptively determine a prediction block using context information on a neighboring block so as to predict a quantization value used by a block to encode, a QP differential value generation module to generate a quantization differential value of the block to encode using a QP of the prediction block determined based on the context information, and a QP storage module to store splitting information on a quantization differential value storage block unit and QP differential values of a corresponding block.

Another embodiment of the present invention provides a video decoding apparatus which includes a dequantization parameter differential value block splitting flag deriving module to decode information on a block having a dequantization parameter differential value in an LCU, a dequantization differential value storage block unit determination module to determine the block having the dequantization parameter differential value in the LCU using a decoded dequantization parameter differential value block splitting flag, a dequantization parameter differential value deriving module to decode a dequantization parameter differential value according to the dequantization parameter differential value block splitting flag, a dequantization parameter value prediction block determination module to determine a block used for prediction based on context information on a neighboring block so as to decode a dequantization parameter value of a block to decode, a dequantization parameter value deriving module to decode the dequantization parameter

value used for dequantization, and a dequantization module to perform dequantization using the decoded dequantization parameter value.

#### Advantageous Effects

Quadtree-based adaptive quantization/dequantization parameter encoding and decoding methods and apparatuses according to exemplary embodiments of the present invention enable allocation of different levels of quantization parameter differential values when a block is split in a quadtree. Such allocation of different levels of quantization parameter differential values allows accurate adjustment of bit rate as compared with allocation of a single quantization parameter value in an LCU. Further, in predicting/decoding a quantization/dequantization parameter value for each block unit, a prediction direction may be adaptively determined using not only quadtree-based zigzag scanning but also context information on neighboring blocks, thereby resolving subjective deterioration in image quality which may occur due to a substantial difference in quantization value from neighboring blocks.

#### DESCRIPTION OF DRAWINGS

FIG. 1A illustrates as for a method and an apparatus for adaptively allocating a quantization parameter (QP) value to a block having a quadtree structure and encoding the QP value in a video encoding apparatus according a first exemplary embodiment of the present invention.

FIG. 1B illustrates as for a quadtree-based adaptive dequantization parameter decoding method and apparatus in a video decoding apparatus according the first exemplary embodiment of the present invention.

FIG. 2 illustrates as for a configuration of the video decoding apparatus according to the first exemplary embodiment of the present invention.

FIG. 3 illustrates as for a context for controlling a quadtree-based quantization differential value recorded in a sequence parameter set according to the first exemplary embodiment of the present invention.

FIG. 4A illustrates as for variables set to initial values in slice data according to the first exemplary embodiment of the present invention.

FIG. 4B illustrates as for variables set to initial values in slice data according to the first exemplary embodiment of the present invention.

FIG. 5 illustrates as for a context of a quantization/dequantization parameter differential value stored by a CU and conditions in which the differential value exists according to the first exemplary embodiment of the present invention.

FIG. 6A illustrates as for operations in a quantization differential value storage block unit determination module and a dequantization differential value storage block unit determination module according to an exemplary embodiment of the present invention.

FIG. 6B illustrates as for operations in a quantization differential value storage block unit determination module and a dequantization differential value storage block unit determination module according to an exemplary embodiment of the present invention.

FIG. 6C illustrates as for operations in a quantization differential value storage block unit determination module and a dequantization differential value storage block unit determination module according to an exemplary embodiment of the present invention.

FIG. 7A illustrates as for operations in a QP value prediction block determination module and a dequantization parameter value prediction block determination module according to the first exemplary embodiment of the present invention.

FIG. 7B illustrates as for operations in a QP value prediction block determination module and a dequantization parameter value prediction block determination module according to the first exemplary embodiment of the present invention.

FIG. 8A illustrates as for operations in a QP value prediction block determination module and a dequantization parameter value prediction block determination module according to a second exemplary embodiment of the present invention.

FIG. 8B illustrates as for operations in a QP value prediction block determination module and a dequantization parameter value prediction block determination module according to a second exemplary embodiment of the present invention.

FIG. 9A illustrates as for operations in a QP value prediction block determination module and a dequantization parameter value prediction block determination module according to a third exemplary embodiment of the present invention.

FIG. 9B illustrates as for operations in a QP value prediction block determination module and a dequantization parameter value prediction block determination module according to a third exemplary embodiment of the present invention.

FIG. 10A illustrates as for operations in a QP value prediction block determination module **102** and a dequantization parameter value prediction block determination module **123** according to a fourth exemplary embodiment of the present invention.

FIG. 10B illustrates as for operations in a QP value prediction block determination module **102** and a dequantization parameter value prediction block determination module **123** according to a fourth exemplary embodiment of the present invention.

FIG. 11A illustrates as for operations in a QP value prediction block determination module and a dequantization parameter value prediction block determination module according to a fifth exemplary embodiment of the present invention.

FIG. 11B illustrates as for operations in a QP value prediction block determination module and a dequantization parameter value prediction block determination module according to a fifth exemplary embodiment of the present invention.

#### MODE FOR INVENTION

Hereinafter, quadtree-based adaptive quantization/dequantization parameter encoding and decoding apparatuses according to an exemplary embodiments of the present invention will be described with reference to the accompanying drawings.

FIG. 1A illustrates a method and an apparatus for adaptively allocating a quantization parameter (QP) value to a block having a quadtree structure and encoding the QP value in a video encoding apparatus according a first exemplary embodiment of the present invention.

Referring to FIG. 1A, a quadtree-based adaptive quantization parameter encoding method and apparatus include a quantization differential value storage block unit determination module **100**, a quantization module **101**, a QP value



prediction block determination module **102**, a QP differential value generation module **103**, and a QP storage module **104**.

The quantization differential value storage block unit determination module **100** may determine a block unit to record a quantization differential value for each coding unit (CU) or a group of a plurality of CUs based on information on splitting of a largest coding unit (LCU) of a picture into CUs. Information on a block storing the quantization differential value may have a quadtree structure.

The quantization module **101** performs quantization on an input block using a QP value allocated to the block.

The QP value prediction block determination module **102** determines a prediction block to be used for prediction of a quantization value allocated to each CU or arbitrary CU using context information on a CU neighboring to the CU so as to effectively encode the quantization value. The context information may include a size of the block, a location of the block, and a prediction mode for the block.

The QP differential value generation module **103** generates a QP differential value by subtracting a quantization value of the current block from a QP value of the quantization value prediction block determined by the QP value prediction block determination module **102**.

The QP storage module **104** serves to entropy-encode a sequence parameter set, flag information on application/non-application by a slice unit, flag information used to indicate splitting information on a block including a quantization differential value, and a QP differential value for quadtree-based adaptive QP encoding.

FIG. **1B** illustrates a quadtree-based adaptive dequantization parameter decoding method and apparatus in a video decoding apparatus according to the first exemplary embodiment of the present invention.

Referring to FIG. **1B**, the quadtree-based adaptive dequantization parameter decoding method and apparatus includes a dequantization parameter differential value block splitting flag deriving module **120**, a dequantization differential value storage block unit determination module **121**, a dequantization parameter differential value deriving module **122**, a dequantization parameter value prediction block determination module **123**, a dequantization parameter value deriving module **124**, and a dequantization module **125**.

The dequantization parameter differential value block partition flag deriving module **120** decodes a sequence parameter set and a block partition flag for a block having a dequantization parameter differential value by an LCU in slice data.

The dequantization differential value storage block unit determination module **121** determines blocks to record dequantization parameter differential values using the decoded dequantization parameter differential value block splitting flag and a CU splitting flag. Information on a block to record a quantization differential value may have a quadtree structure.

The dequantization parameter differential value deriving module **122** derives a dequantization parameter differential value of each block determined by the dequantization differential value storage block unit determination module **121**.

The dequantization parameter value prediction block determination module **123** derives determines a block for adaptive reference using context information on a neighboring block in dequantization. The context information may include a size of the block, a location of the block, and a prediction mode for the block.

The dequantization parameter value deriving module **124** derives a dequantization parameter value used for the

dequantization module **125** by adding a dequantization parameter value of a prediction block derived by the dequantization parameter value prediction block determination module **123** and a dequantization parameter differential value derived by the dequantization parameter differential value deriving module **122**.

The dequantization module **125** performs dequantization on the input block using the parameter derived by the dequantization parameter value deriving module **124**.

FIG. **2** illustrates a configuration of the video decoding apparatus according to the first exemplary embodiment of the present invention.

Referring to FIG. **2**, the video decoding apparatus includes an entropy-decoding module **200**, a quadtree-based dequantization parameter deriving module **210**, a rearrangement module **220**, a dequantization module **230**, an inverse discrete cosine transform encoding module **240**, an intra/inter prediction module **250**, and a filtering module **260**.

The entropy-decoding module **200** includes the dequantization parameter differential value block splitting flag deriving module **120** to derive a block partition flag used for quadtree-based adaptive dequantization, the dequantization differential value storage block unit determination module **121** to determine a block storing a QP from the derived block splitting flag, and the dequantization parameter differential value deriving module **122** to decode a dequantization parameter differential value stored in a corresponding block.

The quadtree-based dequantization parameter deriving module **210** includes the dequantization parameter value prediction block determination module **123** to determine a prediction block for reference in decoding a dequantization parameter and the dequantization parameter value deriving module **124** to derive a dequantization parameter by adding a dequantization parameter of the prediction block and the derived dequantization parameter differential value.

FIG. **3** illustrates a context for controlling a quadtree-based quantization differential value stored in a sequence parameter set according to the first exemplary embodiment of the present invention.

When `cu_qp_delta_enabled_flag` **300** has a value of 1 in the sequence parameter set, quantization/dequantization parameter differential values of various quadtree blocks ranging from CUs of minimum size to CUs of maximum size in all slices in a sequence may be controlled.

FIG. **4A** illustrates variables set to initial values in slice data according to the first exemplary embodiment of the present invention.

When a slice is split in a quadtree and encoded/decoded, the slice is first split into LCUs that are a quadtree of maximum size, which are then encoded/decoded in sequential scanning order. In encoding/decoding each LCU, an LCU may be further split into a plurality of CUs in a quadtree, and such splitting may be performed until CUs are partitioned into CUs of minimum size.

In FIG. **4A**, `CuQpDeltaCoded` **400** is a variable for controlling a quantization/dequantization parameter differential value which may be stored in each CU when an arbitrary CU is split into N CUs. This variable is always initialized to 0 before each LCU in the slice is encoded/decoded.

In FIG. **4A**, `coding_tree` **401** is a function of performing encoding/decoding on one LCU in the slice. A fourth factor in this function is a flag indicating whether a quantization/dequantization parameter differential value exists in a corresponding CU, and always imports a value of 1 before each

LCU in the slice is encoded/decoded since at least one quantization/dequantization parameter differential value is stored in the LCU.

FIG. 4B illustrates a context of dequantization parameter differential value block splitting stored in a coding tree block according to the first exemplary embodiment of the present invention.

A coding tree block expresses a context of a CU. A CU having a  $2N \times 2N$  size may be split into four CUs having an  $N \times N$  size and encoded/decoded according to split\_coding\_unit\_flag 420. Alternatively, the CU having a  $2N \times 2N$  size may not be split into CUs of smaller size any more but be encoded/decoded as it is.

The current CU receives an input of a flag indicating whether a quantization/dequantization parameter differential value exists in a higher CU, that is, cu\_qp\_delta\_exist\_flag 421. When the current CU having a  $2N \times 2N$  size is further split into CUs having an  $N \times N$  size according to a value of split\_coding\_unit\_flag 420, split\_qp\_delta\_flag 422 is additionally encoded/decoded. Information on such additional splitting is encoded/decoded only when cu\_qp\_delta\_enabled\_flag 300 stored in the sequence parameter set and cu\_qp\_delta\_exist\_flag 421 input from the higher CU have a value of 1. A value of split\_qp\_delta\_flag 422 is encoded/decoded only when the current CU having a  $2N \times 2N$  size is split into the CU having an  $N \times N$  size, and is input as the value of cu\_qp\_delta\_exist\_flag 421 when the lower CUs having an  $N \times N$  size are encoded/decoded.

When the value of split\_qp\_delta\_flag 422 is 0, the current CU having a  $2N \times 2N$  size is partitioned into the CUs having an  $N \times N$  size but a block storing a quantization/dequantization parameter differential value is not split any more from a  $2N \times 2N$  size to an  $N \times N$  size. When the value of split\_qp\_delta\_flag 422 is 0, a value of IsCuQpDeltaCoded 400 is additionally initialized to 0, so that a quantization/dequantization parameter differential value is stored only in a first  $N \times N$  CU when the current CU is split into the CUs having  $N \times N$  size.

FIG. 5 illustrates a context of a quantization/dequantization parameter differential value stored by a CU and conditions in which the differential value exists according to the first exemplary embodiment of the present invention.

When a CU is not in a skip mode, a quantization/dequantization parameter differential value may be recorded in the CU. When a value of cu\_qp\_delta\_exist\_flag 500 and 421 is 1, a quantization/dequantization parameter differential value exists in the current CU, in which case a value of cu\_qp\_delta 501 may be stored by a CU according to a value of cu\_qp\_delta\_enabled\_flag 300 stored in the sequence parameter set. For example, when the value of cu\_qp\_delta\_exist\_flag 500 and 421 is 1 and the value of cu\_qp\_delta\_enabled\_flag 300 is 0, cu\_qp\_delta 501 is not stored.

Alternatively, when a  $2N \times 2N$  CU is split into four  $N \times N$  CUs in a quadtree, only one quantization/dequantization parameter differential value may be stored. In this case, the quantization/dequantization parameter differential value is stored in a first CU among the four CUs, while the other three CUs do not record the quantization/dequantization parameter differential value. Here, since the value of split\_qp\_delta\_flag 422 encoded/decoded in the  $2N \times 2N$  CU is 0, the value of cu\_qp\_delta\_exist\_flag 500 input to the  $N \times N$  CU is 0. Thus, although no cu\_qp\_delta 501 basically exists in the split four  $N \times N$  CUs, a value of cu\_qp\_delta 501 may be stored in a first  $N \times N$  CU using a variable NIsCuQpDeltaCoded. The value of cu\_qp\_delta 501 is not stored in the other three CUs since the first CU changes the value of IsCuQpDeltaCoded to 1 after decoding cu\_qp\_delta 501.

Even in this case, the value of cu\_qp\_delta 501 may be stored only when the value of cu\_qp\_delta\_enabled\_flag 300 stored in the sequence parameter set is 1, simultaneously checking the value of cu\_qp\_delta\_enabled\_flag 300.

FIG. 6A illustrates operations of the quantization differential value storage block unit determination module 100 and the dequantization differential value storage block unit determination module 121 according to the first exemplary embodiment of the present invention.

A  $2N \times 2N$  LCU to encode/decode may be split into four  $N \times N$  CUs, each of which may be further partitioned to be processed. Even though the  $2N \times 2N$  LCU is partitioned into a plurality of CUs to be encoded/decoded, when split\_qp\_delta\_flag 422 has a value of 0 as shown in FIG. 6A, a quantization/dequantization parameter differential value is stored in a first CU of the LCU. A quantization/dequantization parameter value reconstructed in the first CU may be used for the other CUs of the LCU.

FIG. 6B illustrates operations of the quantization differential value storage block unit determination module 100 and the dequantization differential value storage block unit determination module 121 according to a second exemplary embodiment of the present invention.

A  $2N \times 2N$  LCU to encode/decode is split into four CUs in a first stage, a second CU of which is further split. In this instance, when a flag indicating splitting into the CUs is encoded/decoded in the first stage, a splitting flag with respect to a quantization/dequantization parameter value, which is split\_qp\_delta\_flag 422 and 631, is additionally encoded/decoded. When a value of split\_qp\_delta\_flag 422 and 631 is 1, all four split CUs have a quantization/dequantization parameter differential value, and thus the splitting flag with respect to the quantization/dequantization parameter value, split\_qp\_delta\_flag 422 and 631, is additionally encoded/decoded.

Even in this case, although the second  $N \times N$  CU is split into CUs until a third stage, the block splitting flag for quantization/dequantization, split\_qp\_delta\_flag 422 and 631, is 0, and thus a single quantization/dequantization parameter value is allocated for a plurality of CUs.

FIG. 6C illustrates operations of the quantization differential value storage block unit determination module 100 and the dequantization differential value storage block unit determination module 121 according to a third exemplary embodiment of the present invention.

FIG. 6C shows that a  $2N \times 2N$  LCU to encode/decode is split into four CUs in a first stage, a second CU of which is further split. Even when the second CU is split into four CUs, each of which is further partitioned into four CUs, a size of a block to record a quantization/dequantization parameter differential value may be determined using a value of split\_qp\_delta\_flag 422 and 661. In FIG. 6C, a CU is split to regions with up to three depth informations, while the quantization/dequantization parameter differential value has relatively up to two depth informations.

FIG. 7A illustrates the QP value prediction block determination module 102 and the dequantization parameter value prediction block determination module 123 according to the first exemplary embodiment of the present invention.

An encoder allocates a QP value to CU blocks determined by the quantization differential value storage block unit determination module 100 and employs a previously used QP value for remaining blocks as it is. Here, the QP value is predicted from a QP value for previous blocks, and only a QP different value is encoded.

A decoder decodes a dequantization parameter differential value in the dequantization parameter differential value

deriving module 122 and derives a dequantization parameter value by adding the differential value with a dequantization parameter value of a block used for prediction.

The QP value prediction block determination module 102 and the dequantization parameter value prediction block determination module 123 serve to determine a neighboring block for reference when the encoder and the decoder predict a QP value of a current block.

In FIG. 7A, when a CU 720 to encode/decode is allocated a quantization/dequantization parameter value, the parameter value is predicted using an average value, minimum value or maximum value of QP values of CUs 712 and 702 or Lc and Tc having a largest block size located on each boundary among CUs 710, 711 and 712 or La, Lb and Lc located on a left boundary of the current CU 720 and CUs 700, 701 and 702 or Ta, Tb and Tc located on an upper boundary of the current CU 720.

FIG. 7B illustrates the QP value prediction block determination module 102 and the dequantization parameter value prediction block determination module 123 according to an alternative example of the first exemplary embodiment of the present invention.

When an LCU is split into a plurality of CUs to be encoded/decoded, a QP value of a current CU 750 to encode/decode is predicted using an average value, minimum value or maximum value of QP values of two CUs having a largest block size located on a left boundary and an upper boundary of the current CU 750 among CUs neighboring to the current CU 750.

FIG. 8A illustrates the QP value prediction block determining module 102 and the dequantization parameter value prediction block determination module 123 according to a second exemplary embodiment of the present invention.

When a QP value of a current CU 840 to encode/decode is predicted, a CU having a largest block size among CUs neighboring to the current CU is used for reference. In this case, when there are a plurality of CUs having a largest block size, an average value, minimum value or maximum value of QP values of CUs is used to predict the QP value of the current CU 840, the CUs including a top CU 820 or La selected among CUs on a left boundary of the current CU 840 and a leftmost CU 800 or Ta preferentially used for reference among CUs on an upper boundary thereof.

FIG. 8B illustrates the QP value prediction block determination module 102 and the dequantization parameter value prediction block determination module 123 according to an alternative example of the second exemplary embodiment of the present invention.

When an LCU is split into a plurality of CUs to be encoded/decoded, a QP value of a current CU 890 to encode/decode is predicted using CUs having a largest block size for reference among CUs neighboring to the current CU 890. Here, when there are a plurality of CUs having a largest block size on a left boundary of the current CU 890, a top CU 870 or La is used as a reference block. Likewise, when there are a plurality of CUs having a largest block size on an upper boundary of the current CU 890, a leftmost CU 850 or Ta is used as a reference block. When the reference blocks on the left and top boundaries are determined, the QP value of the current CU 890 to encode/decode is predicted using an average value, minimum value or maximum value of QP values of these two CUs.

FIG. 9A illustrates the QP value prediction block determination module 102 and the dequantization parameter value prediction block determination module 123 according to a third exemplary embodiment of the present invention.

When a QP value of a current CU 920 to encode/decode is predicted, all possible reference CUs 900, 901, 902, 910, 911 and 912 or Ta, Tb, Tc, La, Lb and Lc neighboring to the current CU are selected as reference blocks. The encoder predicts the QP value of the current CU 920 to encode using an average value, minimum value or maximum value of QP values of all possible reference CUs and encodes a QP differential value.

The decoder decodes a dequantization parameter value of the CU 920 to decode by adding the decoded QP differential value with an average value, minimum value or maximum value of dequantization parameter values of all possible reference CUs.

FIG. 9B illustrates the QP value prediction block determination module 102 and the dequantization parameter value prediction block determination module 123 according to an alternative example of the third exemplary embodiment of the present invention.

When a CU 950 to encode/decode is located in an LCU, a QP value of the CU 950 is predicted using all possible reference CUs 930, 931, 932, 940, 941 and 942 or La, Lb, Lc, Ta, Tb and Tc neighboring to the current CU.

The encoder predicts the QP value of the current CU 950 to encode using an average value, minimum value or maximum value of QP values of all adjacent possible reference CUs and encodes a QP differential value therebetween only.

The decoder decodes a dequantization parameter value of the CU 950 to decode by adding the decoded QP differential value with an average value, minimum value or maximum value of dequantization parameter values of all adjacent possible reference CUs.

FIG. 10A illustrates an operation in the QP value prediction block determination module 102 and the dequantization parameter value prediction block determination module 123 according to a fourth exemplary embodiment of the present invention.

When a CU 1020 located on a boundary between LCUs is encoded/decoded, a CU 1012 or Lc having a largest block size among possible reference CUs 1010, 1011 and 1012 or La, Lb and Lc located on a left boundary of the current CU 1020 is used for reference. Here, when there are one or more CUs having a largest block size among the possible reference CUs on the left boundary, a top CU is selected as a reference block.

The encoder predicts a QP value of the CU 1020 to encode using a QP value of the CU 1012 or Lc selected on the left boundary as the reference block and encodes a QP differential value therebetween.

The decoder decodes a dequantization parameter differential value of the CU 1020 to decode and adds the differential value with a dequantization parameter value of the CU 1012 or Lc, thereby decoding a dequantization parameter value of the CU 1020.

FIG. 10B illustrates an operation in the QP value prediction block determination module 102 and the dequantization parameter value prediction block determination module 123 according to an alternative example of the fourth exemplary embodiment of the present invention.

When an LCU is split into a plurality of CUs to be encoded/decoded, a CU 1030 or La having a largest block size among CUs 1030, 1031 and 1032 or La, Lb and Lc located on a left boundary of a CU 1050 to encode/decode is used for reference. Here, when there are one or more CUs having a largest block size among the CUs on the left boundary, a top CU 1030 or La is selected as a reference block.

## 11

The encoder predicts a QP value of the CU 1050 to encode using a QP value of the CU 1030 or La selected on the left boundary as the reference block and encodes a QP differential value therebetween.

The decoder decodes a dequantization parameter differential value of the CU 1050 to decode and adds the differential value with a dequantization parameter value of the CU 1030 or La, thereby decoding a dequantization parameter value of the CU 1050.

FIG. 11A illustrates an operation in the QP value prediction block determination module 102 and the dequantization parameter value prediction block determination module 123 according to a fifth exemplary embodiment of the present invention.

When a CU 1120 located on a boundary between LCUs is encoded/decoded, all possible reference CUs 1110, 1111 and 1112 or La, Lb and Lc located on a left boundary of the current CU 1220 are used as reference blocks.

The encoder predicts a QP value of the CU 1120 to encode using an average value, minimum value or maximum value of QP values of all possible reference CUs 1110, 1111 and 1112 or La, Lb and Lc located on the left boundary and encodes a QP differential value.

The decoder decodes a dequantization parameter differential value of the CU 1120 to decode and decodes a dequantization parameter value of the CU 1120 to decode by adding the differential value with an average value, minimum value or maximum value of dequantization parameter values of all possible reference CUs 1110, 1111 and 1112 or La, Lb and Lc.

FIG. 11B illustrates an operation in the QP value prediction block determination module 102 and the dequantization parameter value prediction block determination module 123 according to an alternative example of the fifth exemplary embodiment of the present invention.

When an LCU is split into a plurality of CUs to be encoded/decoded, all possible reference CUs located on a left boundary of a CU 1150 to encode/decode are used as reference blocks.

The encoder predicts a QP value of the CU 1150 to encode using an average value, minimum value or maximum value of QP values of all possible reference CUs located on the left boundary and encodes a QP differential value.

The decoder decodes a dequantization parameter differential value of the CU 1150 to decode and decodes a dequantization parameter value of the CU 1150 to decode by adding the differential value with an average value, minimum value or maximum value of dequantization parameter values of all possible reference CUs located on the left boundary.

The invention claimed is:

[1. A method for decoding a video by a decoding apparatus using derivation of a dequantization parameter, the method comprising:

determining a parameter recorded unit for which dequantization parameter information is signaled, wherein the parameter recorded unit is split in a quadtree structure; determining a parameter prediction unit used for deriving a predicted dequantization parameter, wherein the parameter prediction unit comprises the parameter recorded unit;

deriving the predicted dequantization parameter for the parameter prediction unit, wherein the predicted dequantization parameter is derived using an average value of dequantization parameters of a block neighboring to a left of the parameter prediction unit and a block neighboring above the parameter prediction unit;

## 12

deriving a differential dequantization parameter for the parameter recorded unit based on the dequantization parameter information;

deriving the dequantization parameter using a sum of the predicted dequantization parameter and the differential dequantization parameter; and

performing dequantization using the dequantization parameter.]

[2. The method of claim 1, wherein the parameter prediction unit is a block which has a size same with one of a coding unit size from size of smallest coding unit to size of largest coding unit when a quantization parameter flag has a value of true, and

wherein the quantization parameter flag indicates whether information with which the dequantization parameter is predicted for coding unit is present or not.]

[3. The method of claim 1, wherein splitting information is a split flag, and

wherein the parameter recorded unit is split into blocks of lower depth in a quadtree structure when the split flag is equal to 1, and the parameter recorded unit is not split further when the split flag is equal to 0.]

[4. The method of claim 1, wherein splitting information is a split flag,

wherein the split flag equal to 0 indicates that the differential dequantization parameter is signaled for the parameter recorded unit and the split flag equal to 1 indicates that the parameter recorded unit is split into sub-blocks and the differential dequantization parameter is not signaled for the parameter recorded unit, and wherein split flags for the sub-blocks are signaled when the split flag is equal to 1.]

5. A method for decoding a video by a decoding apparatus using derivation of a dequantization parameter, the method comprising:

determining a parameter recorded unit to which a single differential dequantization parameter is applied, wherein when the a parameter recorded unit is split into four coding units based on a block partition flag, the differential dequantization parameter is signaled on a first coding unit and is not signaled on other coding units;

determining a parameter prediction unit used for deriving a predicted dequantization parameter;

deriving the predicted dequantization parameter for the parameter prediction unit, wherein the predicted dequantization parameter is derived using an average value of dequantization parameters of a block neighboring to a left of the parameter prediction unit and a block neighboring above the parameter prediction unit; deriving the dequantization parameter using the predicted dequantization parameter and the differential dequantization parameter; and

performing dequantization using the dequantization parameter.

6. The method of claim 5, wherein the parameter prediction unit is a block which has a size same with one of a coding unit size from a size of a smallest coding unit to a size of a largest coding unit when a quantization parameter flag has a value of true, and

wherein the quantization parameter flag indicates whether information with which the dequantization parameter is predicted for a coding unit is present or not.