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(54) Title: AN IMPROVED DEPTH LOOKUP TABLE

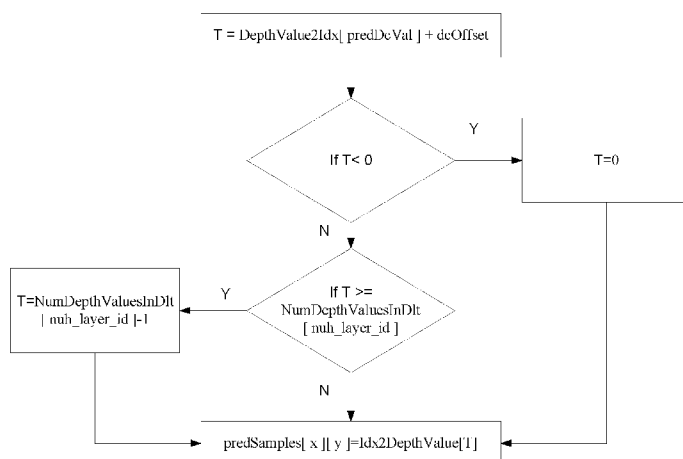


Fig. 2

(57) Abstract: It is proposed to clip the reconstructed index of the depth lookup table (DLT) to a proper value. In this case, meaningless DLT indices can be avoided.

AN IMPROVED DEPTH LOOKUP TABLE

FIELD OF INVENTION

The invention relates generally to Three-Dimensional (3D) video processing. In particular,
 5 the presented invention relates to depth coding.

BACKGROUND OF THE INVENTION

Depth lookup table (DLT) is adopted into 3D-HEVC. Since there are often only several values appearing in the depth component, DLT signals those valid values from the encoder to the decoder. When a CU is coded in intra simplified depth coding (SDC) mode or depth map modeling (DMM) mode, DLT is used to map the valid depth value to a DLT index which is much easier to compress. Fig.1 demonstrates an example of DLT approach. DLT is signaled in picture parameter set (PPS). And it is left to be an encoder issue how to get the DLT when encoding.

15 In the current design, the prediction samples are calculated as follows:

$\text{predSamples}[x][y] = \text{Idx2DepthValue}[\text{DepthValue2Idx}[\text{predDcVal}] + \text{dcOffset}]$,

wherein (x, y) represents the sample coordination, predDcVal is the DC prediction value, dcOffset is an offset signaled from the encoder to the decoder, DepthValue2Idx is a mapping table that maps a depth value to a DLT index, and Idx2DepthValue is a mapping table that maps a DLT index to a depth value.

In such a design, $\text{DepthValue2Idx}[\text{predDcVal}] + \text{dcOffset}$ might exceed the range of valid DLT indices. In such a case, $\text{Idx2DepthValue}[\text{DepthValue2Idx}[\text{predDcVal}] + \text{dcOffset}]$ will try to map an invalid DLT index to a depth value. The mapping will fail and the decoding process cannot run correctly. For example, when there are only 10 entries in DLT, the valid DLT indices are 0, 1, ..., 8, 9. If $\text{DepthValue2Idx}[\text{predDcVal}] + \text{dcOffset}$ is equal to 20 or -1, the value of $\text{Idx2DepthValue}[20]$ is undefined and the decoding process will be crashed.

JCT3V-I0057 was proposed to address this problem. In JCT3V-I0057,

$\text{predSamples}[x][y] = \text{Idx2DepthValue}[\text{DepthValue2Idx}[\text{predDcVal}] + \text{dcOffset}]$

is replaced by

$\text{predSamples}[x][y] = \text{Idx2DepthValue}[\text{Clip3}(0, (1 \ll \text{bitDepth}) - 1, \text{DepthValue2Idx}[\text{predDcVal}] + \text{dcOffset})]$,

wherein bitDepth is the bit depth of depth samples. For example, bitDepth is 8 when depth

values are from 0 to 255.

However, JCT3V-I0057 does not solve the problem completely. It make a constrain that $\text{DepthValue2Idx}[\text{predDcVal}] + \text{dcOffset}$ cannot exceed $(1 \ll \text{bitDepth}) - 1$. But the number of DLT entries usually is smaller than $(1 \ll \text{bitDepth})$. For example, when bitDepth is 8 then the prediction samples are calculated in JCT3V-I0057 as

$\text{predSamples}[x][y] = \text{Idx2DepthValue}[\text{Clip3}(0, 255, \text{DepthValue2Idx}[\text{predDcVal}] + \text{dcOffset})]$.

When there are only 10 entries in DLT, the valid DLT indices are 0, 1, ...8, 9. If $\text{DepthValue2Idx}[\text{predDcVal}] + \text{dcOffset}$ is equal to 20, the value of $\text{Idx2DepthValue}[20]$ is still undefined and the decoding process will be crashed.

SUMMARY OF THE INVENTION

In light of the previously described problems, methods are proposed to improve the depth lookup table (DLT).

Other aspects and features of the invention will become apparent to those with ordinary skill in the art upon review of the following descriptions of specific embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention can be more fully understood by reading the subsequent detailed description and examples with references made to the accompanying drawings, wherein:

Fig. 1 is a diagram illustrating an example of DLT. There are five valid values appears in depth samples Therefore, there are five entries in DLT in the order: 50, 108, 110, 112 and 200;

Fig. 2 is a diagram illustrating the flowchart to clip the DLT index to a valid value;

Fig. 3 is a diagram illustrating an example of the original Idx2DepthValue table and the proposed Idx2DepthValue table for $i \geq \text{NumDepthValuesInDlt}$. $\text{NumDepthValuesInDlt}=5$ in the example;

Fig. 4 is a diagram illustrating an example of the original Idx2DepthValue table and the proposed Idx2DepthValue table for $i < 0$. $\text{NumDepthValuesInDlt}=5$ in the example.

DETAILED DESCRIPTION

The following description is of the best-contemplated mode of carrying out the invention. This description is made for the purpose of illustrating the general principles of the invention and should not be taken in a limiting sense. The scope of the invention is best determined by

reference to the appended claims.

It is proposed to make the prediction samples always valid when depth lookup table is applied.

In one embodiment, the derivation of prediction samples as

predSamples[x][y] = Idx2DepthValue[DepthValue2Idx[predDcVal] + dcOffset]

is replaced by

predSamples[x][y] = Idx2DepthValue[Clip3(0, NumDepthValuesInDlt[nuh_layer_id] - 1, DepthValue2Idx[predDcVal] + dcOffset)],

wherein NumDepthValuesInDlt[nuh_layer_id] is the number of depth values in the DLT for the current coding layer nuh_layer_id. Fig.2 illustrates the clipping process.

In another embodiment, the DC values for two segments in segment-wise depth coding (SDC) or depth-map model (DMM) are calculated as

DcVal[0] = Idx2DepthValue[Clip3(0, NumDepthValuesInDlt[nuh_layer_id] - 1, DepthValue2Idx[dcValLT] + (dcOffsetAvailFlag ? DcOffset[xTb][yTb][0] : 0))];

DcVal[1] = Idx2DepthValue[Clip3(0, NumDepthValuesInDlt[nuh_layer_id] - 1, DepthValue2Idx[dcValBR] + (dcOffsetAvailFlag ? DcOffset[xTb][yTb][1] : 0))].

In still another embodiment, Idx2DepthValue[i] is set equal to DltDepthValue[NumDepthValuesInDlt-1] for all i larger than or equal to NumDepthValuesInDlt as illustrated in Fig. 3. Idx2DepthValue is the table mapping a DLT index to a depth value. NumDepthValuesInDlt is the number of entries in the current DLT. DltDepthValue is the table mapping a depth value to a DLT index.

In still another embodiment, the list elements Idx2DepthValue[i] specifying the depth value of the i-th index in the lookup table with i ranging from NumDepthValuesInDlt[nuh_layer_id] to (1 << bitDepth) - 1, inclusively, is set equal to DltDepthValue[nuh_layer_id][NumDepthValuesInDlt[nuh_layer_id] - 1].

In still another embodiment, Idx2DepthValue[i] is set equal to DltDepthValue[0] for all i lower than 0 as illustrated in Fig. 4. NumDepthValuesInDlt. Idx2DepthValue is the table mapping a DLT index to a depth value. DltDepthValue is the table mapping a depth value to a DLT index.

In still another embodiment, the list elements Idx2DepthValue[i] specifying the depth value of the i-th index in the lookup table with i ranging from 1-(1 << bitDepth) to -1, inclusive, is set equal to DltDepthValue[nuh_layer_id][0].

CLAIMS

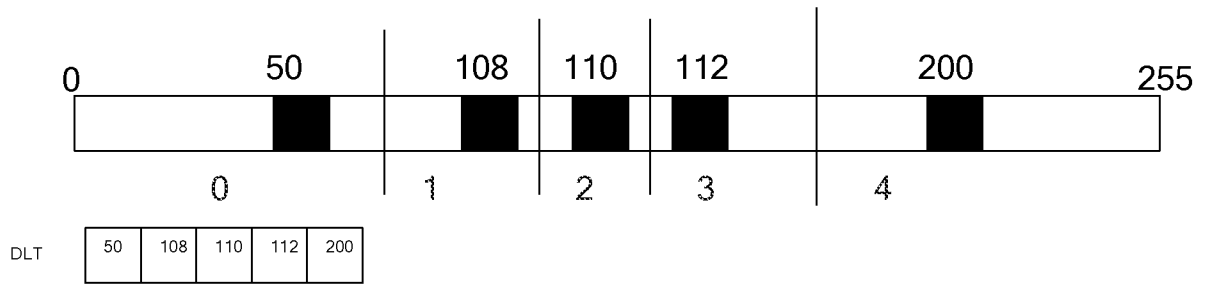
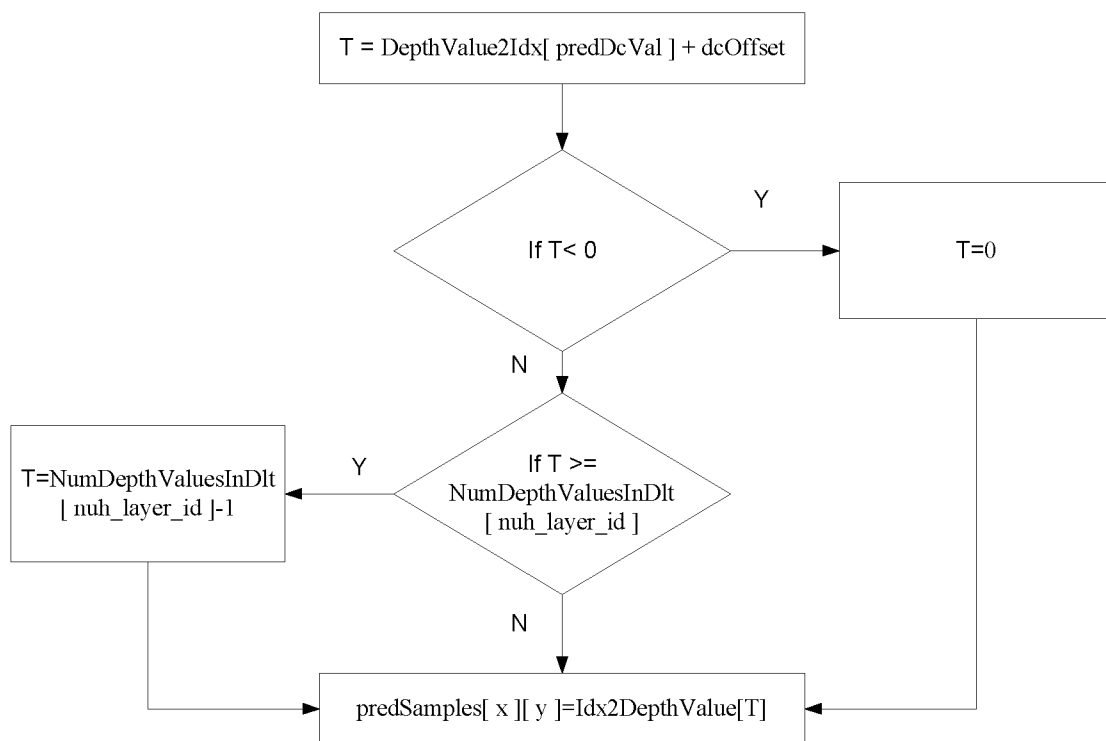
1. A method of depth coding, comprising mapping a valid depth value from a reconstructed depth lookup table (DLT) index.

5 2. The method as claimed in claim 1, wherein the reconstructed DLT index is clipped to a valid DLT index before it is used to map a depth value.

3. The method as claimed in claim 2, wherein the reconstructed DLT index is clipped to $\text{NumDepthValuesInDlt} - 1$ if it is larger than or equal to $\text{NumDepthValuesInDlt}$, where $\text{NumDepthValuesInDlt}$ is a number of entries in the current DLT.

10 4. The method as claimed in claim 1, wherein $\text{Idx2DepthValue}[i]$ is set equal to $\text{DltDepthValue}[\text{NumDepthValuesInDlt}-1]$ for all i larger than or equal to $\text{NumDepthValuesInDlt}$; Idx2DepthValue is the table mapping a DLT index to a depth value; $\text{NumDepthValuesInDlt}$ is a number of entries in the current DLT; and DltDepthValue is the table mapping a depth value to a DLT index.

15 5. The method as claimed in claim 1, wherein $\text{Idx2DepthValue}[i]$ is set equal to $\text{DltDepthValue}[0]$ for all i lower than 0; $\text{NumDepthValuesInDlt}$; Idx2DepthValue is the table mapping a DLT index to a depth value; and DltDepthValue is the table mapping a depth value to a DLT index.

**Fig. 1****Fig. 2**

Original Idx2DepthValue table

Index	0	1	2	3	4
Depth value	50	108	110	112	200

Proposed Idx2DepthValue Table

Index	0	1	2	3	4	5	6	...
Depth value	50	108	110	112	200	200	200	200

Fig. 3

Original Idx2DepthValue table

Index	0	1	2	3	4
Depth value	50	108	110	112	200

Proposed Idx2DepthValue Table

Index	...	-2	-1	0	1	2	3
Depth value	...	50	50	50	108	110	112

Fig. 4

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2014/081387

A. CLASSIFICATION OF SUBJECT MATTER

H04N 19/50(2014.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04N; G06T

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI,EPODOC,CNPAT,CNKI,IEEE:3D,HEVC,high efficiency video coding,DLT,depth lookup table,depth look-up table, depth lookup-table,lookup table,look-up table,lookup-table,depth,Idx2DepthValue,NumDepthValueInDlt,index,depth value,clip, reconstruct,depth intra coding,LUT,map,depth map coding,simplified depth coding,SDC,depth mode-based coding,DMC,table index,DMM,DltDepthValue

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 101465004 A (SAMSUNG ELECTRONICS CO., LTD.) 24 June 2009 (2009-06-24) the whole document	1-5
X	Fabian Jäger. "JCT3V-D0054, CE6.H related: Results on Updating Mechanism for Coding of Depth Lookup Table (Delta-DLT)" <i>Joint Collaborative Team on 3D Video Coding Extensions of ITU-T SG 16 WP 3 and ISO/IEC JTC 1/SC 29/WG 11 4th Meeting: Incheon, KR, 26 April 2013 (2013-04-26),</i> sections 1, 4.5-4.6	1-2
A	ZHANG, Kai et al. "JCT3V-H0091, On DLT signaling in 3D-HEVC" <i>Joint Collaborative Team on 3D Video Coding Extension Development of ITU-T SG 16 WP 3 and ISO/IEC JTC 1/SC 29/WG 11 8th Meeting: Valencia, ES, 04 April 2014 (2014-04-04),</i> the whole document	1-5



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

- “A” document defining the general state of the art which is not considered to be of particular relevance
- “E” earlier application or patent but published on or after the international filing date
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- “O” document referring to an oral disclosure, use, exhibition or other means
- “P” document published prior to the international filing date but later than the priority date claimed

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- “&” document member of the same patent family

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Name and mailing address of the ISA/CN

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2014/081387

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	Fabian Jäger. "JCT3V-B0036, 3D-CE6.h: Simplified Depth Coding with an optional Depth Lookup Table" <i>Joint Collaborative Team on 3D Video Coding Extension Development of ITU-T SG 16 WP 3 and ISO/IEC JTC 1/SC 29/WG 11 2nd Meeting: Shanghai, CN, 19 October 2012 (2012-10-19),</i> the whole document	1-5
A	Fabian Jäger. "JCT2-A0010, 3D-CE6.h related: Model-based Intra Coding for Depth Maps using a Depth Lookup Table" <i>Joint Collaborative Team on 3D Video Coding Extension Development of ITU-T SG 16 WP 3 and ISO/IEC JTC 1/SC 29/WG 11 1st Meeting: Stockholm, SE, 20 July 2012 (2012-07-20),</i> the whole document	1-5

International application No.
PCT/CN2014/081387

Form PCT/ISA/210 (patent family annex) (July 2009)