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[Continued on next page]

(54) Title: ADVANCED LINEAR MODEL PREDICTION FOR CHROMA CODING

(57) Abstract: An advanced linear model prediction method for chroma coding method is proposed. In the proposed method, more neighboring samples can be used to derive parameters. And more extensive LM modes are proposed.

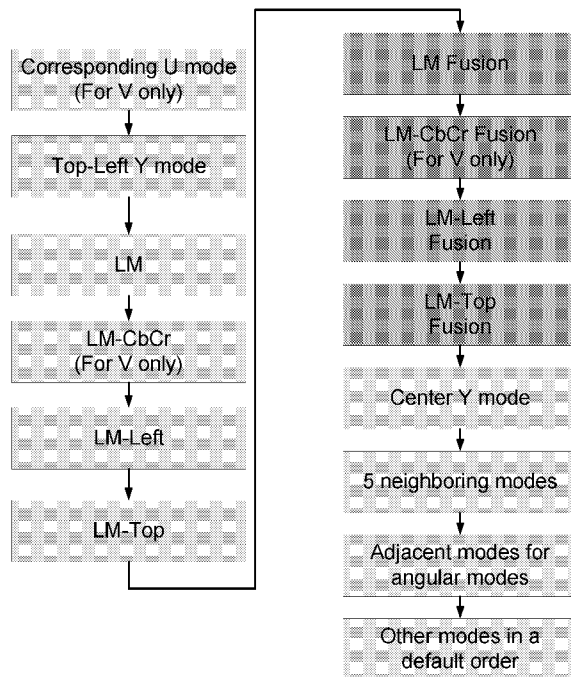


Fig. 13



LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, **Published:**
SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, — *with international search report (Art. 21(3))*
GW, KM, ML, MR, NE, SN, TD, TG).

TITLE

ADVANCED LINEAR MODEL PREDICTION FOR CHROMA CODING

BACKGROUND OF THE INVENTION

Field of the Invention

5 [0001] The invention relates generally to video coding. In particular, the presented invention relates to linear model prediction for chroma coding.

Description of the Related Art

[0002] Linear model prediction mode (LM mode) is developed to improve the coding performance of chroma components (U/V components or Cb/Cr components) by exploring the correlation between the luma (Y) component and chroma componets.
10

[0003] In LM mode, a linear model is assumed between values of a luma sample and a chroma sample as formulated as

[0004] $C = a*Y + b$,

15 [0005] where C represents the prediction value for a sample of chroma component; Y represents the value of the corresponding sample of luma; a and b are two parameters.

[0006] In some image formats such as 4:2:0 or 4:2:2, samples in the chroma component and in the luma component are not in a 1-1 mapping. Fig. 1 demonstrates an example of samples of luma component (circles) and in chroma component (triangles).
20

[0007] In LM mode, an interpolated luma value is derived to get the luma sample value corresponding to a chroma sample value. As exemplified in Fig. 1, $Y =$

$(Y1+Y2)/2$ is calculated as the corresponding luma sample value to the chroma sample C .

[0008] Parameters a and b are derived from top and left neighboring chroma decoded samples and corresponding decoded luma samples. Fig. 2 demonstrates the neighboring samples of a 4x4 block.

[0009] There are several extensions of LM mode.

[0010] In one extension, parameters a and b are derived from top neighboring chroma samples and corresponding luma samples. Fig. 3 demonstrates the top neighboring samples of a 4x4 block. This extended mode is called LM_TOP mode.

[0011] In another extension, parameters a and b are derived from left neighboring chroma samples and corresponding luma samples. Fig. 4 demonstrates the left neighboring samples of a 8x8 block. This extended mode is called LM_LEFT mode.

[0012] In still another extension, a linear model is assumed between values of a sample of one chroma component (e.g. Cb) and a sample of another chroma component (e.g. Cr) as formulated as

$$\mathbf{[0013] \quad } C_1 = a * C_2 + b,$$

[0014] where C_1 represents the prediction value for a sample of one chroma component (e.g. Cr); C_2 represents the value of the corresponding sample of another chroma component (e.g. Cb); a and b are two parameters, which are derived from top and left neighboring samples of one chroma component and corresponding samples of another chroma component. This extended LM mode is called LM_CbCr.

[0015] Although LM and its extended modes can improve coding efficiency significantly, it does not take texture directions into account.

BRIEF SUMMARY OF THE INVENTION

[0016] In light of the previously described problems, some advanced linear model (LM) prediction modes for chroma coding is proposed. In the proposed method, LM mode can be fused with other prediction modes. Besides, more extended LM modes are proposed.

[0017] 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:

[0018] Fig. 1 is a diagram illustrating an example of samples of luma component (circles) and in chroma component (triangles).

[0019] Fig. 2 is a diagram illustrating neighboring chroma samples and corresponding luma samples used to derive linear model parameters in LM mode;

[0020] Fig. 3 is a diagram illustrating neighboring chroma samples and corresponding luma samples used to derive linear model parameters in LM_TOP mode;

[0021] Fig. 4 is a diagram illustrating neighboring chroma samples and corresponding luma samples used to derive linear model parameters in LM_LEFT mode;

[0022] Fig. 5 is a diagram illustrating exemplary neighboring chroma samples

and corresponding luma samples used to derive linear model parameters in LM_TOP_RIGHT mode;

[0023] Fig. 6 is a diagram illustrating exemplary neighboring chroma samples and corresponding luma samples used to derive linear model parameters in LM_RIGHT mode;

[0024] Fig. 7 is a diagram illustrating exemplary neighboring chroma samples and corresponding luma samples used to derive linear model parameters in LM_LEFT_BOTTOM mode;

[0025] Fig. 8 is a diagram illustrating exemplary neighboring chroma samples and corresponding luma samples used to derive linear model parameters in LM_BOTTOM mode;

[0026] Fig. 9 is a diagram illustrating exemplary neighboring chroma samples and corresponding luma samples used to derive linear model parameters in LM_LEFT_TOP mode;

[0027] Fig. 10 is a diagram illustrating an example of Fusion mode;

[0028] Fig. 11 is a diagram illustrating an example of a 4x4 sub-block in a 8x8 current block;

[0029] Fig. 12 is a diagram illustrating examples of mapping a chroma sample to a luma sample value;

[0030] Fig. 13 is a diagram illustrating an exemplary coding table with LM Fusion modes;

[0031] Fig. 14 is a diagram illustrating an exemplary coding table with LM_Phase1 and LM_Phase2 modes;

[0032]

DETAILED DESCRIPTION OF THE INVENTION

[0033] 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.

[0034] In the following description, Y component is identical to luma component, U component is identical to Cb component and V component is identical to Cr component

[0035] Advanced LM prediction modes are proposed.

[0036] In one embodiment, parameters a and b are derived from top and right neighboring chroma samples and corresponding luma samples. This proposed extended mode is called LM_TOP_RIGHT mode as the example illustrated in Fig. 5.

[0037] In one embodiment, parameters a and b are derived from right neighboring chroma samples and corresponding luma samples. This proposed extended mode is called LM_RIGHT mode as the example illustrated in Fig. 6.

[0038] In one embodiment, parameters a and b are derived from left and bottom neighboring chroma samples and corresponding luma samples. This proposed extended mode is called LM_LEFT_BOTTOM mode as the example illustrated in Fig. 7.

[0039] In one embodiment, parameters a and b are derived from bottom neighboring chroma samples and corresponding luma samples. This proposed extended mode is called LM_BOTTOM mode as the example illustrated in Fig. 8.

[0040] In one embodiment, parameters a and b are derived from left top neighboring chroma samples and corresponding luma samples. This proposed extended mode is called LM_LEFT_TOP mode as the example illustrated in Fig. 9.

[0041] In one embodiment, a chroma block is predicted by utilizing LM mode or its extended modes with one or more other mode together. In this case, the chroma block is coded by the 'Fusion mode'.

[0042] In one embodiment of fusion mode, a chroma block is first predicted by mode L . For a sample (i,j) in this block, its prediction value with mode L is $P^L(i,j)$. Then the chroma block is predicted by another mode, named mode K other than the LM mode. For a sample (i,j) in this block, its prediction value with mode K is $P^K(i,j)$. The final prediction for sample (i,j) denoted as $P(i,j)$ in this block is calculated as

$$[0043] \quad P(i,j) = w1 * P^L(i,j) + w2 * P^K(i,j)$$

[0044] where $w1$ and $w2$ are weighting values (real number) and $w1 + w2 = 1$;

[0045] In another embodiment

$$[0046] \quad P(i,j) = (w1 * P^L(i,j) + w2 * P^K(i,j) + D) \gg S$$

[0047] Where $w1$, $w2$, D and S are integers, $S \geq 1$, and $w1 + w2 = 1 \ll S$. In one example, D is 0. In another example, D is $1 \ll (S-1)$.

[0048] In one example, $P(i,j) = (P^L(i,j) + P^K(i,j) + 1) \gg 1$.

[0049] In another example, $P(i,j) = (P^L(i,j) + P^K(i,j)) \gg 1$.

[0050] Fig. 10 demonstrates the concept of Fusion mode.

[0051] In one embodiment, mode L is LM mode.

[0052] In one embodiment, mode L is LM_TOP mode.

[0053] In one embodiment, mode L is LM_LEFT mode.

[0054] In one embodiment, mode L is LM_TOP_RIGHT mode.

[0055] In one embodiment, mode L is LM_RIGHT mode.

[0056] In one embodiment, mode L is LM_LEFT_BOTTOM mode.

[0057] In one embodiment, mode L is LM_BOTTOM mode.

[0058] In one embodiment, mode L is LM_LEFT_TOP mode.

[0059] In one embodiment, mode L is LM_CbCr mode.

[0060] In one embodiment, mode K can be any angular mode with a prediction direction.

[0061] In one embodiment, mode K can be any of DC mode, Planar mode,
5 Planar_Ver mode or Planar_Hor mode.

[0062] In one embodiment, mode K is the mode used by the luma component of the current block.

[0063] In one embodiment, mode K is the mode used by Cb component of the current block.

10 [0064] In one embodiment, mode K is the mode used by Cr component of the current block.

[0065] In one embodiment, mode K is the mode used by the luma component of any sub-block in the current block. Fig. 11 demonstrates an exemplary sub-block.

[0066] In one embodiment, if a chroma block is predicted by LM mode or its
15 extended modes and, samples in the chroma component and in the luma component are not in a 1-1 mapping such as when the image format is 4:2:0 or 4:2:2, there can be more than one options to be chosen to map a chroma sample value (C) to its corresponding luma value (Y) in the linear model $C = a*Y+b$.

[0067] In one embodiment, LM modes (or its extended modes) with different
20 mapping from C to its corresponding Y are regarded as different LM modes, denoted as LM_Phase_X, X from 1 to N, where N is the number of mapping methods from C to its corresponding Y .

[0068] Some exemplary mapping method in an image with format 4:2:0 are proposed referring to Fig. 12

25 1. $Y = Y_0$

$$2. \quad Y = Y1$$

$$3. \quad Y = Y2$$

$$4. \quad Y = Y3$$

$$5. \quad Y = (Y0+Y1)/2$$

$$5 \quad 6. \quad Y = (Y0+Y2)/2$$

$$7. \quad Y = (Y0+Y3)/2$$

$$8. \quad Y = (Y1+Y2)/2$$

$$9. \quad Y = (Y1+Y3)/2$$

$$10. \quad Y = (Y2+Y3)/2$$

$$10 \quad 11. \quad Y = (Y0+Y1+Y2+Y3)/2$$

[0069] In an example, two mapping methods are used. In mode LM_Phase_1, $Y = Y0$; in mode LM_Phase_2, $Y = Y1$.

[0070] To code the chroma mode, LM Fusion mode is put into the code table after LM modes, i.e., LM Fusion modes requires a codeword no less than LM and its extension modes. An example code table order is demonstrated in Fig. 13.

[0071] To code the chroma mode, LM_Phase_1 mode is put into the code table to replace the original LM mode. LM_Phase_2 mode is put into the code table after LM modes and LM Fusion modes, i.e., LM_Phase_2 mode requires a codeword no less than LM and its extension modes, and LM_Phase_2 mode requires a codeword no less than LM Fusion and its extension modes. An example code table order is demonstrated in Fig. 14.

[0072] The methods described above can be used in a video encoder as well as in a video decoder. Embodiments of disparity vector derivation methods according to the present invention as described above may be implemented in various hardware, software codes, or a combination of both. For example, an embodiment of the present invention can be a circuit integrated into a video compression chip or program codes integrated into video compression software to perform the processing described herein. An embodiment of the present invention may also be program

codes to be executed on a Digital Signal Processor (DSP) to perform the processing described herein. The invention may also involve a number of functions to be performed by a computer processor, a digital signal processor, a microprocessor, or field programmable gate array (FPGA). These processors can be configured to perform particular tasks according to the invention, by executing machine-readable software code or firmware code that defines the particular methods embodied by the invention. The software code or firmware codes may be developed in different programming languages and different format or style. The software code may also be compiled for different target platform. However, different code formats, styles and languages of software codes and other means of configuring code to perform the tasks in accordance with the invention will not depart from the spirit and scope of the invention.

[0073] The invention may be embodied in other specific forms without departing from its spirit or essential characteristics. The described examples are to be considered in all respects only as illustrative and not restrictive. To the contrary, it is intended to cover various modifications and similar arrangements (as would be apparent to those skilled in the art). Therefore, the scope of the appended claims should be accorded the broadest interpretation so as to encompass all such modifications and similar arrangements.

What is claimed is

1. An advanced linear model prediction method for chroma coding, comprising:

- Parameters a and b are derived from neighboring chroma samples and corresponding luma samples besides the top/left neighboring samples.
- A chroma block is predicted by utilizing LM mode or its extended modes with one or more other mode together. In this case, the chroma block is coded by the 'Fusion mode'.
- There can be more than one options to be chosen to map a chroma sample value (C) to its corresponding luma value (Y) in the linear model $C = a*Y+b$, if a chroma block is predicted by LM mode or its extended modes and, samples in the chroma component and in the luma component are not in a 1-1 mapping such as when the image format is 4:2:0 or 4:2:2.

2. The method as claimed in claim 1, wherein parameters a and b are derived from top and right neighboring chroma samples and corresponding luma samples.

3. The method as claimed in claim 1, wherein parameters a and b are derived from right neighboring chroma samples and corresponding luma samples.

4. The method as claimed in claim 1, wherein parameters a and b are derived from left and bottom neighboring chroma samples and corresponding luma samples.

5. The method as claimed in claim 1, wherein parameters a and b are derived from bottom neighboring chroma samples and corresponding luma samples.

6. The method as claimed in claim 1, wherein parameters a and b are derived from left top neighboring chroma samples and corresponding luma samples.

7. The method as claimed in claim 1, wherein a chroma block is first predicted by mode L . For a sample (i,j) in this block, its prediction value with mode L is $P^L(i,j)$. Then the chroma block is predicted by another mode, named mode K other than the LM mode. For a sample (i,j) in this block, its prediction value with mode K is $P^K(i,j)$. The final prediction for sample (i,j) denoted as $P(i,j)$ in this block is calculated as $P(i,j) = w1 * P^L(i,j) + w2 * P^K(i,j)$.

8. The method as claimed in claim 7, wherein $w1$ and $w2$ are real numbers and $w1 + w2 = 1$.

9. The method as claimed in claim 7, wherein $P(i,j) = (w1 * P^L(i,j) + w2 * P^K(i,j) + D) \gg S$

10. The method as claimed in claim 9, wherein $w1$, $w2$, D and S are integers, $S \geq 1$, and $w1 + w2 = 1 \ll S$.

11. The method as claimed in claim 9, wherein D is 0.

12. The method as claimed in claim 9, wherein D is $1 \ll (S-1)$.

13. The method as claimed in claim 9, wherein $P(i,j) = (P^L(i,j) + P^K(i,j) + I) \gg 1$.

14. The method as claimed in claim 9, wherein $P(i,j) = (P^L(i,j) + P^K(i,j)) \gg 1$.

15. The method as claimed in claim 7, wherein

- mode L can be LM mode.
- mode L can be LM_TOP mode.
- mode L can be LM_LEFT mode.
- mode L can be LM_TOP_RIGHT mode.

- mode L can be LM_RIGHT mode.
- mode L can be LM_LEFT_BOTTOM mode.
- mode L can be LM_BOTTOM mode.
- mode L can be LM_LEFT_TOP mode.
- mode L can be LM_CbCr mode.

5

16. The method as claimed in claim 7, wherein

- mode K can be any angular mode with a prediction direction.
- mode K can be any of DC mode, Planar mode, Planar_Ver mode or Planar_Hor mode.
- mode K can be the mode used by the luma component of the current block.
- mode K can be the mode used by Cb component of the current block.
- mode K can be the mode used by Cr component of the current block.
- mode K can be the mode used by the luma component of any sub-block in the current block.

10

15

17. The method as claimed in claim 1, wherein LM modes (or its extended modes) with different mapping from C to its corresponding Y are regarded as different LM modes, denoted as LM_Phase_X, X from 1 to N, where N is the number of mapping methods from C to its corresponding Y .

20

18. The method as claimed in claim 17, wherein mapping method in an image with format 4:2:0 referring to Fig. 12 can be

- $Y = Y_0$

- $Y = Y1$
- $Y = Y2$
- $Y = Y3$
- $Y = (Y0+Y1)/2$
- 5 • $Y = (Y0+Y2)/2$
- $Y = (Y0+Y3)/2$
- $Y = (Y1+Y2)/2$
- $Y = (Y1+Y3)/2$
- $Y = (Y2+Y3)/2$
- 10 • $Y = (Y0+Y1+Y2+Y3)/2$

19. The method as claimed in claim 17, wherein two mapping methods are used. In mode LM_Phase_1, $Y = Y0$; in mode LM_Phase_2, $Y = Y1$.

20. The method as claimed in claim 1, wherein LM Fusion mode is put into the code table after LM modes, i.e., LM Fusion modes requires a codeword no less
15 than LM and its extension modes.

21. The method as claimed in claim 1, wherein LM_Phase_1 mode is put into the code table to replace the original LM mode. LM_Phase_2 mode is put into the code table after LM modes and LM Fusion modes, i.e., LM_Phase_2 mode requires a codeword no less than LM and its extension modes, and LM_Phase_2
20 mode requires a codeword no less than LM Fusion and its extension modes.

FIGURES

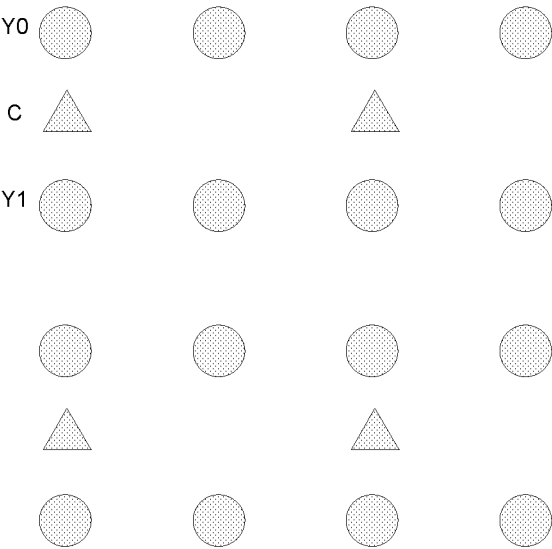


Fig.1

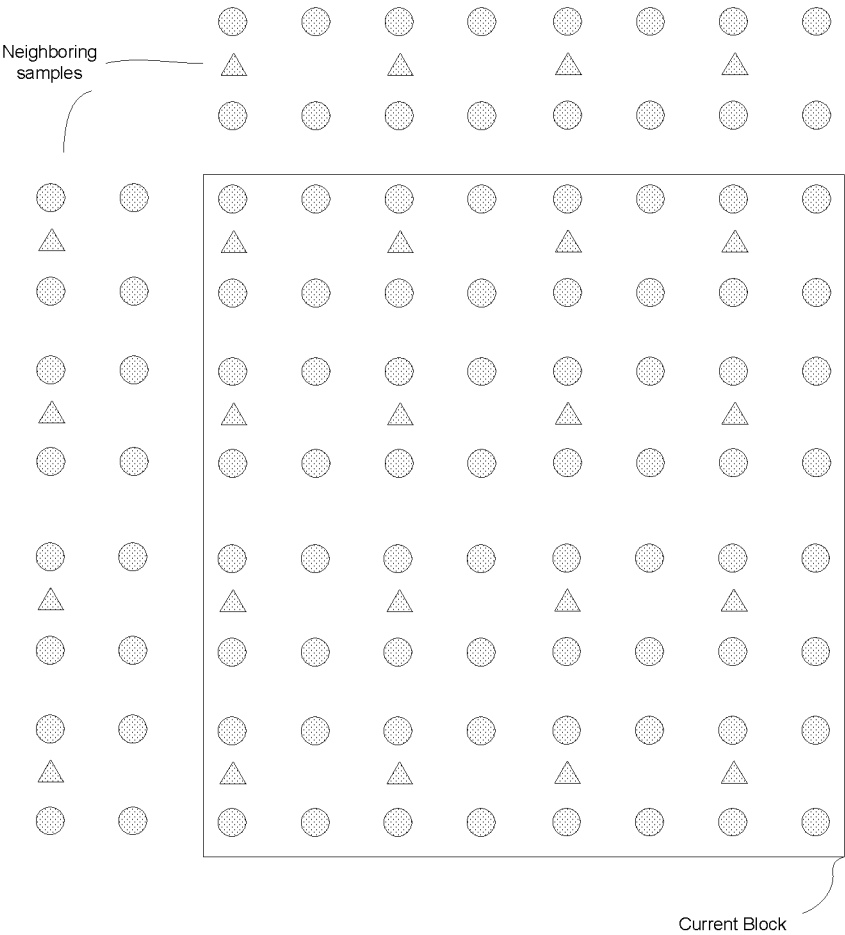


Fig. 2

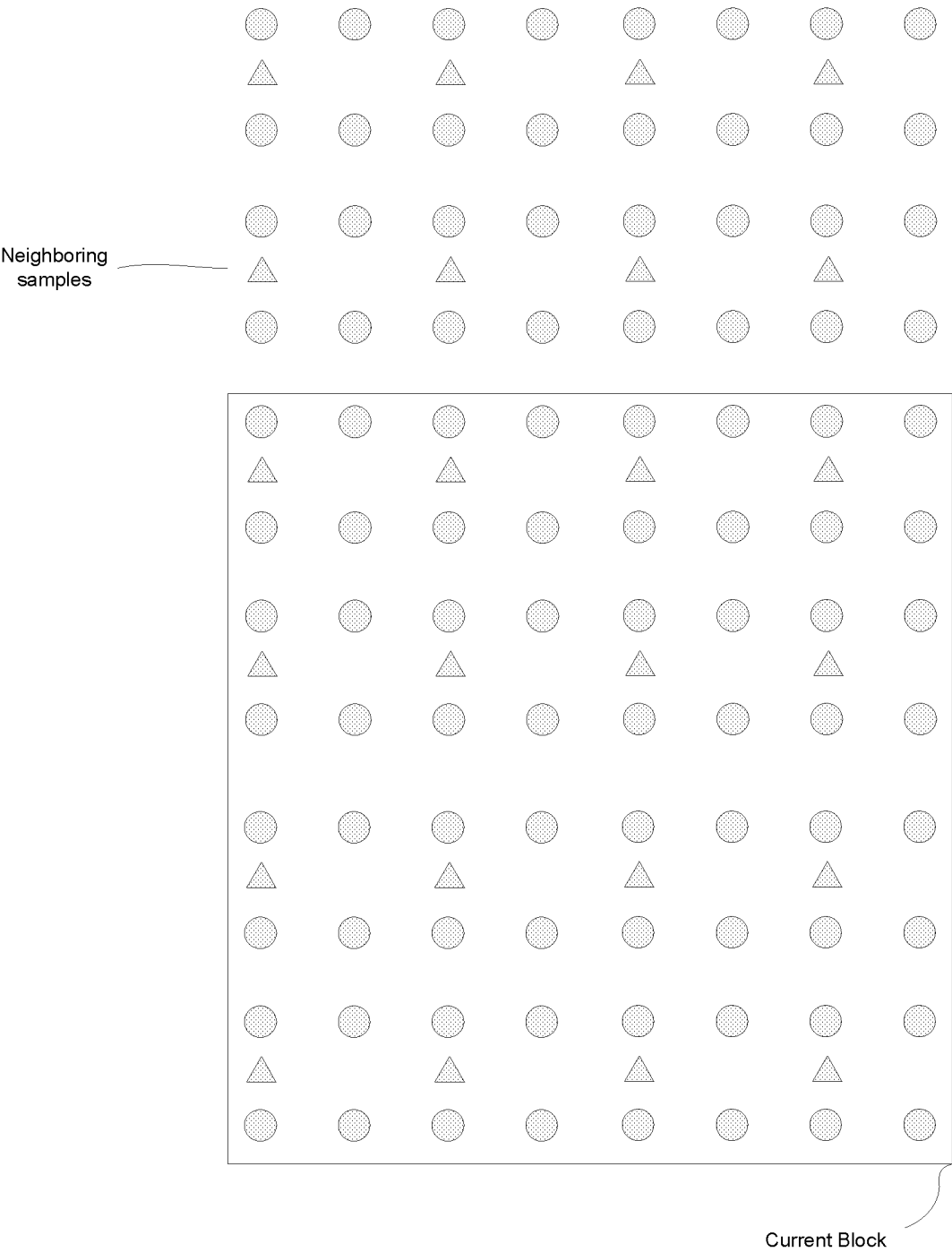


Fig. 3

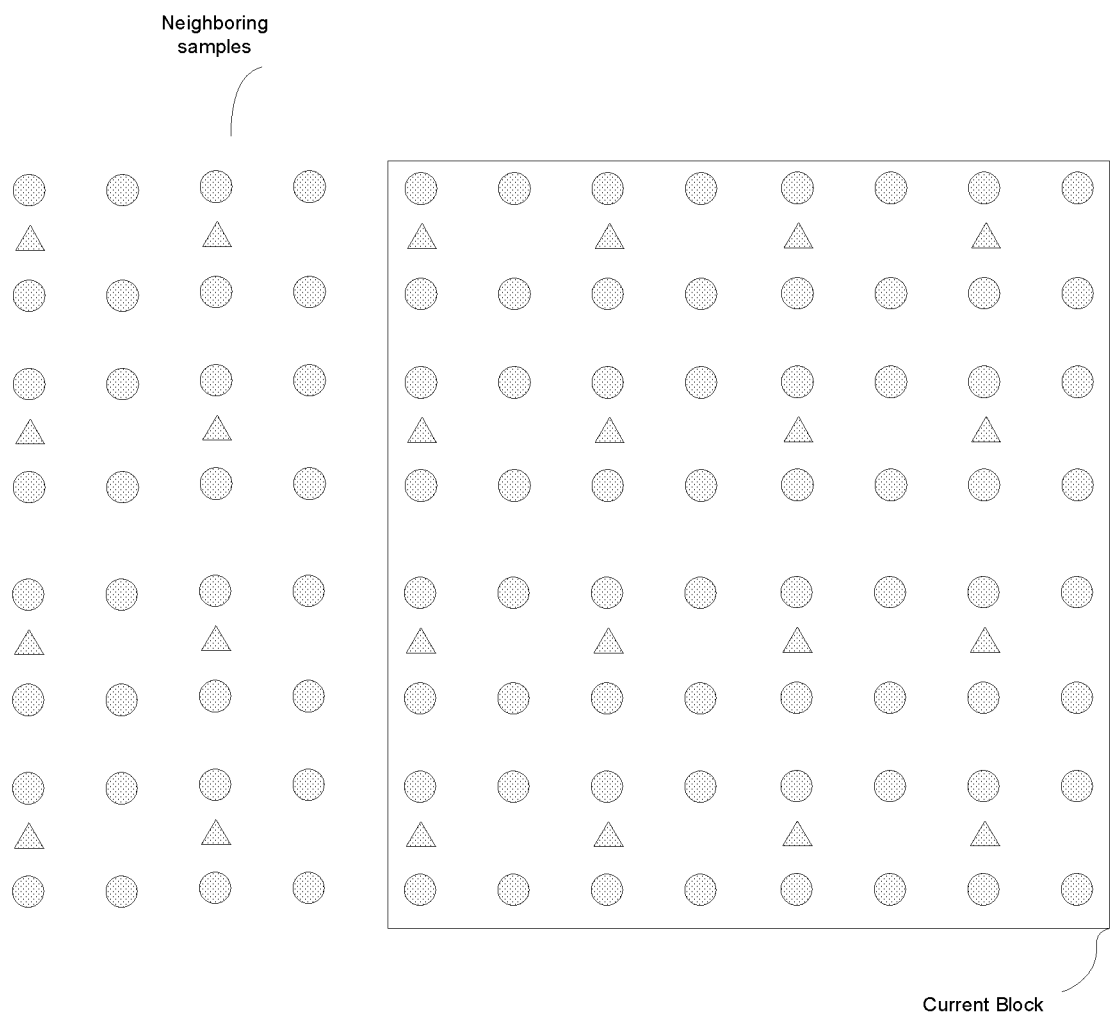


Fig. 4

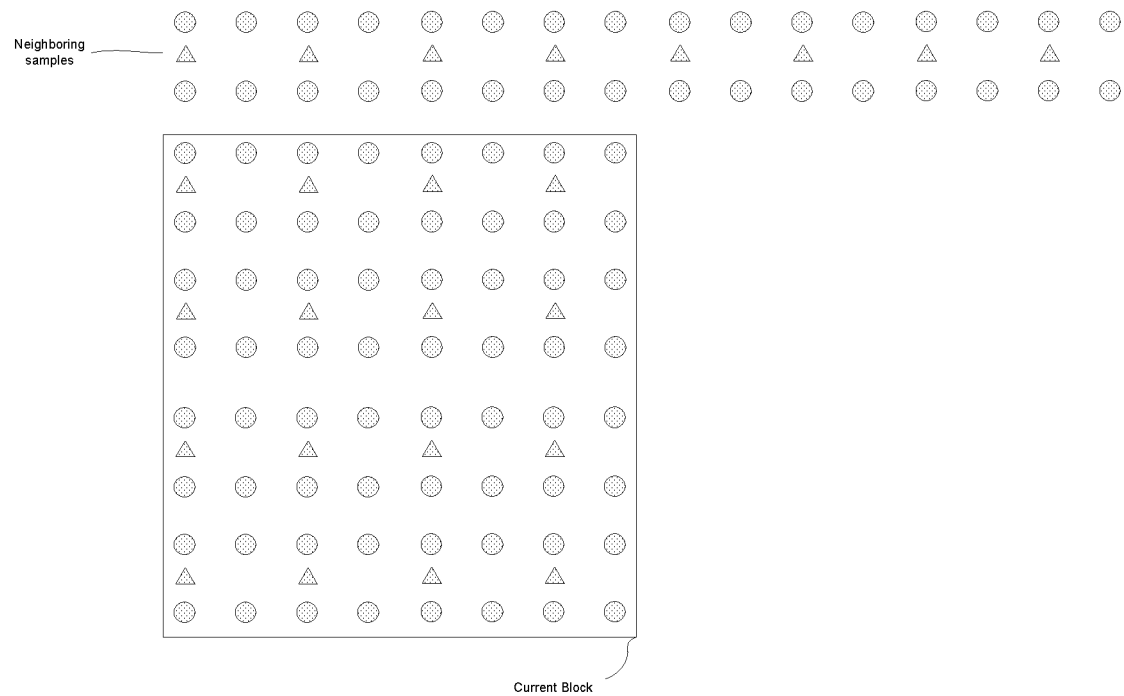


Fig. 5

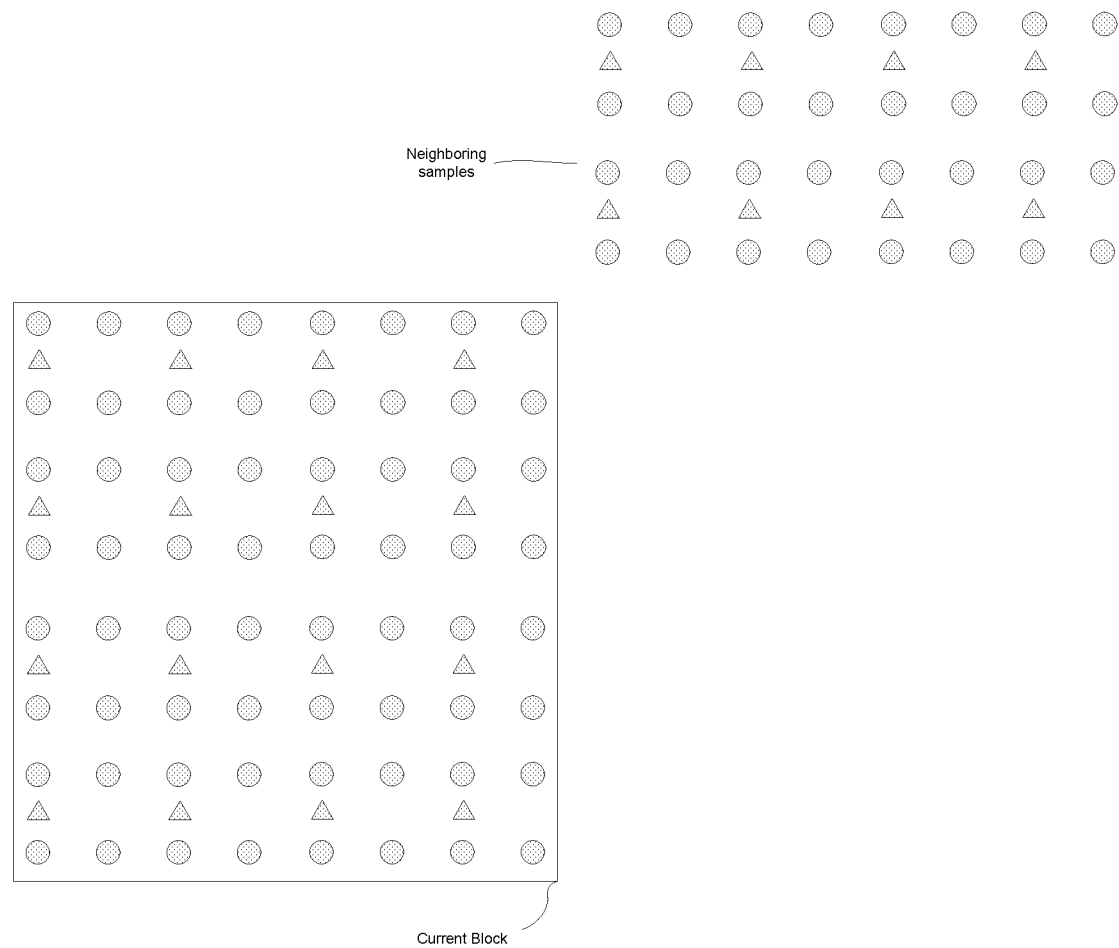


Fig. 6

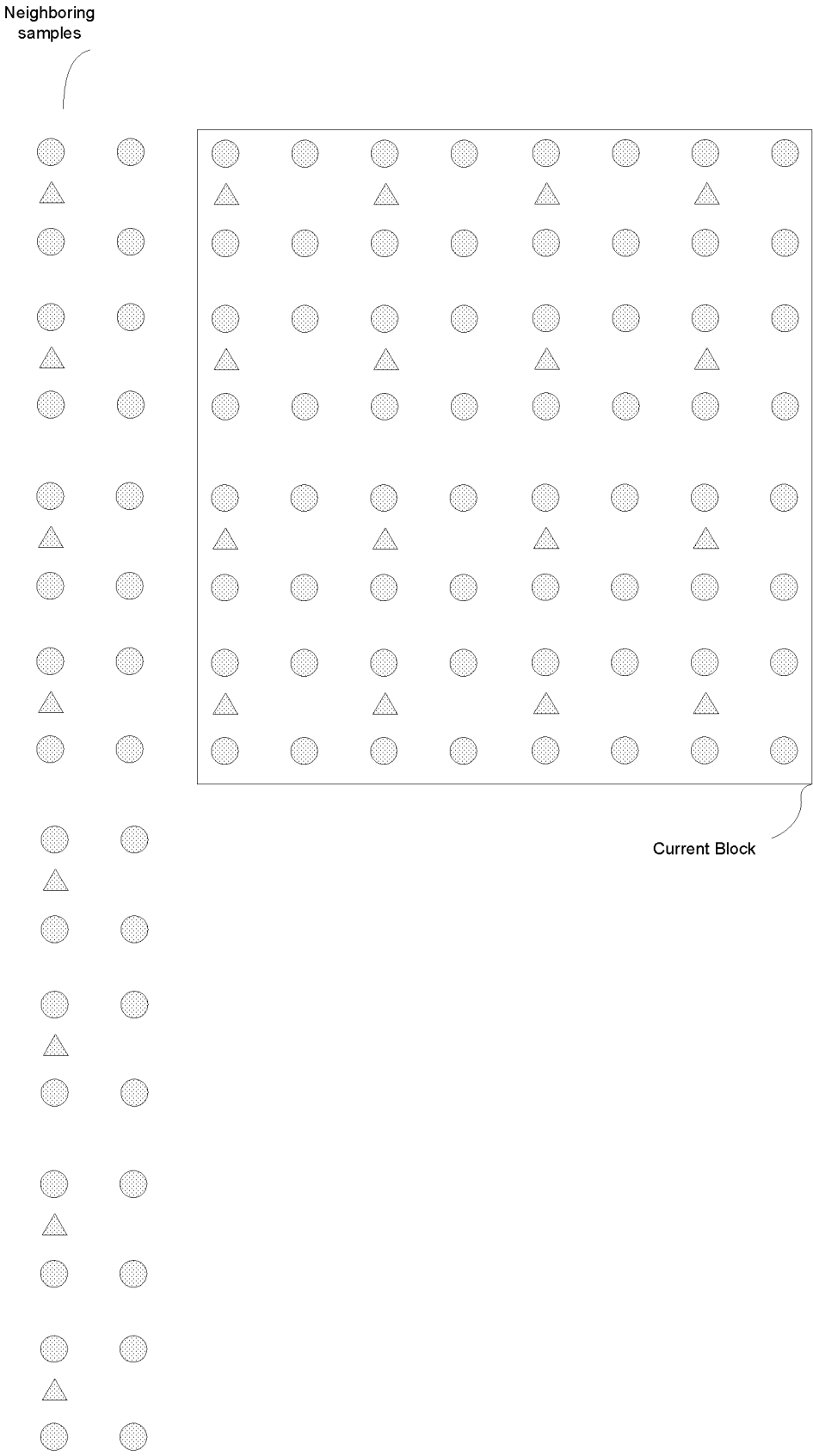


Fig. 7

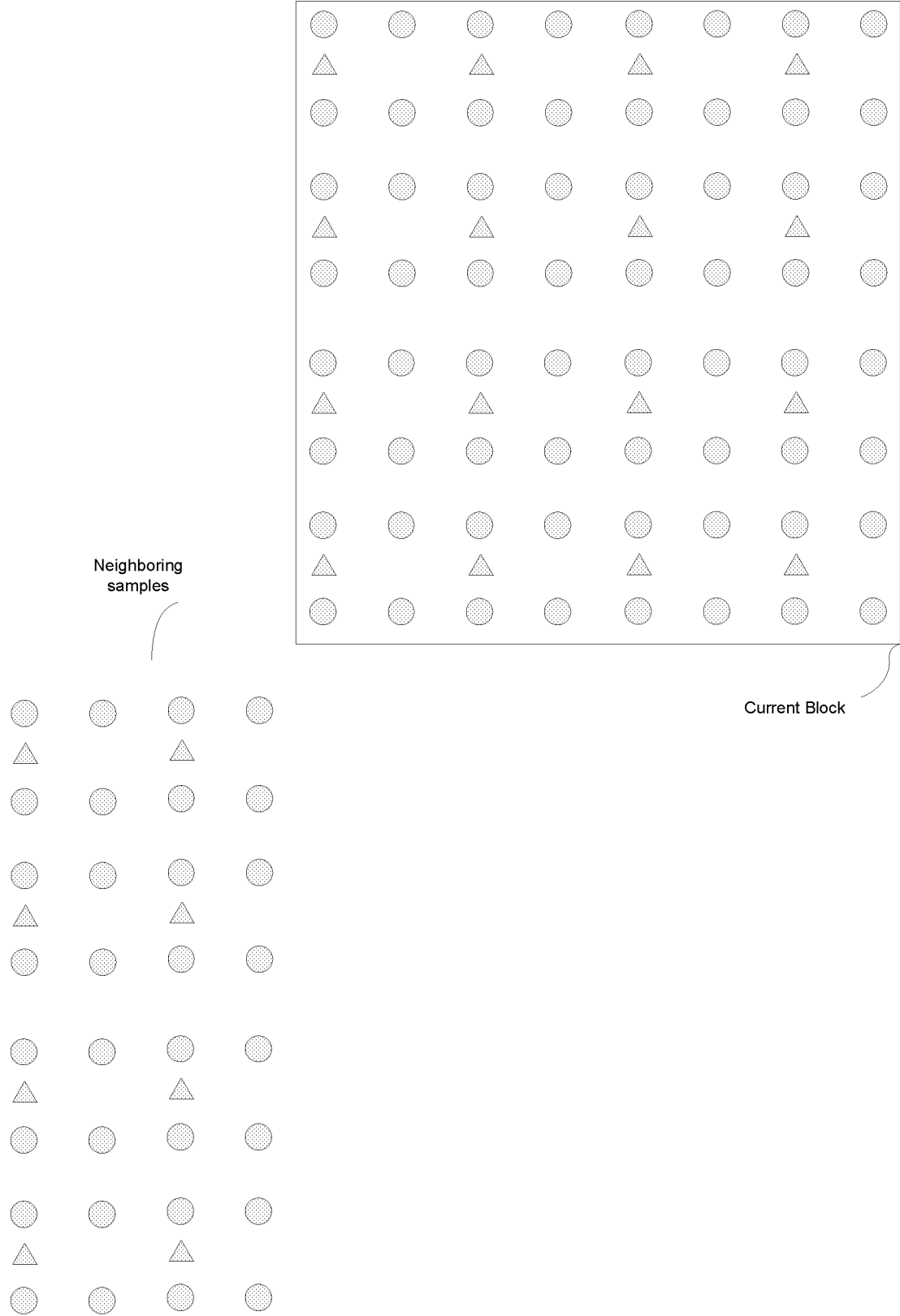


Fig. 8

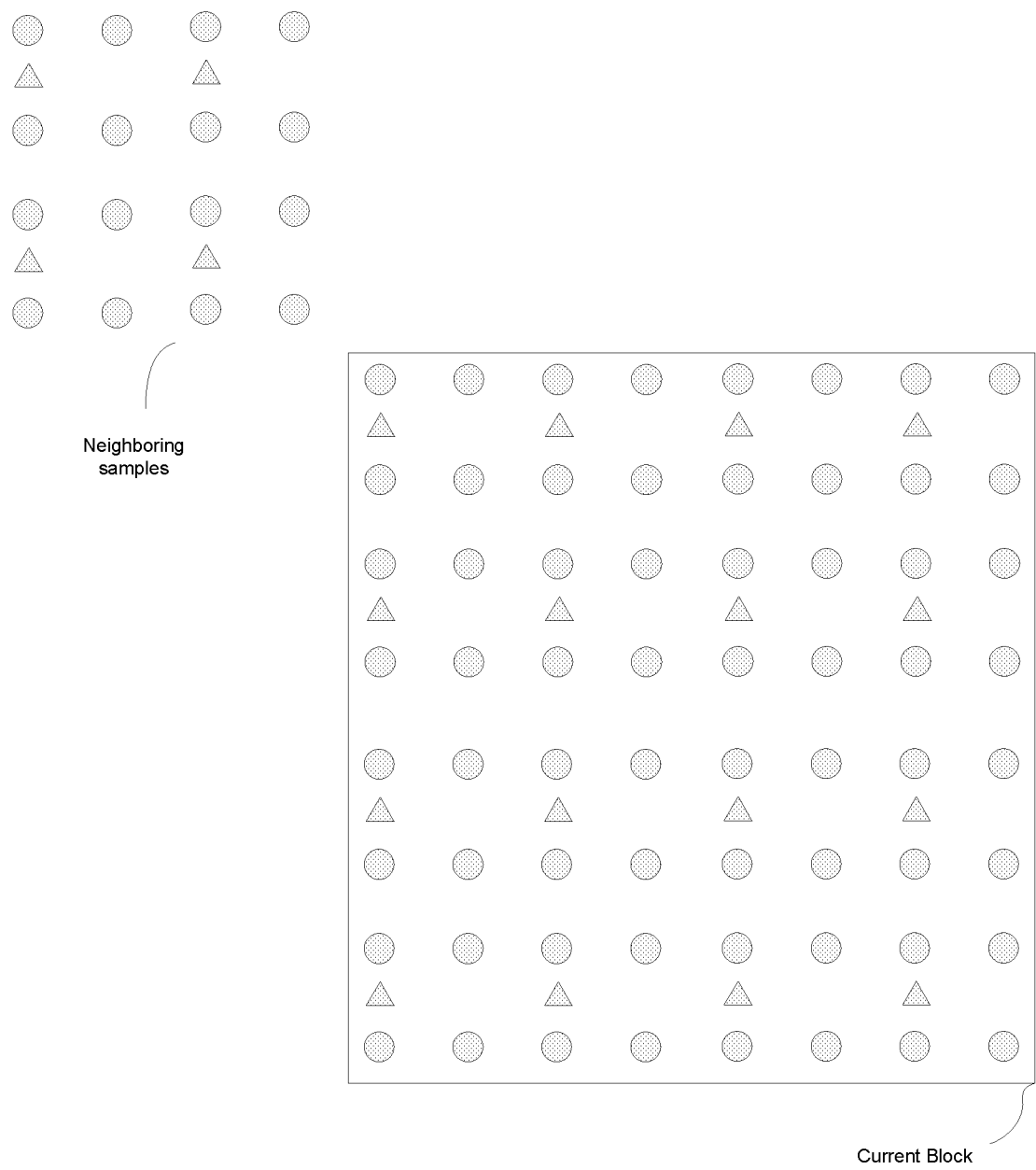


Fig. 9

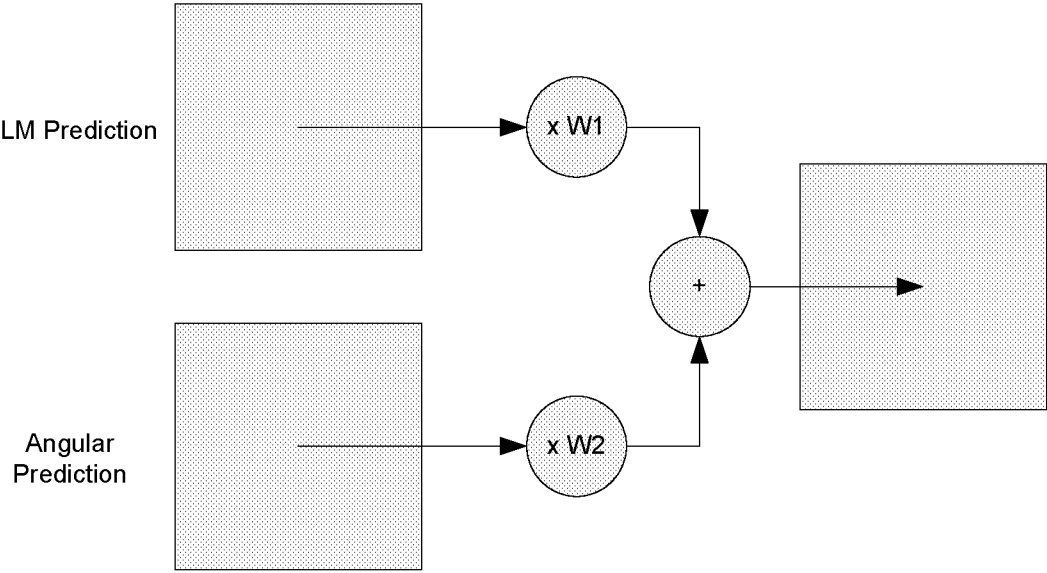


Fig. 10

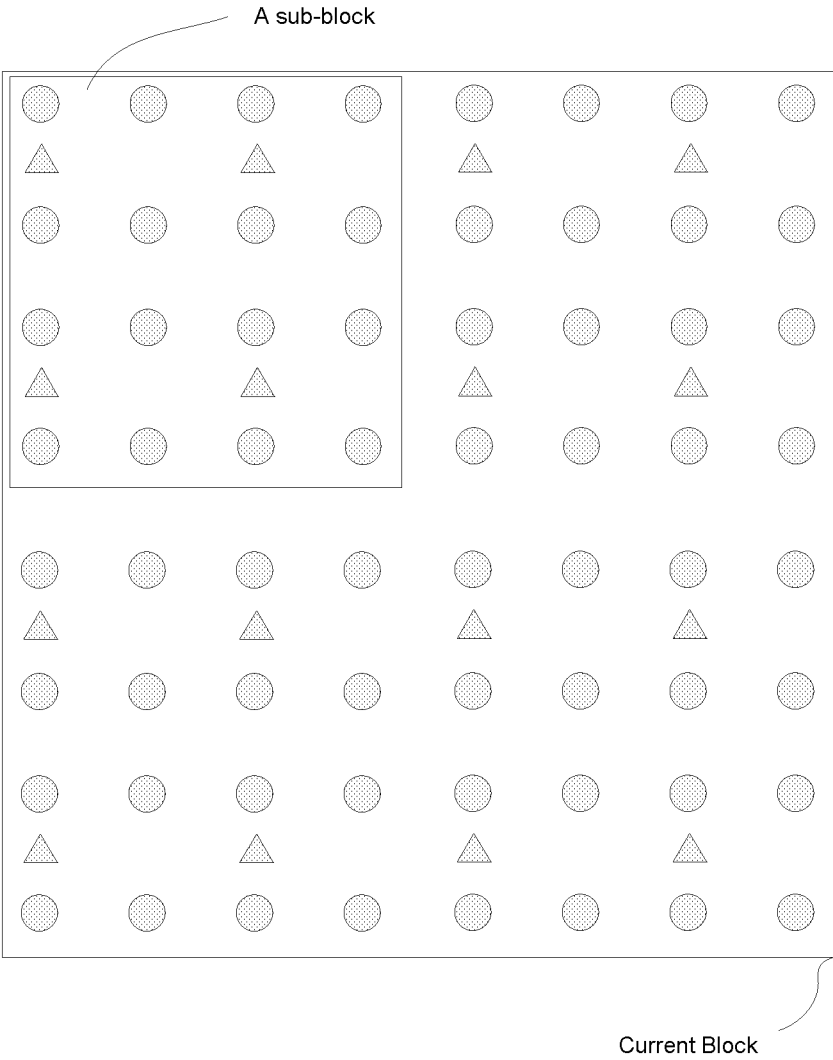


Fig. 11

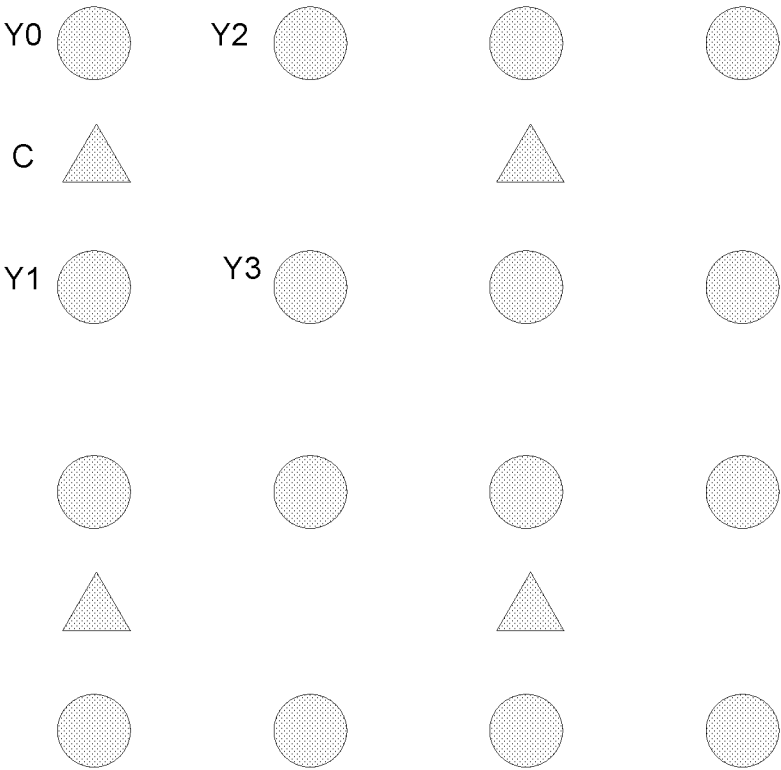


Fig. 12

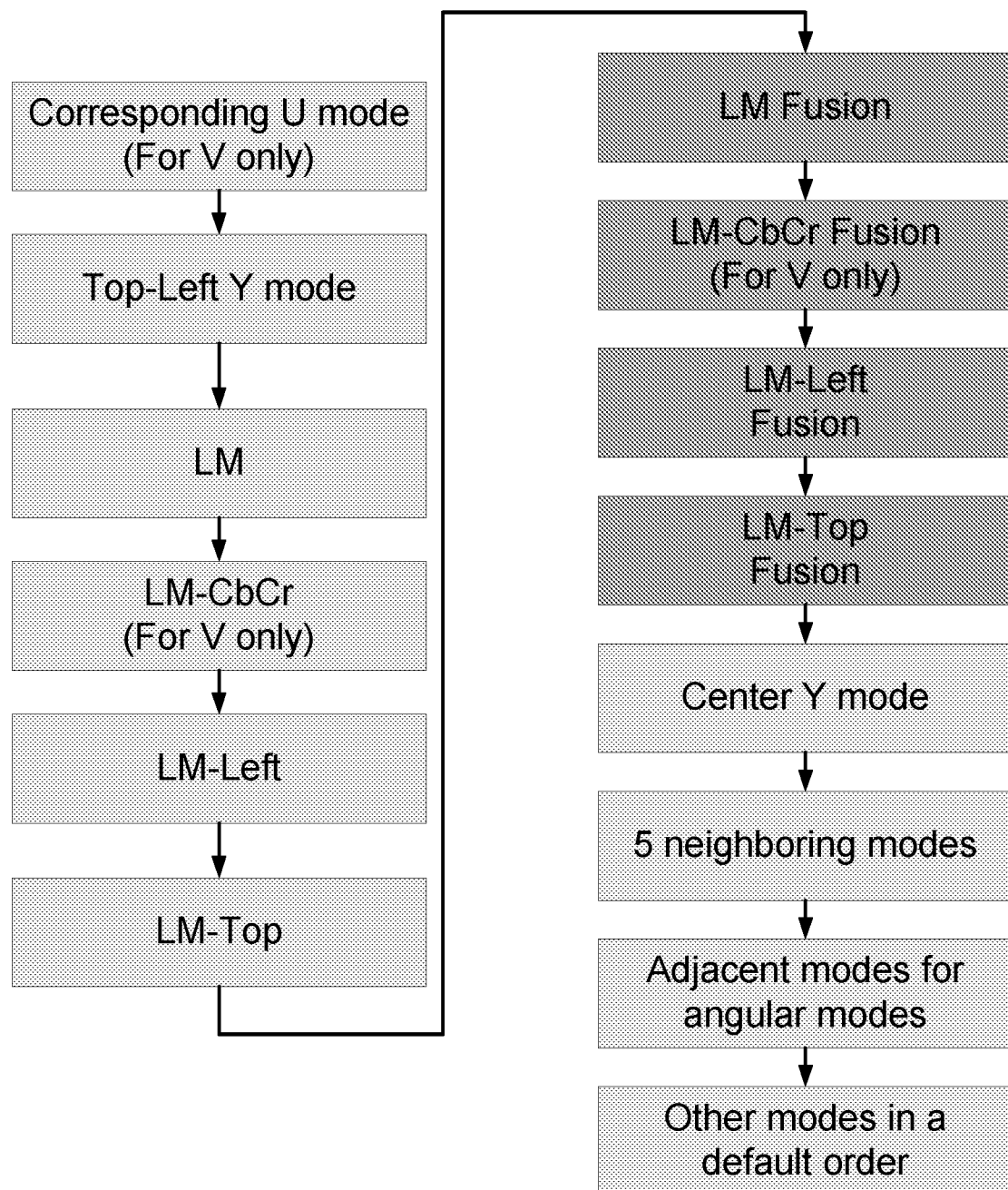


Fig. 13

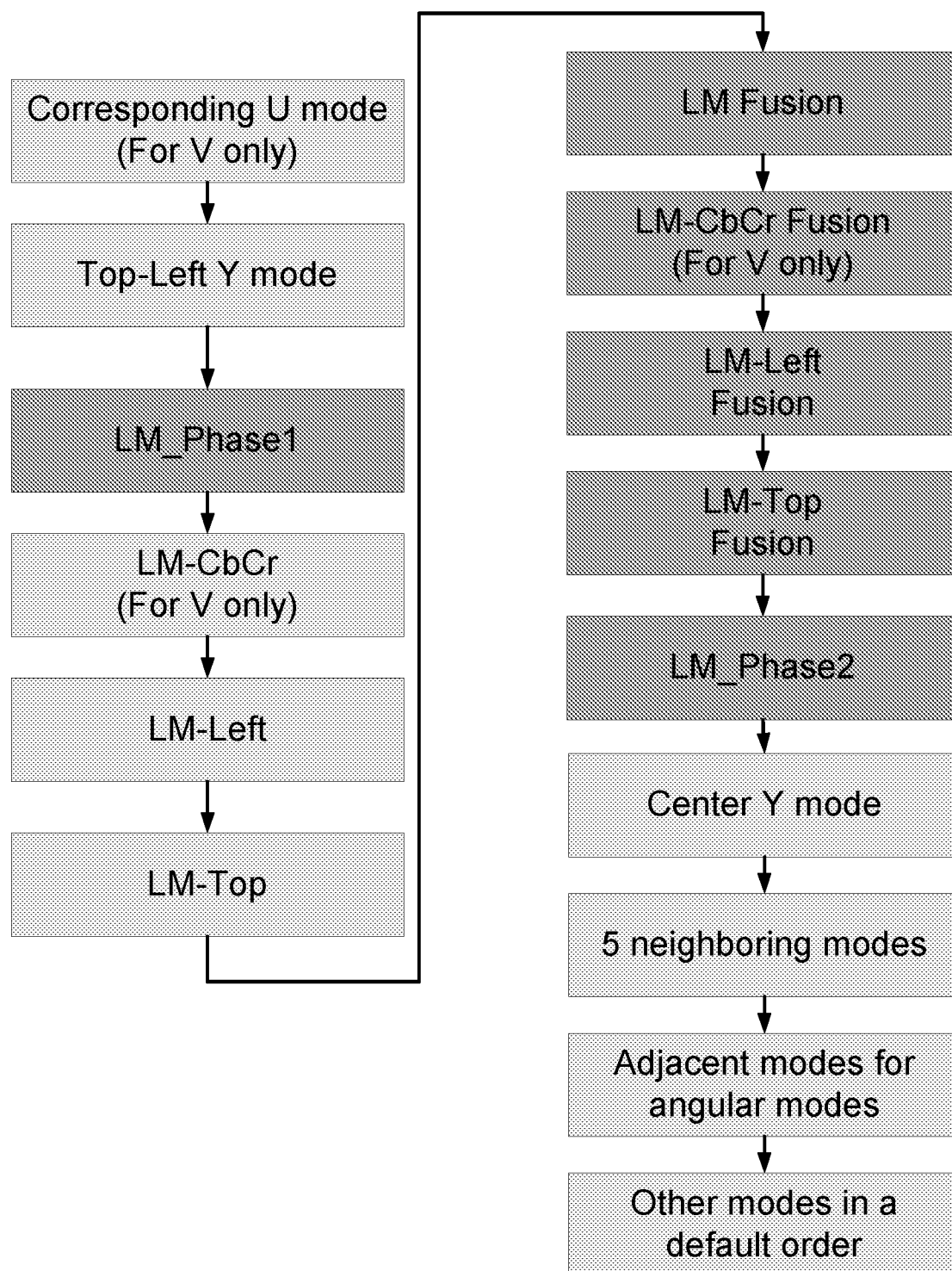


Fig. 14

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2016/073998

A. CLASSIFICATION OF SUBJECT MATTER H04N 19/159(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 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) CNKI,CNPAT,WPI,EPODOC: code, linear, model, predication, chroma, luma, parameter, block, mode, sample, fusion, LM																							
C. DOCUMENTS CONSIDERED TO BE RELEVANT <table border="1"> <thead> <tr> <th>Category*</th> <th>Citation of document, with indication, where appropriate, of the relevant passages</th> <th>Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td>A</td> <td>WO 2014154094 A1 (MEDIATEK INC.) 02 October 2014 (2014-10-02) description, paragraphs [0004]-[0007], [0010], fig.1</td> <td>1-21</td> </tr> <tr> <td>A</td> <td>US 2014233650 A1 (HUAWEI TECHNOLOGIES CO., LTD.) 21 August 2014 (2014-08-21) the whole document</td> <td>1-21</td> </tr> <tr> <td>A</td> <td>US 2014086502 A1 (GUO, MEI ET AL.) 27 March 2014 (2014-03-27) the whole document</td> <td>1-21</td> </tr> <tr> <td>A</td> <td>US 2014355667 A1 (MEDIATEK SINGAPORE PTE. LTD.) 04 December 2014 (2014-12-04) the whole document</td> <td>1-21</td> </tr> <tr> <td>A</td> <td>US 2015036745 A1 (MEDIATEK SINGAPORE PTE. LTD.) 05 February 2015 (2015-02-05) the whole document</td> <td>1-21</td> </tr> <tr> <td>A</td> <td>WO 2013155817 A1 (HUAWEI TECHNOLOGIES CO., LTD. ET AL.) 24 October 2013 (2013-10-24) the whole document</td> <td>1-21</td> </tr> </tbody> </table>			Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	A	WO 2014154094 A1 (MEDIATEK INC.) 02 October 2014 (2014-10-02) description, paragraphs [0004]-[0007], [0010], fig.1	1-21	A	US 2014233650 A1 (HUAWEI TECHNOLOGIES CO., LTD.) 21 August 2014 (2014-08-21) the whole document	1-21	A	US 2014086502 A1 (GUO, MEI ET AL.) 27 March 2014 (2014-03-27) the whole document	1-21	A	US 2014355667 A1 (MEDIATEK SINGAPORE PTE. LTD.) 04 December 2014 (2014-12-04) the whole document	1-21	A	US 2015036745 A1 (MEDIATEK SINGAPORE PTE. LTD.) 05 February 2015 (2015-02-05) the whole document	1-21	A	WO 2013155817 A1 (HUAWEI TECHNOLOGIES CO., LTD. ET AL.) 24 October 2013 (2013-10-24) the whole document	1-21
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Date of the actual completion of the international search 05 September 2016		Date of mailing of the international search report 19 October 2016																					
Name and mailing address of the ISA/CN STATE INTELLECTUAL PROPERTY OFFICE OF THE P.R.CHINA 6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088 China Facsimile No. (86-10)62019451		Authorized officer ZHANG,Xuan Telephone No. (86-10)61648236																					

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2016/073998**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

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