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10175505.6 6 September 2010 (06.09.2010) EP(71) Applicant (for all designated States except US): **Advanced Digital Broadcast S.A.** [CH/CH]; Avenue de Tournay 7, CH-1292 Chambes (CH).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **HREBIEN, Maciej** [PL/PL]; ADB Polska Sp. z o.o., ul. Trasa Polnocna 16, PL-65-119 Zielona Gora (PL). **KOBZDA, Piotr** [PL/PL]; ADB Polska Sp. z o.o., ul. Trasa Polnocna 16, PL-65-119 Zielona Gora (PL). **SZAJNA, Tomasz** [PL/PL]; ADB Polska Sp. z o.o., ul. Trasa Polnocna 16, PL-65-119 Zielona Gora (PL).(74) Agent: **PAWLOWSKI, Adam**; EUPATENT.PL, Al. Kosciuszki 23/25, PL-90-418 Lodz (PL).

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(54) Title: A METHOD AND A SYSTEM FOR DETERMINING A VIDEO FRAME TYPE

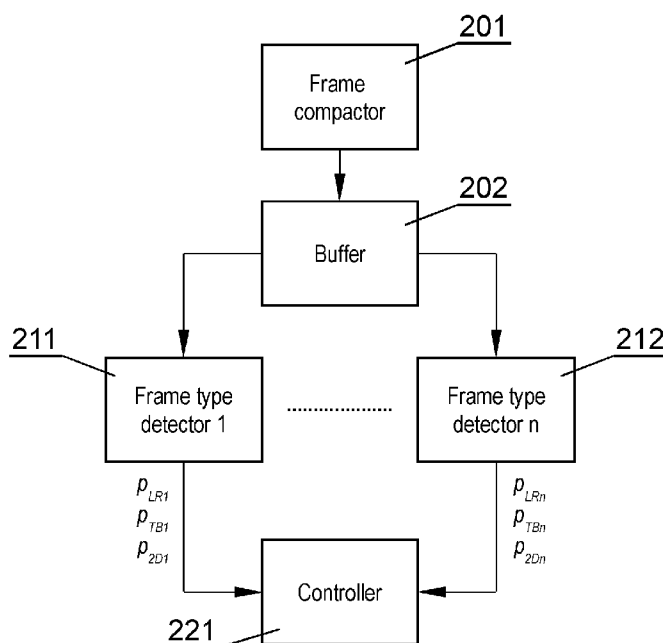


Fig. 5

(57) Abstract: A computer-implemented method for determining a video frame type, comprising the steps of: receiving a video frame, analyzing the video frame in a plurality of frame type detectors (211, 212) using at least one algorithm configured to output a plurality of type coefficients (p_{LR} , p_{TB} , p_{2D}) indicative of a probability that the frame is of a 2D or 3D type, wherein at least two of the coefficients (p_{LR} , p_{TB} , p_{2D}) are calculated independently of each other and wherein the sum of the probability coefficients can be different than 100%, wherein each of the frame type detectors (211, 212) utilizes at least one algorithm different than the algorithms utilized by the other frame type detectors (211, 212), and wherein the frame type detectors (211, 212) operate in parallel, and generating a predicted frame type indicator based on the type coefficients (p).

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A METHOD AND A SYSTEM FOR DETERMINING A VIDEO FRAME TYPE

DESCRIPTION

5

TECHNICAL FIELD

The present invention relates to determining video frame type, in particular distinguishing between a two-dimensional (2D) and three-dimensional
10 (3D) video frames.

BACKGROUND ART

Stereoscopic video displays can be used to display both 2D and 3D
15 video signals, by processing the frames of the signals depending on the type of signal. The type of the signal can be specified manually by the user, which can be troublesome for inexperienced users. The type of signal can be also specified by supplementary data included in the signal itself or by a supplementary signal, which requires the video display unit to be able to decode
20 and recognize the supplementary data or the supplementary signal.

A US patent application US2009/0009508 presents an apparatus and a method for driving a 2D/3D switchable display, which includes an image mode determination unit determining whether input image signals of continuous frames are in a 2D mode or 3D mode. The 3D mode is recognized by
25 determining a syntax indicating a stereo or a multiview image included in the header information of the input image signal. Alternatively, the image mode can be determined based on the presence of a stereo sync signal. Therefore, the mode determination requires data or signals supplementary to the basic image data.

30 A PCT patent application WO2010/014973 presents a method and an apparatus for encoding or tagging a video frame which provide a way to indicate, to a receiver, whether the video content is 3-D content or 2-D content, by replacing lines of at least one video frame in a 3-D content with a specific

color or pattern. Therefore, the method is useful only for receivers, which are able to recognize the specific color or patterns as an indication of a 3-D content.

A US patent application US2010/0182404 presents a 3D video reproduction apparatus and method, wherein the input video frame is analyzed
5 by a comparing a left and right half or the top and bottom half of the image to determine whether the input signal is a signal for displaying a 3D image or a 2D image. Only one type of detection algorithm is used, which may lead to incorrect frame detection in case the detection algorithm is inaccurate.

10 In case the display lacks the functionality of decoding supplementary data included in the signal or is not able to decode supplementary signals describing the video type, or the video signal contains only basic image contents without the image type indicated, the signal must be recognized in an alternative way.

15

The aim of the present invention is to provide a method for determining the video frame type by analyzing video signals having no or unknown indication of video frame type.

20 DISCLOSURE OF THE INVENTION

The object of the invention is a computer-implemented method for determining a video frame type, comprising the steps of receiving a video frame, analyzing the video frame in a plurality of frame type detectors using at least one algorithm configured to output a plurality of type coefficients (p_{LR} , p_{TB} ,
25 p_{2D}) indicative of a probability that the frame is of a 2D or 3D type, wherein at least two of the coefficients (p_{LR} , p_{TB} , p_{2D}) are calculated independently of each other and wherein the sum of the probability coefficients can be different than 100%, wherein each of the frame type detectors utilizes at least one algorithm different than the algorithms utilized by the other frame type detectors, and
30 wherein the frame type detectors operate in parallel, and generating a predicted frame type indicator based on the type coefficients (p).

The method may further comprise the step of generating a compacted frame by discarding rectangular regions located at the top, bottom, left, right, horizontal centre and/or vertical centre of the received video frame and providing the compacted frame for analyzing.

- 5 The method may further comprise the step of generating a compacted frame by scaling-down the video frame and providing the compacted frame for analyzing.

10 The method may further comprise the step of generating a compacted frame by discarding color information of the video frame and providing the compacted frame for analyzing.

In at least one frame type detector a type coefficient indicative of a probability that the frame is of a 2D type (p_{2D}) and a type coefficient indicative of a probability that the frame is of a 3D type (p_{LR}, p_{TB}) can be output.

15 In at least one frame type detector a type coefficient indicative of a probability that the frame is of an Left-Right (LR) 3D type (p_{LR}) and a type coefficient indicative of a probability that the frame is of a Top-Bottom (TB) 3D type (p_{TB}) can be output.

20 In at least one frame type detector a type coefficient indicative of a probability that the frame is of a 2D type (p_{2D}) can be output as equal to the inverse of the larger of the type coefficients indicative of a probability that the frame is of a 3D type (p_{LR}, p_{TB}).

The video frame can be received upon a change of an input video signal.

The video frame can be received with a predetermined frequency.

25 The video frame can be received upon a change of the output frame type indicator.

The frame type indicator can be output upon detecting a change of the frame type indicator for a plurality of consecutive video frames.

30 The object of the invention is also a computer program comprising program code means for performing all the steps of the computer-implemented method according to the invention when said program is run on a computer, as well as a computer readable medium storing computer-executable instructions performing all the steps of the computer-implemented method according to the invention when executed on a computer.

The object of the invention is also a system for determining a video frame type, the system comprising a buffer configured to receive a video frame, a plurality of frame type detectors configured to read the video frame received in the buffer and to analyze the frame using at least one algorithm configured to
5 output a plurality of type coefficients (p_{LR} , p_{TB} , p_{2D}) indicative of a probability that the frame is of a 2D or 3D type, wherein at least two of the coefficients (p_{LR} , p_{TB} , p_{2D}) are calculated independently of each other and wherein the sum of the probability coefficients can be different than 100%, wherein each of the frame type detectors utilizes at least one algorithm different than the algorithms
10 utilized by the other frame type detectors, and wherein the frame type detectors are configured to operate in parallel, and a controller configured to receive the type coefficients (p) from the frame type detectors and to generate a predicted frame type indicator based on the received type coefficients (p).

The system may further comprise a frame compactor configured to
15 receive a video frame, generate a compacted frame by discarding rectangular regions located at the top, bottom, left, right, horizontal centre and/or vertical centre of the video frame and output the compacted frame to the buffer.

BRIEF DESCRIPTION OF DRAWINGS

20

The present invention will be shown by means of an exemplary embodiment on a drawing, in which:

Figs. 1A-1D show examples of typical 2D video frames.

Figs. 2A-2H show examples of typical 3D video frames of an Left-Right
25 (LR) type.

Figs. 3A-3H show examples of typical 3D video frames of a Top-Bottom (TB) type.

Fig. 4 shows the common non-active image regions of a video frame.

Fig. 5 shows the structure of a system for determining video frame type.

30 Fig. 6 shows the procedure of operation of a frame compactor.

Fig. 7 shows the procedure of operation of a frame type detector.

Fig. 8 shows the procedure of operation of a frame type controller.

MODES FOR CARRYING OUT THE INVENTION

Fig. 1A-1D show examples of typical 2D video frames. The frame may comprise only an active image region 111 as shown in Fig. 1A. Alternatively, the 2D frame may further comprise a non-active image region 110, such as bars of a uniform color, e.g. black, at the top and bottom edges of the frame as shown in Fig. 1B or bars at the top, bottom, left and right edges of the frame as shown in Fig. 1C or bars at the left and right edges of the frame as shown in Fig. 1D.

Figs. 2A-2H show examples of typical 3D video frames of a Left-Right (LR) type. Such frame, as shown in Fig. 2A, comprises two active image regions 111, 112, which define the content to be displayed for the left and right eye. The active regions 111, 112 may be scaled-down in the horizontal direction in order to fit into dimensions of a standardized 2D frame. A 3D frame may also contain non-active image regions 110, such as bars of a uniform color, e.g. black, at the top and bottom edges of the frame as shown in Fig. 2B, at the top, bottom, left and right edges of the frame as shown in Fig. 2C, at the left and right edges of the frame as shown in Fig. 2D, at the top, bottom, left and right edges of the frame and between the active regions as shown in Fig. 2E, at the left and right edges of the frame and between the active regions as shown in Fig. 2F, between the active regions as shown in Fig. 2G or at the top and bottom edges of the frame and between the active regions as shown in Fig. 2H.

Figs. 3A-3H show examples of typical 3D video frames of a Top-Bottom (TB) type. Such frame, as shown in Fig. 3A, comprises two active image regions 111, 112, which define the content to be displayed for the left (e.g. the top region) and the right (e.g. the bottom region) eye. The active regions 111, 112 may be scaled-down in the vertical direction in order to fit into dimensions of a standard 2D frame. A 3D frame may also contain non-active image regions 110, such as: bars of a uniform color, e.g. black, at the left and right edges of the frame as shown in Fig. 3B, at the top, bottom, left and right edges of the frame as shown in Fig. 3C, at the top and bottom edges of the frame as shown in Fig. 3D, at the top, bottom, left and right edges of the frame and between the active regions as shown in Fig. 3E, at the top and bottom edges of the frame

and between the active regions as shown in Fig. 3F, between the active regions as shown in Fig. 3G or at the left and right edges of the frame and between the active regions as shown in Fig. 3H.

Therefore, for any 2D or 3D video frame, the most probable non-active regions 110 may form bars at the top, bottom, left, right, horizontal centre and vertical centre of the frame, as shown in Fig. 4.

Fig. 5 shows the structure of a system for determining video frame type according to the invention. The system comprises a frame compactor 201 configured to extract from the input video frames data representing an active region and discard the data representing the non-active region of the frame, according to the procedure shown in Fig. 6, and possibly to reduce the amount of data by scaling-down and/or discarding the color information. The reduced frame representation is passed to a buffer 202, from which it is collected by a plurality of frame type detectors 211, 212, each utilizing a different frame type detection algorithm and operating according to the procedure shown in Fig. 7. Each frame type detector 211, 212 provides an output in form of coefficients p , indicative of a probability that the frame is a 2D (p_{2D}) or a 3D frame, wherein for 3D frames the detector may indicate the type of frame: an LR frame (p_{LR}) or a TB frame (p_{TB}). The coefficients are collected by a frame type controller 221, operating according to the procedure shown in Fig. 8 and configured to output the predicted frame type indicator.

Fig. 6 shows the procedure of operation of the frame compactor 201. In step 301, the received input frame may be reduced for easier analysis, by scaling it down, i.e. reducing the size of the frame. Next, in step 302 the color information can be discarded, either by converting the frame contents into a grayscale or selecting contents of only one color channel. Next, in step 303 the frame is analyzed to detect the non-active regions, preferably in areas indicated in Fig. 4, namely in the bars located at the top, bottom, left, right, horizontal centre and vertical centre of the frame. The contents of the detected non-active regions are discarded in step 304 so as to generate a frame containing only data of active regions, as shown in Fig. 1A, 2A or 3A. The processing of a frame by the frame compactor 201 may be initiated after a change of the video input signal, for example a change of a channel in a television decoder, in order to

determine the type of the new signal. Alternatively, the frame compactor 201 may be operated continuously, in order to detect change of type of the received signal, for example to detect a 2D commercial break in a 3D video film. In such a case, the frame compactor 201 may receive the frames with a specific
 5 frequency, preferably lower than the frame display rate, such as 2 frames per second, in order to minimize the computational load of the signal receiver.

Fig. 7 shows the procedure of operation of the frame type detector 211, 212. A compacted frame is collected from the buffer 202 in step 401. Next, in steps 402, 403, 404 it can be pre-processed in order to adapt it to a following
 10 type-recognition algorithm. The pre-processing steps 402-404 may be performed for each algorithm individually, or if the algorithms require the same pre-processing, the pre-processing step can be executed once for all algorithms. Pre-processing may include filtering, normalization, Fourier transformations etc. In steps 405, 406, 407 the algorithms for detecting whether
 15 the frame is of a 3D LR type, a 3D TB type or a 2D type are executed. In a simple embodiment, the 2D type detection algorithm may be not used. The algorithms are different for each frame type detector 211, 212. Preferably, the algorithms used are of various types, such as determining the phase correlation between two frame halves, subtracting the frame halves, multiplying the frame
 20 halves, etc. The algorithms are configured to provide a coefficient indicative of the probability that the frame is of a given type. In case the 2D type detection algorithm is not used, the coefficient for indicating a 2D frame can be calculated as the inverse of the larger of the 3D coefficients:

$$25 \quad p_{2D} = 1 - \text{Max} (p_{LR}, p_{TB})$$

Some algorithms may provide inaccurate results for particular types of frame contents, such as large areas of the same colour, therefore the coefficients p_{2D} , p_{LR} , p_{TB} (preferably indicated as a number from 0 to 1) do not
 30 have to sum up to 1. The calculated set of coefficients is output in step 408.

Fig. 8 shows the procedure of operation of the frame type controller 221. In step 501, the coefficients are collected from the detectors 211, 212. For example, the following sets of coefficients may be collected:

	p_{LR}	p_{TB}	p_{2D}
Detector 1	0,9	0,1	0,1
Detector 2	0,8	0,1	0,2
Detector 3	0,5	0,5	0,5
Detector 4	0,1	0,1	0,1

In other embodiments, not all detectors have to provide coefficients for all frame types.

5 As indicated in the table, detectors 1 and 2 determined the frame as a 3D LR-type frame. The algorithms of detector 3 indicated inability to determine the type of frame. None of the algorithms of detector 4 recognized the frame as matching a specific type. By using a plurality of detectors, each using a different set of frame type detection algorithms, it is possible to correctly determine a
10 wide range of frame types, which are not always detectable by a particular algorithm.

In step 502, the most probable frame type is selected. In addition, in step 503 the frame type may be compared with a history for e.g. the last 5 analyzed frames, in order to limit accidental, incorrect frame type changes. For example,
15 the frame type may be changed only if the frame type was selected as a given type for the past 3 analyzed frames. Although this may delay the time of frame type change, such approach reduces the risk of accidental, incorrect frame type detections in case inaccurate algorithms are used. In step 504, the determined frame type is output. In order to minimize the delay related to low-pass filtering
20 of the history of coefficients in case the detectors 211, 212 analyze frames with frequency lower than the frame rate, then in case a frame type change is detected, the detectors 211, 212 may be ordered to analyze the next possible frame, thereby to operate with a higher frequency at the moment of predicted frame change.

25 In case the system according to the invention is embedded in a video display unit, the determined frame type can be used to select the method of processing the signal to be displayed. In case the system according to the

invention is embedded in a video decoder, such as a television set-top box, the determined frame type can be used to select the method of processing the signal to be passed to a display unit, for example converting a 2D signal to a 3D format in case the display unit is set to receive 3D video signals.

5

It can be easily recognized, by one skilled in the art, that the aforementioned system and method for determining video frame type may be performed and/or controlled by one or more computer programs. Such computer programs are typically executed by utilizing the computing resources
10 of a processing unit which can be embedded within various video signal receivers, such as personal computers, personal digital assistants, cellular telephones, receivers and decoders of digital television, video display units or the like. The computer programs can be stored in a non-volatile memory, for example a flash memory or in a volatile memory, for example RAM and are
15 executed by the processing unit. These memories are exemplary recording media for storing computer programs comprising computer-executable instructions performing all the steps of the computer-implemented method according the technical concept presented herein.

While the invention presented herein has been depicted, described, and
20 has been defined with reference to particular preferred embodiments, such references and examples of implementation in the foregoing specification do not imply any limitation on the invention. It will, however, be evident that various modifications and changes may be made thereto without departing from the broader scope of the technical concept. The presented preferred embodiments
25 are exemplary only, and are not exhaustive of the scope of the technical concept presented herein. Accordingly, the scope of protection is not limited to the preferred embodiments described in the specification, but is only limited by the claims that follow.

30

CLAIMS

1. A computer-implemented method for determining a video frame type, characterized in that it comprises the steps of:
 - 5 - receiving a video frame,
 - analyzing the video frame in a plurality of frame type detectors (211, 212) using at least one algorithm configured to output a plurality of type coefficients (p_{LR} , p_{TB} , p_{2D}) indicative of a probability that the frame is of a 2D or 3D type, wherein at least two of the coefficients (p_{LR} , p_{TB} , p_{2D}) are
10 calculated independently of each other and wherein the sum of the probability coefficients can be different than 100%, wherein each of the frame type detectors (211, 212) utilizes at least one algorithm different than the algorithms utilized by the other frame type detectors (211, 212), and wherein the frame type detectors (211, 212) operate in parallel,
 - 15 - generating a predicted frame type indicator based on the type coefficients (p).
2. The method according to claim 1, further comprising the step of generating a compacted frame by discarding rectangular regions (110) located
20 at the top, bottom, left, right, horizontal centre and/or vertical centre of the received video frame and providing the compacted frame for analyzing.
3. The method according to any of previous claims, further comprising the step of generating a compacted frame by scaling-down the video frame and
25 providing the compacted frame for analyzing.
4. The method according to any of previous claims, further comprising the step of generating a compacted frame by discarding color information of the video frame and providing the compacted frame for analyzing.
- 30 5. The method according to any of previous claims, wherein in at least one frame type detector (211, 212) a type coefficient indicative of a probability that

the frame is of a 2D type (p_{2D}) and a type coefficient indicative of a probability that the frame is of a 3D type (p_{LR}, p_{TB}) is output.

6. The method according to any of previous claims, wherein in at least one
5 frame type detector (211, 212) a type coefficient indicative of a probability that the frame is of an Left-Right (LR) 3D type (p_{LR}) and a type coefficient indicative of a probability that the frame is of a Top-Bottom (TB) 3D type (p_{TB}) is output.

7. The method according to claim 6, wherein in at least one frame type
10 detector (211, 212) a type coefficient indicative of a probability that the frame is of a 2D type (p_{2D}) is output as equal to the inverse of the larger of the type coefficients indicative of a probability that the frame is of a 3D type (p_{LR}, p_{TB}).

8. The method according to any of previous claims, wherein the video frame
15 is received upon a change of an input video signal.

9. The method according to any of previous claims, wherein the video frame is received with a predetermined frequency.

20 10. The method according to any of previous claims, wherein the video frame is received upon a change of the output frame type indicator.

11. The method according to any of previous claims, wherein the frame type
25 indicator is output upon detecting a change of the frame type indicator for a plurality of consecutive video frames.

12. A computer program comprising program code means for performing all
the steps of the computer-implemented method according to any of claims 1-11
when said program is run on a computer.

30

13. A computer readable medium storing computer-executable instructions
performing all the steps of the computer-implemented method according to any
of claims 1-11 when executed on a computer.

14. A system for determining a video frame type, characterized in that it comprises:

- a buffer (202) configured to receive a video frame,
- 5 - a plurality of frame type detectors (211, 212) configured to read the video frame received in the buffer (202) and to analyze the frame using at least one algorithm configured to output a plurality of type coefficients (p_{LR} , p_{TB} , p_{2D}) indicative of a probability that the frame is of a 2D or 3D type, wherein at least two of the coefficients (p_{LR} , p_{TB} , p_{2D}) are calculated
10 independently of each other and wherein the sum of the probability coefficients can be different than 100%, wherein each of the frame type detectors (211, 212) utilizes at least one algorithm different than the algorithms utilized by the other frame type detectors (211, 212), and wherein the frame type detectors (211, 212) are configured to operate in
15 parallel,
- a controller (221) configured to receive the type coefficients (p) from the frame type detectors (211, 212) and to generate a predicted frame type indicator based on the received type coefficients (p).

- 20 15. The system according to claim 14, further comprising a frame compactor (201) configured to receive a video frame, generate a compacted frame by discarding rectangular regions (110) located at the top, bottom, left, right, horizontal centre and/or vertical centre of the video frame and output the compacted frame to the buffer (202).

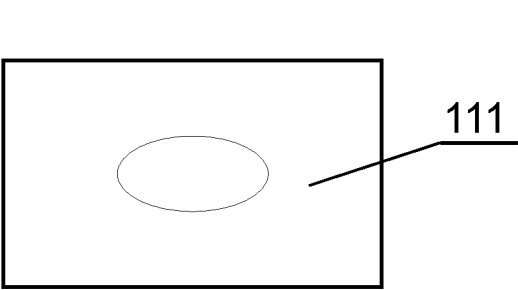


Fig. 1A

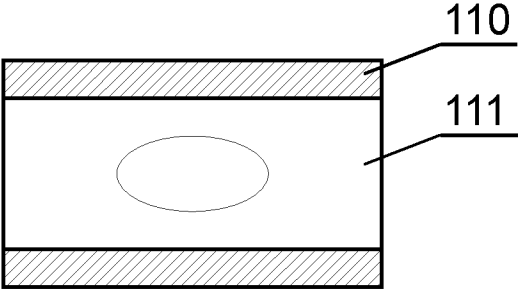


Fig. 1B

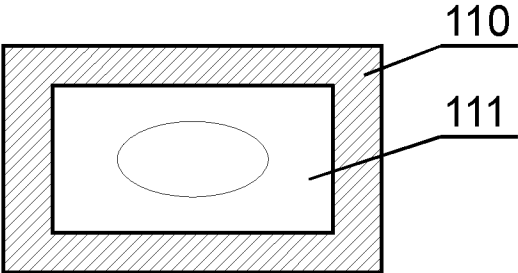


Fig. 1C

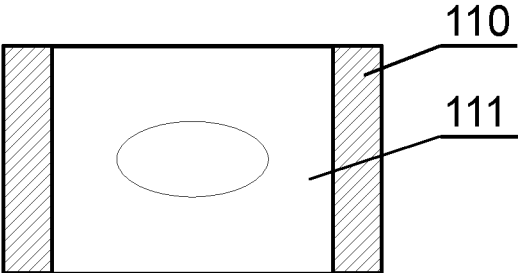


Fig. 1D

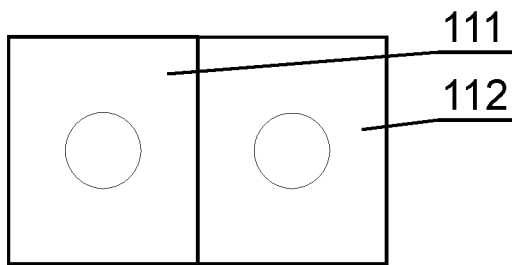


Fig. 2A

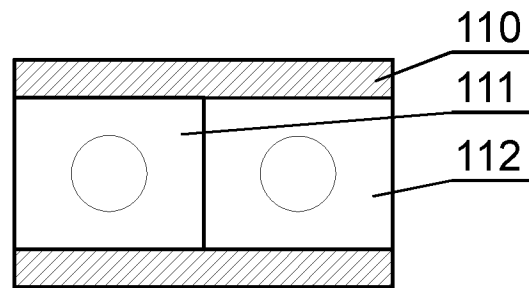


Fig. 2B

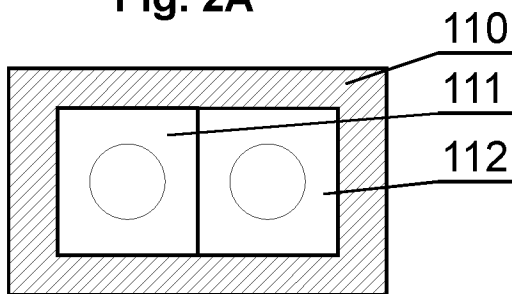


Fig. 2C

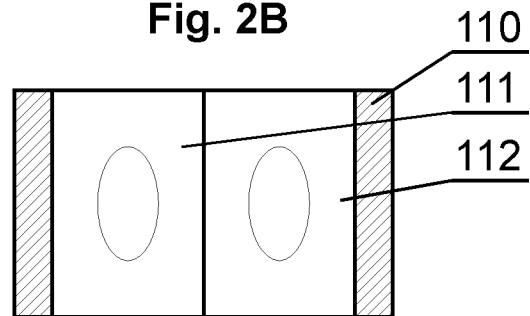


Fig. 2D

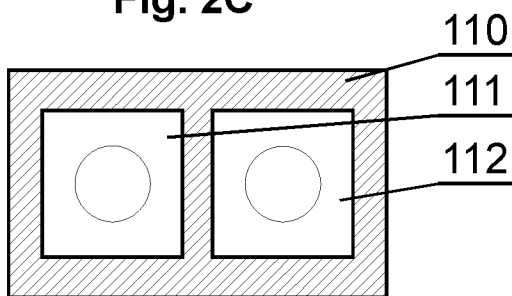


Fig. 2E

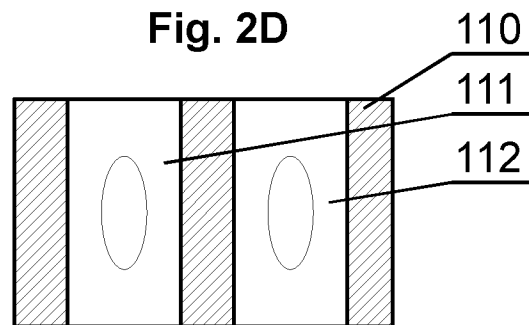


Fig. 2F

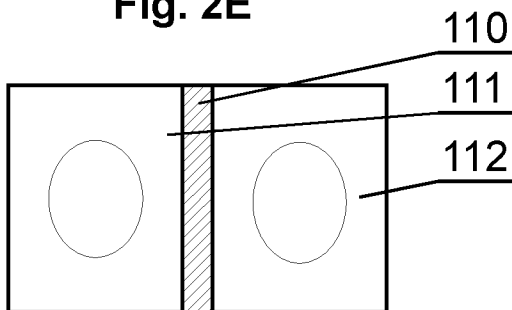


Fig. 2G

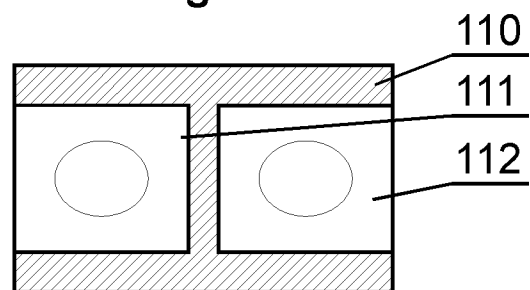


Fig. 2H

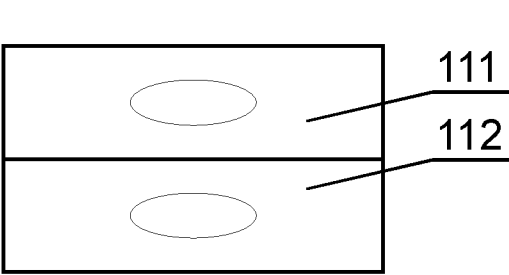


Fig. 3A

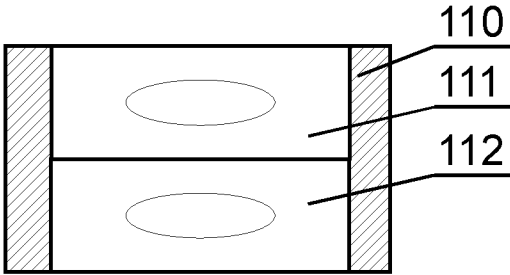


Fig. 3B

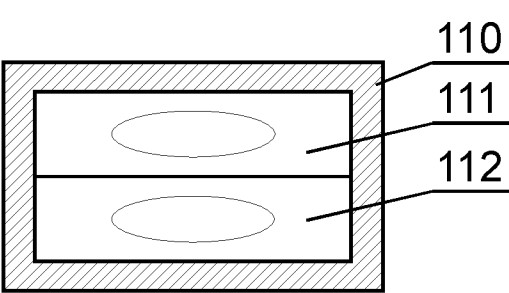


Fig. 3C

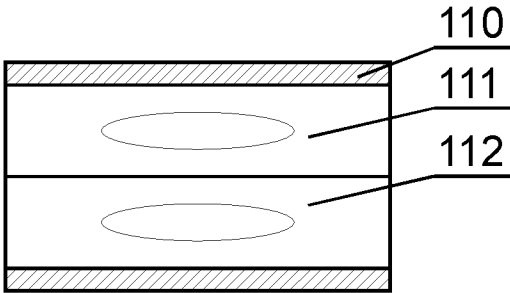


Fig. 3D

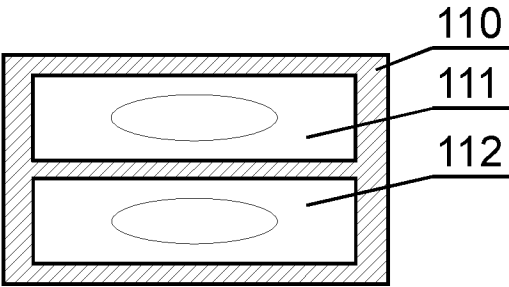


Fig. 3E

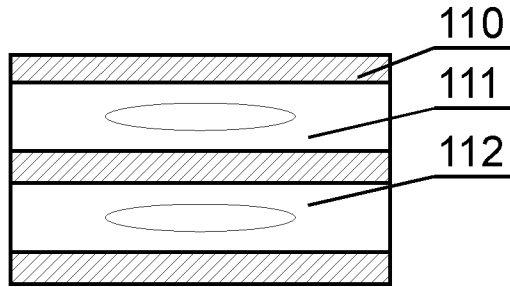


Fig. 3F

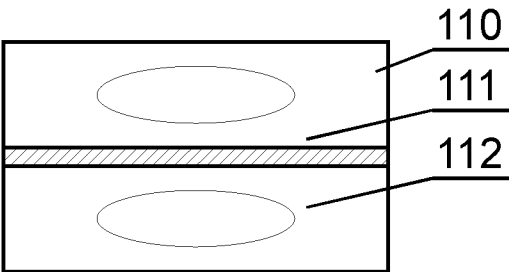


Fig. 3G

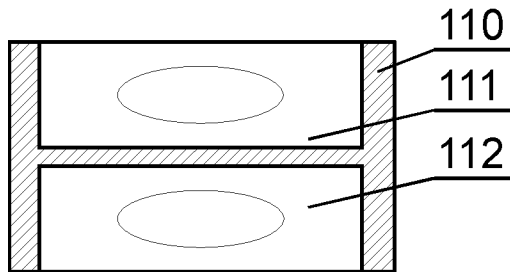
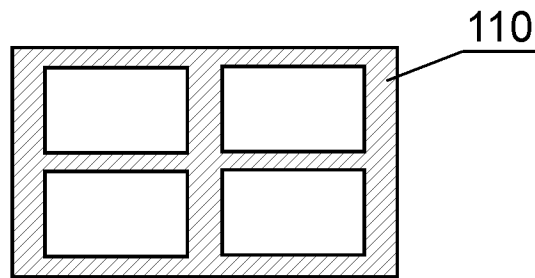
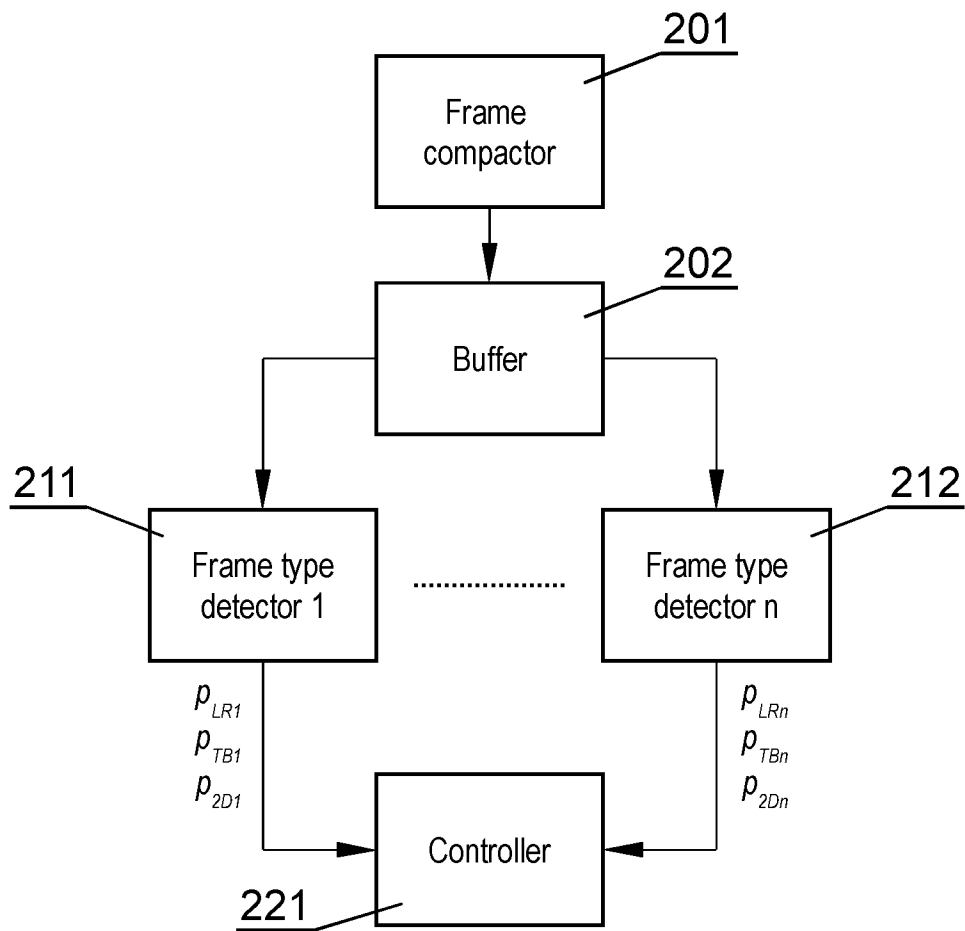


Fig. 3H

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**Fig. 4****Fig. 5**

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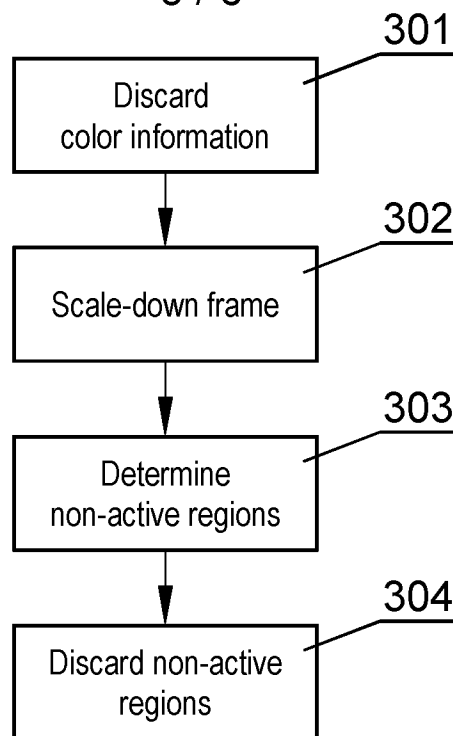


Fig. 6

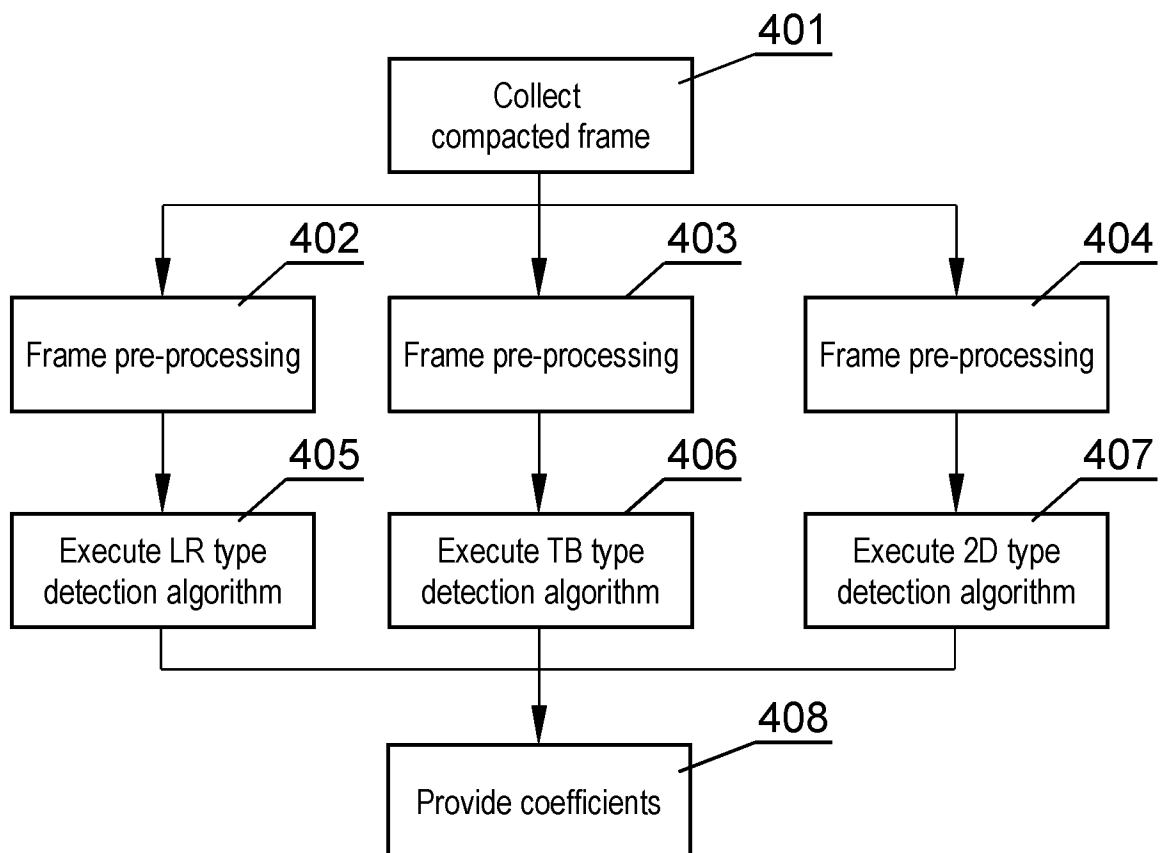
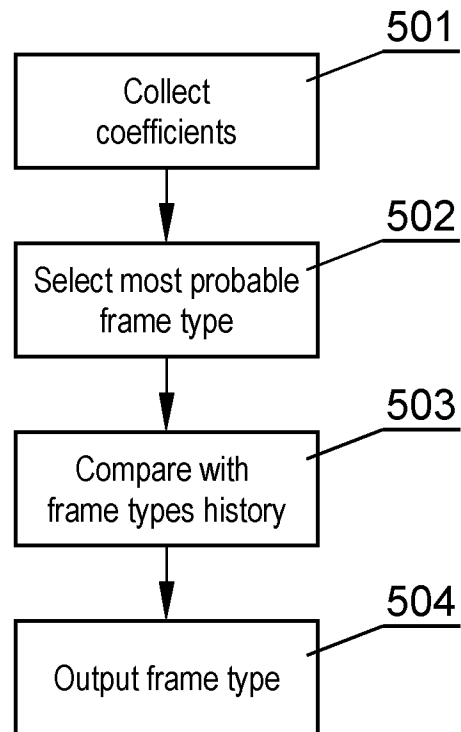


Fig. 7

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**Fig. 8**

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2011/065248

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04N13/00
ADD.

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 practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2010/182404 A1 (KUNO YOSHIKI [JP]) 22 July 2010 (2010-07-22) paragraph [0090] - paragraph [0096]; figure 9	1-15
A	----- WAHID NASRI ET AL: "A hybrid performance modeling approach for adaptive algorithm selection on hierarchical clusters", COMPUTER SYSTEMS AND APPLICATIONS (AICCSA), 2010 IEEE/ACS INTERNATIONAL CONFERENCE ON, IEEE, PISCATAWAY, NJ, USA, 16 May 2010 (2010-05-16), pages 1-8, XP031764305, ISBN: 978-1-4244-7716-6 the whole document -----	1,12-14



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

16 January 2012

Date of mailing of the international search report

23/01/2012

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European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
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Wahba, Alexander

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2011/065248

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2010182404 A1	22-07-2010	CN 102239699 A	09-11-2011
		EP 2375767 A1	12-10-2011
		US 2010182404 A1	22-07-2010
		WO 2010064448 A1	10-06-2010
