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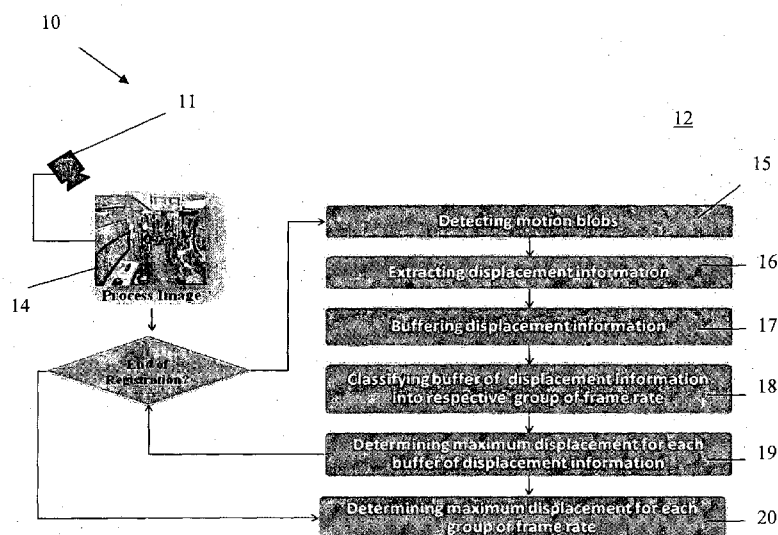
(54) **Title:** ABRUPT OBJECT MOVEMENT DETECTION SYSTEM AND METHOD THEREOF

Figure 2

(57) **Abstract:** An abrupt object movement detection system (10) comprises at least one capturing device (11) for capturing a sequence of image frames at a monitoring area, means for registering (12) frame of images having different types of frame rates, wherein motion blobs of the images are extracted to obtain object's displacement information for categorizing into predefined categories of frame rates and the maximum displacement information for each frame rate is chosen as a filtering threshold for the respective frame rate categories; and means for detecting (13) abrupt object movement by filtering a scene displacement information with the filtering threshold based on a corresponding predefined frame rate category and determining abrupt movement from total density of the filtered displacement information.

- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

Abrupt Object Movement Detection System and Method Thereof**Field of Invention**

5 The present invention relates generally to a detection system, more particularly to a detection system for detecting abrupt object movement in inconsistent frame rate and the method thereof.

10 Background of the Invention

Video surveillance systems are widely used apparatuses to detect and monitor objects within a monitoring area. Usually those video surveillance systems are used to detect and track
15 individuals or vehicles entering or leaving a building facility or to monitor individuals within the monitoring area where the safety of the occupants may be of concern. And another example of application for the surveillance system is to monitor crowds as surveillance cameras are low cost and
20 require no physical contact with the object being monitored.

Abrupt movement indicates object moves in large displacement in a short time. This detection is useful to determine abnormal crowd activities including riot and panic incident
25 due to danger. However, accurate crowd monitoring is a challenging problem because the environments and groups of

people vary and unpredictable and also due to the inconsistent frame rate of the monitoring system. The accuracy of the detection is dropped due to the high false positive in the system and the false positive is the situation when the system
5 gives the alert of the detection during no actual event. And this major cause of false positive is due to the unstable networks that caused inconsistent frame rate.

The inconsistent frame rate includes low frame rate that
10 resulting in lagging issue. Therefore when the video input containing lagging problem is converted to image frame, there will be some missing frame of images due to lagging video as shown in Figures 1a and 1b. This situation gives large error because the movement of moving object is measured by measuring
15 the different locations of the moving object between every two frame of images. The higher of the differences will be interpreted as higher movement. Therefore, if there is some missing frame of images, the different of location of moving object between two frames will be higher. Then the system will
20 interpret it as high movement even though there is no high movement in the sample data as shown in Figure 1c. Hence, false positive happened which is when no any abnormalities in the monitoring area but the system triggered the detection.

25 A system that detects abrupt object movement in inconsistent frame rate has not been developed. Therefore, the present

invention aims to provide a system and method to detect abrupt object movement with the ability to work in unstable network is needed.

5 Other objects of this invention will become apparent on the reading of this entire disclosure.

Summary of the Invention

10 In the present invention, an abrupt object movement detection system comprises at least one capturing device for capturing a sequence of image frames at a monitoring area, means for registering frame of images having different types of frame rates, wherein motion blobs of the images are extracted to
15 obtain object's displacement information for categorizing into predefined categories of frame rates and the maximum displacement information for each frame rate is chosen as a filtering threshold for the respective frame rate categories; and means for detecting abrupt object movement by filtering a
20 scene displacement information with the filtering threshold based on a corresponding predefined frame rate category and determining abrupt movement from total density of the filtered displacement information.

25 A method for detecting abrupt object movement with a detection system, the method comprising the steps of capturing a

sequence of image frames at a monitoring area as input images for processing, registering frame of images having different types of frame rates by extracting motion blobs of the images to obtain object's displacement information for categorizing
5 into predefined categories of frame rates and determining the maximum displacement information as a filtering threshold for the respective frame rate categories, and detecting an abrupt object movement event by filtering a scene displacement information with the filtering threshold based on a
10 corresponding predefined frame rate category and determining abrupt movement from total density of the filtered displacement information.

Brief Description of the Drawings

15

Other objects, features, and advantages of the invention will be apparent from the following description when read with reference to the accompanying drawings. In the drawings, wherein like reference numerals denote corresponding parts
20 throughout the several views:

Figure 1a shows a series of frame of image converted from stream of video for a similar scene at different frame rate of an existing detection system;

25

Figure 1b shows a sequence of frame of image having some of the frames of image missing due to unstable network issue;

Figure 1c illustrates two frames of images which are
5 interpreted as high movement due to the issue shown in figure 1b;

Figure 2 is a flowchart showing the method for the registration process of the abrupt object movement detection
10 system of the present invention;

Figure 3a depicts an original input image;

Figure 3b shows the image of figure 3a with extracted motion
15 blobs;

Figure 3c is the image of figure 3b showing the displacement information;

20 Figure 4 is a schematic diagram showing the step of buffering the displacement information and examining the information to determine the frame rate category;

Figure 5 is a flowchart showing the method for the step of
25 detecting process of the of the abrupt object movement detection system of the present invention;

Figure 6 shows a schematic diagram showing the displacement information within a sliding window filtered based on the selected filtering threshold and the remaining displacement information; and

5

Figure 7 illustrates an example of connected movement information.

Detailed Description of the Preferred Embodiments

10

In the following detailed description, numerous specific details are set forth in order to provide a thorough understanding of the invention. However, it will be understood by those of ordinary skill in the art that the invention may
15 be practiced without these specific details. In other instances, well-known methods, procedures and/or components have not been described in detail so as not to obscure the invention. Reference will now be made in detail to the preferred embodiments of the present invention, examples of
20 which are illustrated in the accompanying drawings.

An abrupt object movement detection system (10) related to the invention will be described with reference to the accompanying drawings. The abrupt object movement detection system (10)
25 includes at least one capturing device (11) for capturing a sequence of image frames at a monitoring area, means for

registering (12) frame of images having different types of frame rates for acquiring optimal filtering threshold, means for detecting (13) abrupt object movement by filtering the displacement information with the filtering threshold based on the frame rate and determining from the total density of the filtered movements, and a displaying device (40) for alerting the user if the abrupt object movement event is detected. There are three different types of frame rates which include the low, medium and high frame rate. The means for registering (12) performs the registration process as shown in Figure 2 and the means for detecting (13) performs the online detection process as shown in Figure 4.

In the registration process, the system (10) will receive a sequence of image frames which is captured by the capturing device (11). These image frames will then be processed (14) by extracting all moving pixels in the current frame and in this case, current frame is compared to the background image for detecting motion blobs (15). The moving pixels are called motion pixels and they represent the moving object of interest within the current frame. Group of connected motion pixels is called motion blobs.

Figure 3a shows an original input image, follows by the example of extracted motion blobs (21) shown in Figure 3b and the displacement information which is the optical flow vector

shown in Figure 3c. With the extracted motion blobs, the current motion blob of the same object and its previous motion blob in previous frame are compared and the optical flow is computed to extract the displacement information (16). In this stage, the extracted motion blobs are used as the mask in computing the optical flow, whereby the stray motion vector resultant from the background pixels will be ignored.

After each object's displacement information is computed, the cumulative or average of the data within current frame is then computed and the value is stored into a buffer. The registration process followed by the step of buffering the displacement information (17) and examining in a sliding window to classify (18) them into three different types of frame rates namely the low, medium and high frame rate as shown in Figure 4. In each sliding window, it contains the same number of image frame but the time duration for each window is different and it is depending on the network.

The frame rate for each sliding window is determined by dividing the number of frames to time duration in second of the window. Then the sliding window is classified into low frame rate category if the computed frame rate is within 0 to 6 fps (frame per second), or into medium frame rate category if the computed frame rate is within 7 to 12 fps or high frame rate category if the computed frame rate within 13 to 25 fps.

Once each sliding window is categorized into its frame rate categories, then the maximum displacement data in each sliding window is extracted (19). Lastly, all maximum displacement data for each frame rate categories is compared (20) and the maximum value is chosen as the filtering threshold for that frame rate category. Therefore, three optimal filtering thresholds for three different frame rate categories are obtained.

Then, in the detection process as shown in Figure 5, the initial processes are the same as in the registration process. For each incoming image frame, the moving objects are extracted from the scene (31) which is the same as in step (15) in the registration process. Then, by comparing the current motion blobs with their corresponding motion blobs in previous frame, the displacement information of each object in the scene is extracted (32). After obtaining each object's displacement information, then the scene displacement information which is the average displacement information in current frame is computed. The scene displacement information is stored into a buffer. The system (10) then performs the step of buffering the displacement (33) wherein if the buffer size is more than the minimum window size, the window is examined to determine its frame rate category (34). Dependent on which frame rate category the window is belong to, the filtering threshold is selected accordingly.

The displacement information within the sliding window is filtered based on the selected filtering threshold. If it is lower than the selected filtering threshold, the displacement information will be removed (35) as shown in Figure 6. The
5 detection process is followed by grouping the remaining displacement information (36). In this step, every single magnitude will be linking to each other with their connected neighbor and the example of connected displacement information is shown in Figure 7. Lastly, the total density of each group
10 of displacement information is then calculated (37). The total density of each group is then compared to the sensitivity threshold to determine (38) the event of an abrupt object movement. If an event is detected, the system will alert the user by displaying the information on the displaying device
15 (40).

As will be readily apparent to those skilled in the art, the present invention may easily be produced in other specific forms without departing from its essential characteristics.
20 The present embodiments is, therefore, to be considered as merely illustrative and not restrictive, the scope of the invention being indicated by the claims rather than the foregoing description, and all changes which come within therefore intended to be embraced therein.

Claims

1. An abrupt object movement detection system (10) comprising:
at least one capturing device (11) for capturing a sequence of
5 image frames at a monitoring area as input images for
processing;
means for registering (12) frame of images having different
types of frame rates, wherein motion blobs of said images are
extracted to obtain object's displacement information for
10 categorizing into predefined categories of frame rates and the
maximum displacement information for each frame rate is chosen
as a filtering threshold for the respective frame rate
categories; and
means for detecting (13) abrupt object movement by filtering a
15 scene displacement information with the filtering threshold
based on a corresponding predefined frame rate category and
determining abrupt movement from total density of the filtered
displacement information.
- 20 2. The abrupt object movement detection system (10) as claimed
in claim 1, wherein said predefined categories of frame rates
include a low frame rate, a medium frame rate and a high frame
rate.

3. The abrupt object movement detection system (10) as claimed in claim 2, wherein said low frame rate category is having the frame rate approximately within 0 to 6 frame per second, fps.

5 4. The abrupt object movement detection system (10) as claimed in claim 3, wherein said medium frame rate is having the frame rate approximately within 7 to 12 frames per second, fps.

5. The abrupt object movement detection system (10) as claimed
10 in claim 2, wherein said high frame rate is having the frame rate approximately within 13 to 25 frames per second, fps.

6. The abrupt object movement detection system (10) as claimed in claim 1, wherein said system further comprising a
15 displaying device (40) for alerting the user if an abrupt object movement event is detected

7. A method for detecting abrupt object movement with a detection system (10), said method comprising the steps of:
20 capturing a sequence of image frames (11) at a monitoring area as input images for processing (14);
registering frame of images having different types of frame rates by extracting motion blobs (15) of said images to obtain object's displacement information (16) for categorizing (18)
25 into predefined categories of frame rates and determining the

maximum displacement information (19) as a filtering threshold for the respective frame rate categories; and

detecting an abrupt object movement event by filtering a scene displacement information (35) with said filtering threshold

5 based on a corresponding predefined frame rate category and determining (38) abrupt movement from total density of said filtered displacement information.

8. The method for detecting abrupt object movement with a
10 detection system (10) as claimed in claim 7, wherein said step of extracting motion blobs (15) of said images to obtain object's displacement information (16) includes the step of comparing the current motion blobs with the corresponding motion blobs in previous frame to compute the optical flow for
15 extracting the object's displacement information.

9. The method for detecting abrupt object movement with a detection system (10) as claimed in claim 7, wherein said step of categorizing (18) into predefined categories of frame rates
20 includes the step of examining in a sliding window to determine the frame rate of the image.

10. The method for detecting abrupt object movement with a detection system (10) as claimed in claim 9, wherein said
25 predefined categories of frame rates include a low frame rate, a medium frame rate and a high frame rate.

11. The method for detecting abrupt object movement with a detection system (10) as claimed in claim 7, wherein said corresponding predefined frame rate category is determined by the steps of extracting motion blobs (31) from the scene to
5 obtain object's displacement information (32), computing the average displacement information in current frame of each object in the scene and buffering said displacement information (33) to determine its frame rate category (34).

10 12. The method for detecting abrupt object movement with a detection system (10) as claimed in claim 7, wherein said prior to the step of determining (38) includes the steps grouping the remaining displacement information (36) and calculating total density of the groups of displacement
15 information (37).

13. The method for detecting abrupt object movement with a detection system (10) as claimed in claim 12, wherein said step of determining (38) includes the step of comparing the
20 total density of each group with the sensitivity threshold.

14. The method for detecting abrupt object movement with a detection system (10) as claimed in claim 7, wherein said method further comprising the step of alerting the user by
25 displaying information at a displaying device (40) if an abrupt object movement event is detected.

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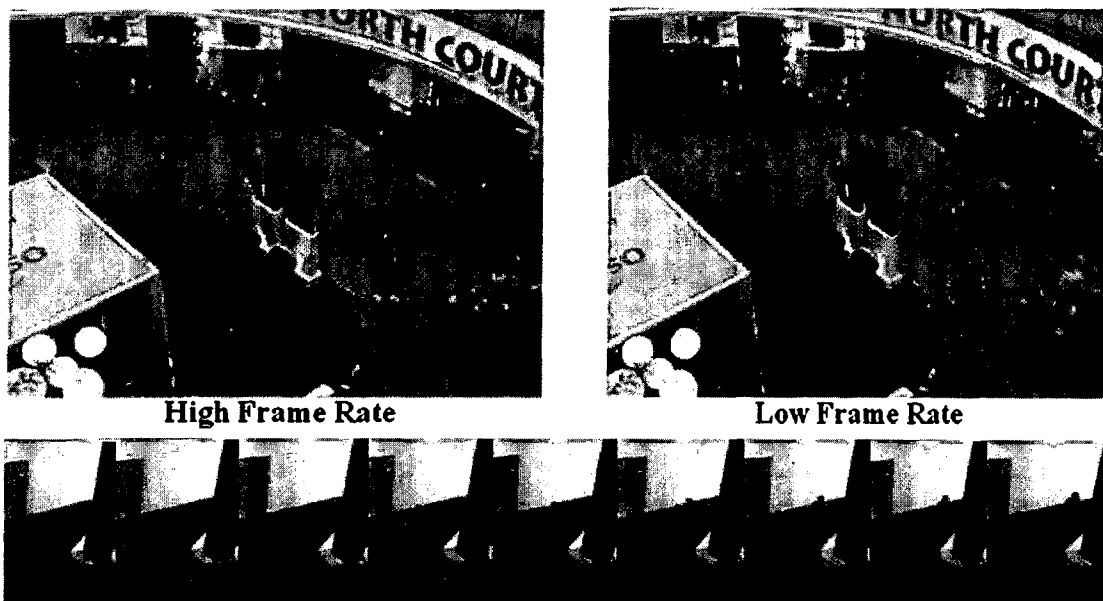


Figure 1a



Figure 1b



Figure 1c

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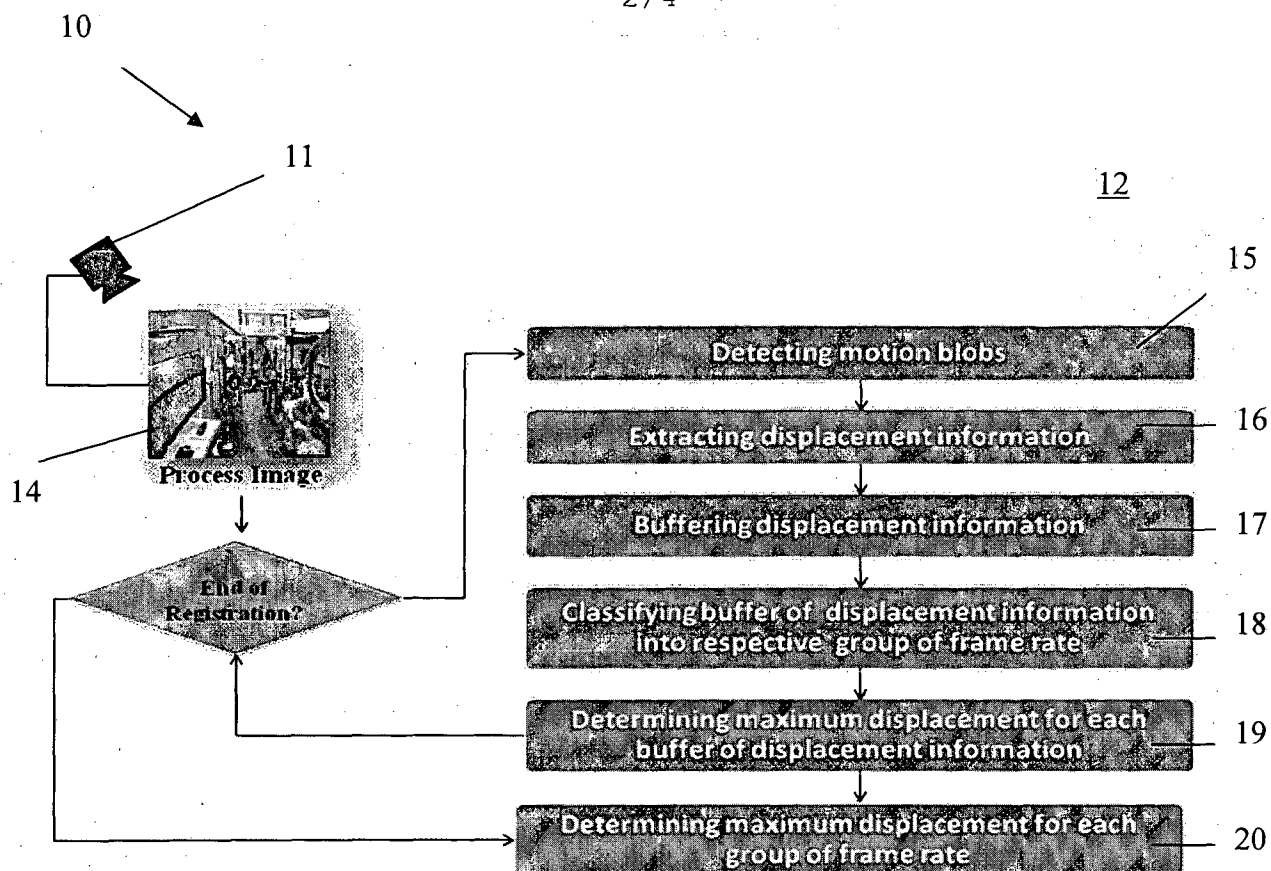


Figure 2

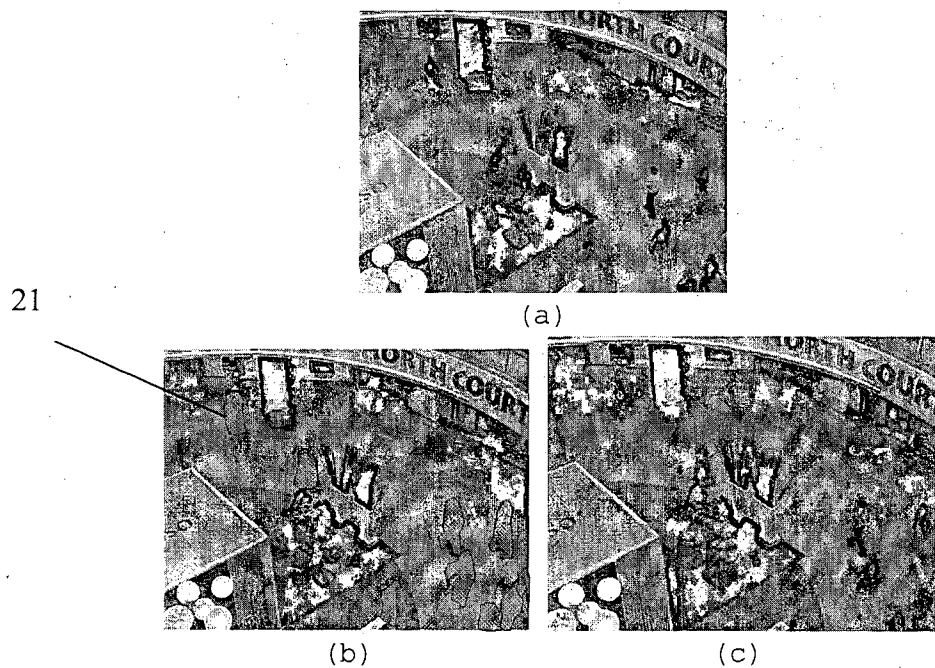


Figure 3

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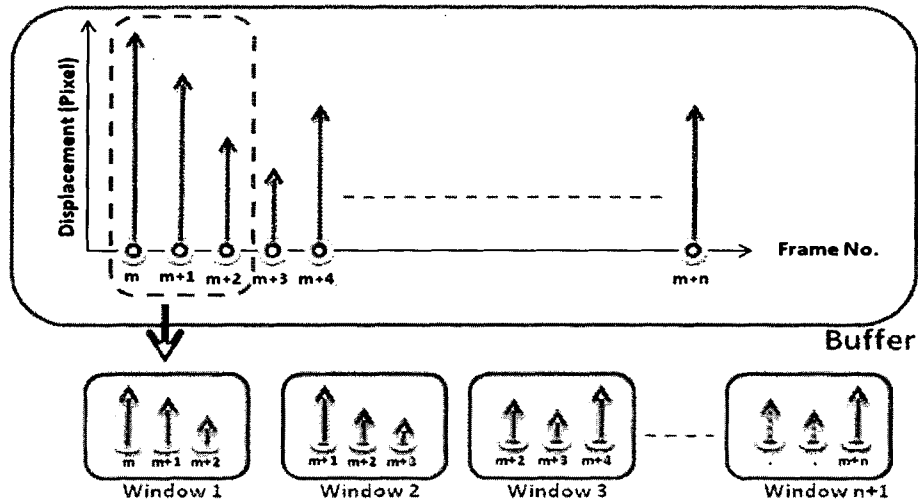


Figure 4

10

13

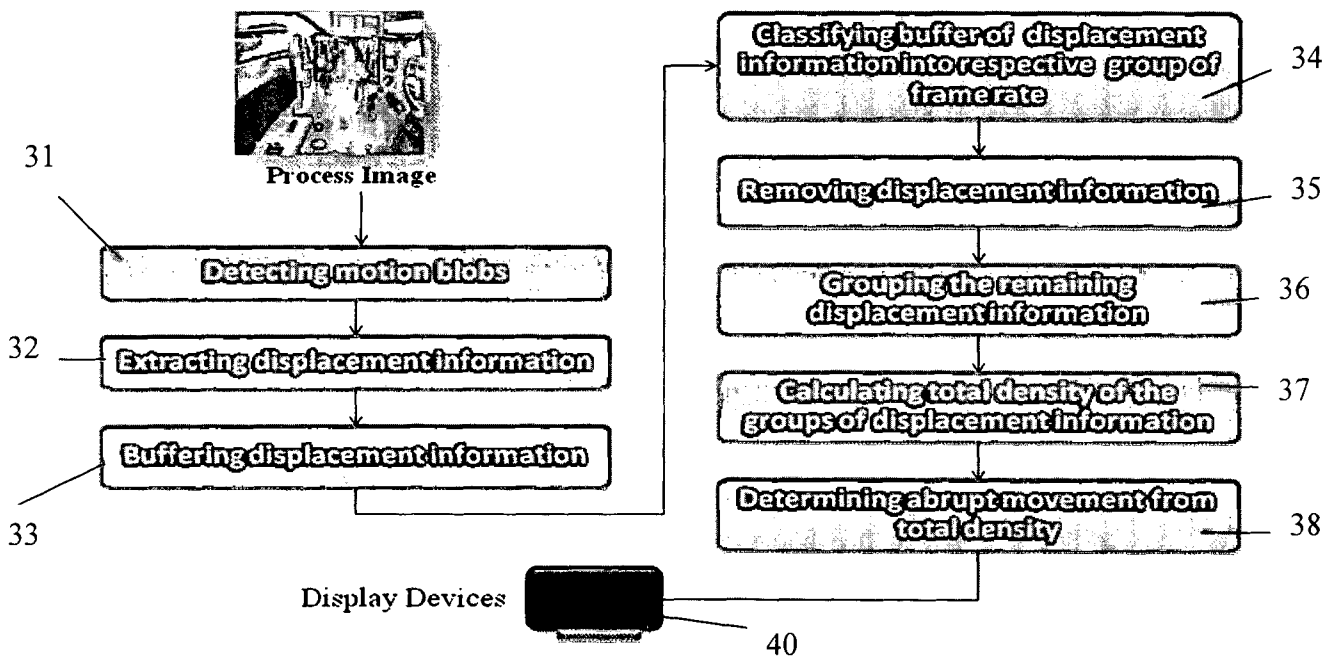


Figure 5

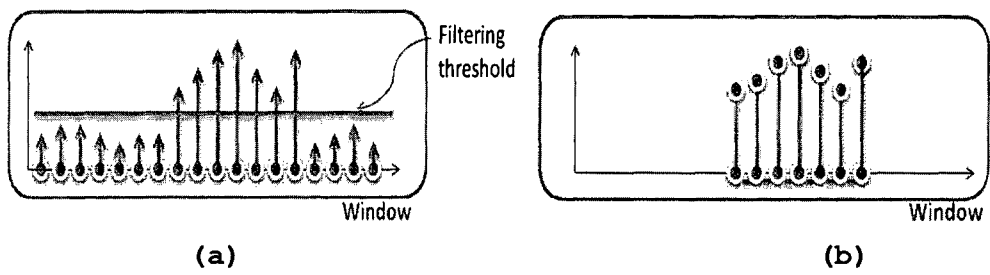


Figure 6

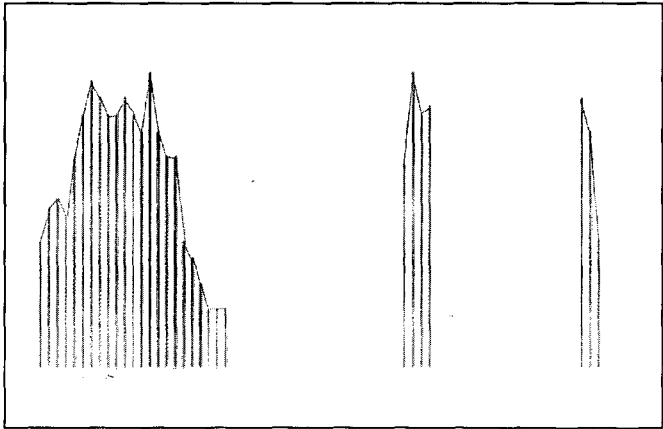


Figure 7

INTERNATIONAL SEARCH REPORT

International application No.

PCT/MY2012/000094

A. CLASSIFICATION OF SUBJECT MATTER

G06T 7/20 (2006.01) G08B 13/194 (2006.01) G08B 5/00 (2006.01)

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)

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)
 Google Patents, Google Scholar, freepatentsonline, espacenet, WPI, EPODOC (terms searched: detect, abrupt, motion, image, video, frame, rate, threshold, classify and the like terms)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Documents are listed in the continuation of Box C.	



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	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"E" earlier application or patent but published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family
"P" document published prior to the international filing date but later than the priority date claimed	

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INTERNATIONAL SEARCH REPORT		International application No.
C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		PCT/MY2012/000094
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2007/0104462 A1 (SAITO et al.) 10 May 2007 abstract, paragraphs [0020] - [0038], [0064], [0103], [0110] - [0113]	1 - 14
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A	US 5,311,306 A (TANAKA et al.) 10 May 1994 abstract, column 3 lines 1 - 46	1 - 14

Form PCT/ISA/210 (fifth sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/MY2012/000094

This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document/s Cited in Search Report		Patent Family Member/s	
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End of Annex

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