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(54) Title: A SYSTEM AND METHOD FOR EXTRACTING OBJECTS FROM INTERLACED IMAGES

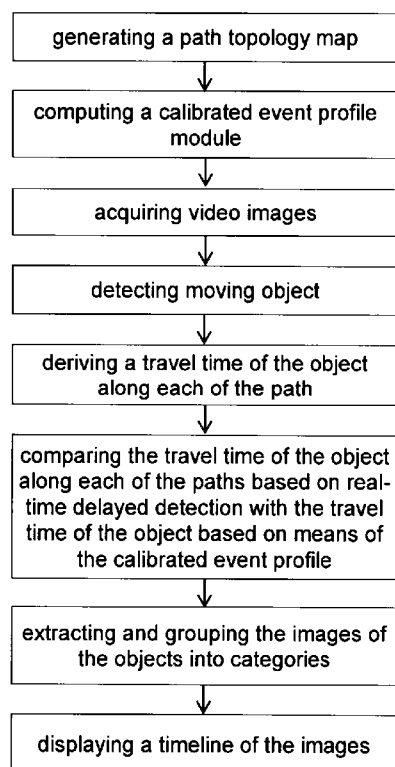


Figure 1

(57) Abstract: The present invention relates to a system and method for extracting objects from interlaced images, wherein the system and method generates a path topology map and computes a calibrated event profile module to identify similar objects moving sequentially in the same direction along the same path and similar objects moving sequentially in different directions along the same path in interlaced images. Most illustrative drawing: Figure



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A SYSTEM AND METHOD FOR EXTRACTING OBJECTS FROM INTERLACED IMAGES

TECHNICAL FIELD OF THE INVENTION

- 5 This invention is related to the field of processing of multiplexed images and more particularly a system and method for extracting objects from interlaced images.

BACKGROUND OF THE INVENTION

- 10 A huge number of apparatuses, methods and systems have been used to capture and identify motor vehicles in flowing traffic. These apparatuses, methods and systems are crucial tools for traffic management and enforcement teams to monitor traffic flow and to enforce the law of traffic to infringers. Most of these apparatuses, methods and systems capture images of the motor vehicles
15 using cameras and sensors, and identify the motor vehicles based on their external or physical features, for instance, license plates of the motor vehicles.

- However, a number of problems have been identified and researchers have been actively involved in solving the problems and improving the apparatuses,
20 methods and systems in order to manage traffic flow in a better manner.

- Due to cognitive overload and short attention span of users, conventional apparatuses, methods and systems are unable to identify vehicles with similar physical features from multiplexed snapshots or images. Conventionally,
25 physical features such as the motor vehicles' dominant colours or license plate contents are used as matching reference to identify motor vehicles or similar motor vehicles. However, the problem of identifying and extracting wrong motor vehicle may occur due to factors such as poor lighting condition, which deters the motor vehicles' colour extraction process, and noise and glare in the
30 distorted license plate images of the motor vehicles captured.

US 20130050492 A1 describes a method and apparatus for identifying motor vehicles for monitoring traffic. The prior art analyses and determines a motor vehicle from the size ratios of a license-plate contour in a distorted image. US 6240217 B1 describes a method for processing digital image information including pixel intensity information that selectively modifies pixel intensity information in order to improve legibility or visibility of parts of a digital image. Both of these prior arts emphasizes on the analysis of images based on the digital information obtained from the captured image but the prior arts did not address the issue of identifying vehicles with similar physical features from multiplexed snapshots or images. Also, the prior arts did not address the issue of analyzing motor vehicles that may be present in interlaced images.

Therefore, it is an aim of this present invention to address the aforesaid technical disadvantages by introducing a system and method for extracting objects from interlaced images that is capable of identifying similar motor vehicles moving sequentially in the same direction along the same path and similar motor vehicles moving sequentially in different directions along the same path by grouping and categorizing similar motor vehicles for analysis of the interlaced images.

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SUMMARY OF THE PRESENT INVENTION

The present invention relates to a system and method for extracting objects from interlaced images. The system as disclosed in one of the embodiment of the present invention comprises a video image acquisition module that captures images of a moving object along a path of interest using optical sensors a moving object detection module that differentiates movement of the object from a static background of the images captured a visualization display that shows the captured images of the object, which the system is characterized by a calibration data profiling module that represents connections of the optical sensors with each other and the paths to be taken by the object and derives the mean of the travel time of the object based on recorded event time of the object detected, and a delayed real-time detection module that calculates the time taken by the

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object to travel along the said path based on real-time delayed detection, and compares the said time with the mean of the travel time of the object based on the recorded event time of the object detected.

- 5 The method as disclosed in a further embodiment of the present invention comprises the steps of generating a path topology map to represent connections of optical sensors with each other, computing a calibrated event profile module to derive the mean of travel time of the object based on time records of the object detected, acquiring video images of the object moving along the paths, detecting moving object, deriving a travel time of the object along each of the path based on real-time delayed detection, comparing the travel time of the object along each of the paths based on real-time delayed detection with the travel time of the object based on means of the calibrated event profile, extracting and grouping the video images of the objects into categories for display, and displaying a timeline of the images of the object based on the categories.

It is an object of the present invention to provide a system and method that is capable of extracting objects or similar objects from interlaced images.

It is another object of the present invention to provide a system and method that is capable of extracting vehicle or similar vehicles from interlaced images.

It is a further object of the present invention to provide a system and method that is capable of extracting vehicle or similar vehicles passing along a path of interest from interlaced images.

It is still an object of the present invention to provide a system and method for monitoring movements of a vehicle or similar vehicles as part of traffic flow monitoring.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 illustrates the flow diagram of the method for extracting objects from interlaced images.

5 Figure 2 illustrates the flow diagram of the step of generating a path topology map.

Figure 3 illustrates the generation of a path topology map and a look-up table for the path topology map.

10 Figure 4 illustrates the flow diagram of the step of computing a calibrated event profile module.

Figure 5 illustrates the calibrated event profile for each path in the path topology map.

15 Figure 6 illustrates the calibrated travel time for each respective path in the path topology map.

Figure 7 illustrates the mean of calibrated travel time for each path.

20 Figure 8 illustrates the flow diagram of the step of acquiring video images of the object moving along the paths.

Figure 9 illustrates the extraction of video streams into frames.

25 Figure 10 illustrates the flow diagram of the step of detecting the presence of moving objects.

30 Figure 11 illustrates the scanning of the frames to differentiate a moving object from background image.

Figure 12 illustrates the flow diagram of the step of deriving the travel time of the object along each of the path based on real-time delayed detection.

Figure 13 illustrates the computation of the travel time of the moving object.

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Figure 14 illustrates the flow diagram of the step of comparing the travel time of the object.

Figure 15 illustrates the computation of the value of the difference in percentage (%) and the comparison of the value with the threshold having a range of $\pm 2.5\%$.

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Figure 16 illustrates the flow diagram of the step of extracting and grouping the images of the objects into categories for display.

Figure 17 illustrates the storing of images in display buffers.

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Figure 18 illustrates the flow diagram of the step of displaying the timeline of the images of the object based on the categories.

Figure 19 illustrates the display of the images in a timeline.

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DETAILED DESCRIPTION OF THE PRESENT INVENTION

The above mentioned and other features and objects of this invention will become more apparent and better understood by reference to the following detailed description. It should be understood that the detailed description made known below is not intended to be exhaustive or limit the invention to the precise form disclosed as the invention may assume various alternative forms. On the contrary, the detailed description covers all the relevant modifications and alterations made to the present invention, unless the claims expressly state otherwise.

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One of the embodiment of the present invention illustrates a system for extracting objects from interlaced images comprising of a video image acquisition module that captures images of a moving object along a path of interest using optical sensors a moving object detection module that
5 differentiates movement of the object from a static background of the images captured a visualization display that shows the captured images of the object, which is characterized by a calibration data profiling module that represents connections of the optical sensors with each other and the paths to be taken by the object and derives the mean of the travel time of the object based on
10 recorded event time of the object detected, and a delayed real-time detection module that calculates the time taken by the object to travel along the said path based on real-time delayed detection, and compares the said time with the mean of the travel time of the object based on the recorded event time of the object detected.

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According to the embodiment, the calibration data profiling module generates a path topology map to represent the connections of the optical sensors with each other and the paths to be taken by the object. It is disclosed in the present embodiment of the present invention that the mean of travel time is changeable
20 to any time period of the day and week.

A further embodiment of the present invention illustrates a method for extracting objects from interlaced images comprising the steps of generating a path topology map to represent connections of optical sensors with each other,
25 computing a calibrated event profile module to derive the mean of travel time of the object based on time records of the object detected, acquiring video images of the object moving along the paths, detecting moving object, deriving a travel time of the object along each of the path based on real-time delayed detection, comparing the travel time of the object along each of the paths based on real-
30 time delayed detection with the travel time of the object based on means of the calibrated event profile, extracting and grouping the video images of the objects into categories for display, and displaying a timeline of the images of the object

based on the categories. The categories mentioned herein are determined based on similarities of the images and the images are grouped into their respective categories based on the similarities that occur in the images. The steps described herein are illustrated in Figure 1.

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Further to the method disclosed herein, the step of generating the path topology map further comprises the steps of retrieving index numbers of the optical sensors and respective location of the optical sensors within the area of interest from a first database, setting a path to any two of the optical sensors that are connected to each other, generating a path topology map to represent the said paths, transforming the path topology map into a look-up table, and storing the path topology map and the look-up table. In one of the embodiments of the invention, the optical sensor is identified as *CamID*. If one of the optical sensor is named CamA and the other optical sensor is named CamB, the path is set with either CamA_CamB and CamB_CamA. The steps described herein are illustrated in Figure 2. The path topology map and look-up table are illustrated in Figure 3.

The second step of the method, which is the computation of the calibrated event profile module further comprising the steps of retrieving a period of time of the object's recorded timestamp for each optical sensor from a second database, searching for paths that are connected to the optical sensors from the path topology map, computing a travel time of the object for each path in a calibrated event profile module, calculating a mean of calibrated travel times for each path, and storing the mean calibrated travel time into a third database. During the retrieval of timestamp, all information related to the particular optical sensor is also retrieved. From the path topology map, the paths that are connected to the particular optical sensor is determined when the path of *CamA_CamB* shows TRUE or the path of *CamB_CamA* shows TRUE. Figure 5 illustrates the calibrated event profile for each path in the path topology map and Figure 6 illustrates the calibrated travel time for each respective path in the path topology map. In a preferred embodiment of the invention, the calibration method is

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carried with constraints such that the object's speed is within a speed limit, the object is not allowed to stop midway of the path, the rear part of the object is not allowed to overtake the front part of the object along the path, and the path is a single lane path. Upon computing a travel time for each path, the computation
5 switches to a subsequent optical sensor having the object's timestamp. If the subsequent optical sensor does not have any timestamp, the computation proceeds with the calculation of the mean of calibrated travel times for each path. Figure 7 illustrates the mean of calibrated travel time for each path. Before storing the mean of calibrated travel times for each path, the computation also
10 determines if a subsequent path exists. If the subsequent path exists, the steps of retrieving timestamps and information of the optical sensors and the following steps are repeated until no subsequent path exists. The steps described herein are illustrated in Figure 4.

15 Subsequently, video images are acquired and the step of acquiring the video images further comprises the steps of retrieving index numbers of the optical sensors and locations within the area of interest from a first database, determining video stream availability from the optical sensors, extracting the video streams into frames, and storing the frames into video buffers. Figure 8
20 illustrates the flow diagram of the steps described herein and Figure 9 illustrates the extraction of video streams into frames.

Thereafter, presence of moving objects is determined. The step of detecting the presence of moving objects further comprises the steps of retrieving frames from
25 video buffers according to the index numbers of the optical sensors, scanning the frames to differentiate a moving object from background image, extracting frames having the moving object together with a recorded timestamp and index number of the optical sensor, and updating the recorded timestamp and index number in a camera event timestamp buffer. However, if the current optical
30 sensor's index has been detected and recorded previously, the previous detected and recorded time with the last value is overwritten. The steps

described herein are illustrated in Figure 10 and the step of scanning the frames to differentiate a moving object from background image is illustrated in Figure 11.

The step of deriving the travel time of the object along each of the path based on
5 real-time delayed detection further comprises the steps of retrieving an index
number and recorded timestamp of a first optical sensor that is connected to one
end of a path from a camera event timestamp buffer, retrieving an index number
and recorded timestamp a second optical sensor that is connected to the other
10 end of the said path from the camera event timestamp buffer, computing a
difference between the recorded timestamps from the first optical sensor and the
second optical sensor to obtain a travel time of the moving object, and storing
the travel time of the moving object into a fourth database. Figure 12 illustrates
the steps described herein and Figure 13 illustrates the computation of the travel
time of the moving object.

15 Then, the travel times of the object are compared by retrieving information of the
optical sensor where the moving object is detected, retrieving mean calibrated
travel time from a third database, retrieving travel time of the moving object
based on real-time delayed detection from a fourth database, computing
20 differences between the travel time obtained from real-time delayed detection
and the mean calibrated travel time to determine whether the object is the same
object or a different object, determining whether the computed difference has a
value that falls within a threshold, and determining validity of the value of the
difference. The value of the difference computed is in percentage (%) and the
25 value is compared with the threshold having a range of $\pm 2.5\%$. The validity of the
said value is determined based on whether the value falls within this range.
Figure 14 illustrates the steps described herein and Figure 15 illustrates the
computation of the value of the difference in percentage (%) and the comparison
of the value with the threshold having a range of $\pm 2.5\%$.

30 Next, the video images of the objects are extracted and grouped into similar
categories for display. The step of extracting and grouping video images of the

objects further comprises the steps of determining whether the same object is detected, obtaining information of the optical sensor, obtaining images of the detected object based on the real-time delayed detection using the recorded timestamp, determining whether category of the object exists, and storing the
5 information of the optical sensor and the images of the object into a first display buffer when the category of the object exists, wherein the information of the optical sensor and the images of the object is stored into a second display buffer when the category does not exists. Figure 16 illustrates the steps described herein and Figure 17 illustrates the storing of images in display buffers.

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Lastly, the step of displaying the timeline of the video images of the object based on the categories further comprises the steps of determining whether there is any update from display buffers, obtaining sequential images of the event detection and counter checking the sequential images with the information of the
15 recorded time for the arrangement of the images in the order of time, sending the images to a display monitor, determining whether a display buffer is generated, and repeating the step of obtaining and counter checking of the sequential images and sending the images to the display monitor. The arrangement of the images is in the order of time forming a timeline and the timeline is arranged in
20 sequence and categories of the images. Figure 18 illustrates the steps described herein and Figure 19 illustrates the display of the images in a timeline.

Further embodiment of the present invention discloses that the object as described is a vehicle, which the system and method may be used for detecting
25 a vehicle or similar vehicles in interlaced images.

The invention described herein is susceptible to variations, modifications and/or additions other than those specifically described and it is to be understood that the invention includes all such variations, modifications and/or additions which
30 fall within the scope of the following claims.

CLAIMS

1. A system for extracting objects from interlaced images comprising of:
 - a video image acquisition module that captures images of a moving object along a path of interest using optical sensors;
 - 5 a moving object detection module that differentiates movement of the object from a static background of the images captured;
 - a visualization display that shows the captured images of the object;is characterized by
 - a calibration data profiling module that represents connections of the
 - 10 optical sensors with each other and the paths to be taken by the object and derives the mean of the travel time of the object based on recorded event time of the object detected; and
 - a delayed real-time detection module that calculates the time taken by the object to travel along the said path based on real-time delayed detection, and
 - 15 compares the said time with the mean of the travel time of the object based on the recorded event time of the object detected.
2. A system according to claim 1, wherein the calibration data profiling module generates a path topology map to represent the connections of the
- 20 optical sensors with each other and the paths to be taken by the object.
3. A method for extracting objects from interlaced images comprising the steps of:
 - generating a path topology map to represent connections of optical
 - 25 sensors with each other;
 - computing a calibrated event profile module to derive the mean of travel time of the object based on time records of the object detected;
 - acquiring video images of the object moving along the paths;
 - detecting moving object;
 - 30 deriving a travel time of the object along each of the path based on real-time delayed detection;

comparing the travel time of the object along each of the paths based on real-time delayed detection with the travel time of the object based on means of the calibrated event profile;

extracting and grouping the images of the objects into categories for display; and

displaying a timeline of the images of the object based on the categories.

4. The method according to claim 3, wherein the step of generating a path topology map further comprises the steps of:

10 retrieving index numbers of the optical sensors and respective location of the optical sensors within the area of interest from a first database;

setting a path to any two of the optical sensors that are connected to each other;

generating a path topology map to represent the said paths;

15 transforming the path topology map into a look-up table; and
storing the path topology map and the look-up table.

5. The method according to claim 3, wherein the step of computing a calibrated event profile module further comprising the steps of:

20 retrieving a period of time of the object's recorded event time for each optical sensor from a second database;

searching for paths that are connected to the optical sensors from the path topology map;

computing a travel time of the object for each path;

25 calculating a mean of calibrated travel times for each path; and

storing the mean calibrated travel time as a calibrated event profile into a third database.

6. The method according to claim 3, wherein the step of acquiring video
30 images further comprises the steps of:

retrieving index numbers of the optical sensors and locations within the area of interest from a first database;

determining video stream availability from the optical sensors;
extracting the video streams into frames; and
storing the frames into video buffers.

5 7. The method according to claim 3, wherein the step of detecting moving object further comprises the steps of:

retrieving frames from video buffers according to the index numbers of the optical sensors;

10 scanning the frames to differentiate a moving object from background image;

extracting frames having the moving object together with a recorded timestamp and index number of the optical sensor; and

updating the recorded timestamp and index number in a camera event timestamp buffer.

15

8. A method according to claim 3, wherein the step of deriving a travel time of the object along each of the path based on real-time delayed detection, further comprises the steps of:

20 retrieving an index number and recorded event time of a first optical sensor that is connected to one end of a path from a camera event timestamp buffer;

retrieving an index number and recorded event time a second optical sensor that is connected to the other end of the said path from the camera event timestamp buffer;

25 computing a difference between the recorded event times from the first optical sensor and the second optical sensor to obtain a travel time of the moving object; and

storing the travel time of the moving object into a fourth database.

30 9. The method according to claim 3, wherein the step of comparing the travel times of the moving object, further comprises the steps of:

retrieving information of the optical sensor where the moving object is detected;

retrieving mean calibrated travel time from a third database;

retrieving travel time of the moving object based on real-time delayed
5 detection from a fourth database;

computing differences between the travel time obtained from real-time delayed detection and the mean calibrated travel time to determine whether the object is the same object or a different object;

determining whether the computed difference has a value that falls within
10 a threshold; and

determining validity of the value of the difference.

10. A method according to claim 3, wherein the step of extracting and grouping the images of the objects into similar category for display, further
15 comprises the steps of:

determining whether the same object is detected;

obtaining information of the optical sensor;

obtaining images of the detected object based on the real-time delayed detection using the recorded event time;

20 determining whether category of the object exists; and

storing the information of the optical sensor and the images of the object into a first display buffer when the category of the object exists;

wherein the information of the optical sensor and the images of the object is stored into a second display buffer when the category does not exists.

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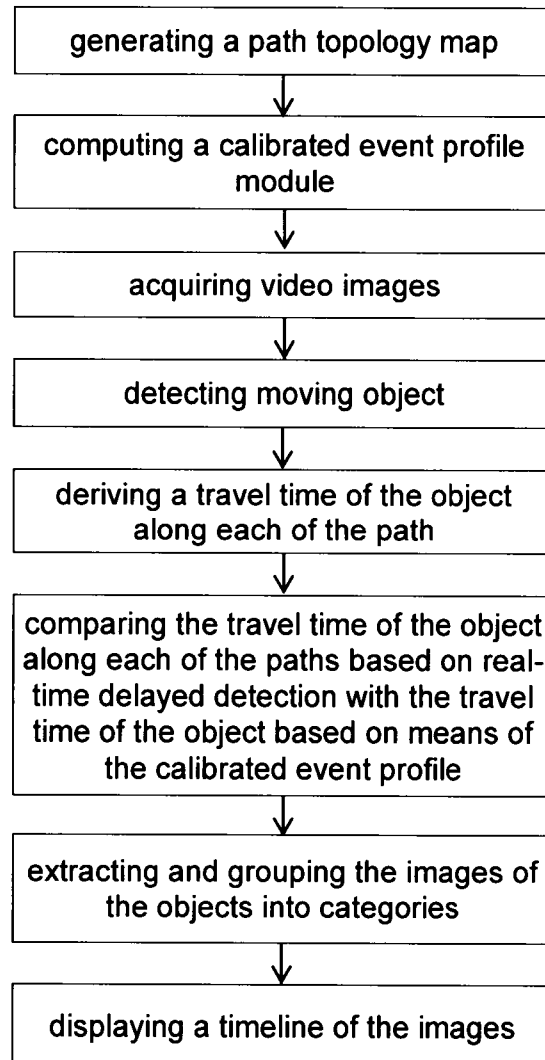
11. A method according to claim 3, wherein the step of displaying a timeline of the images of the object based on the categories further comprises the steps of:

determining whether there is any update from a first display buffer;

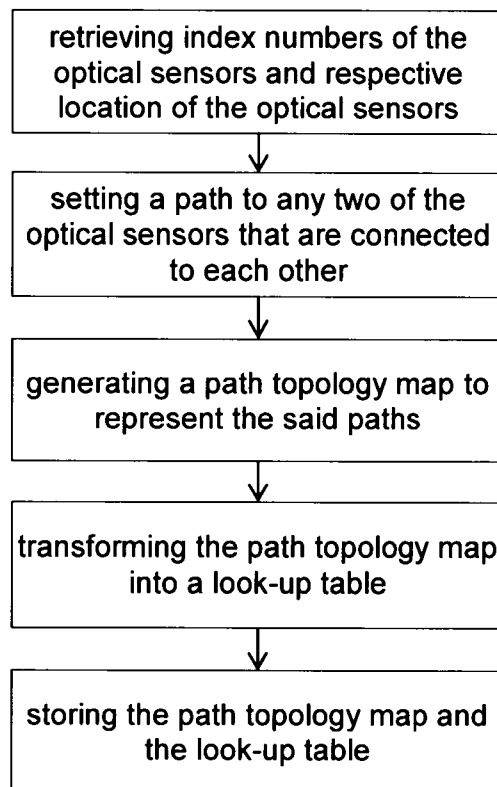
30 obtaining images of the event detection in sequence and counter checking the images with the information of the recorded time for the arrangement of the images in the order of time;

sending the images to a display monitor; and
determining whether a second display buffer is generated,
wherein the step of obtaining and counter checking of the images and
sending the images to the display monitor are repeated when a second display
5 buffer is generated.

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**Figure 1**

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**Figure 2**

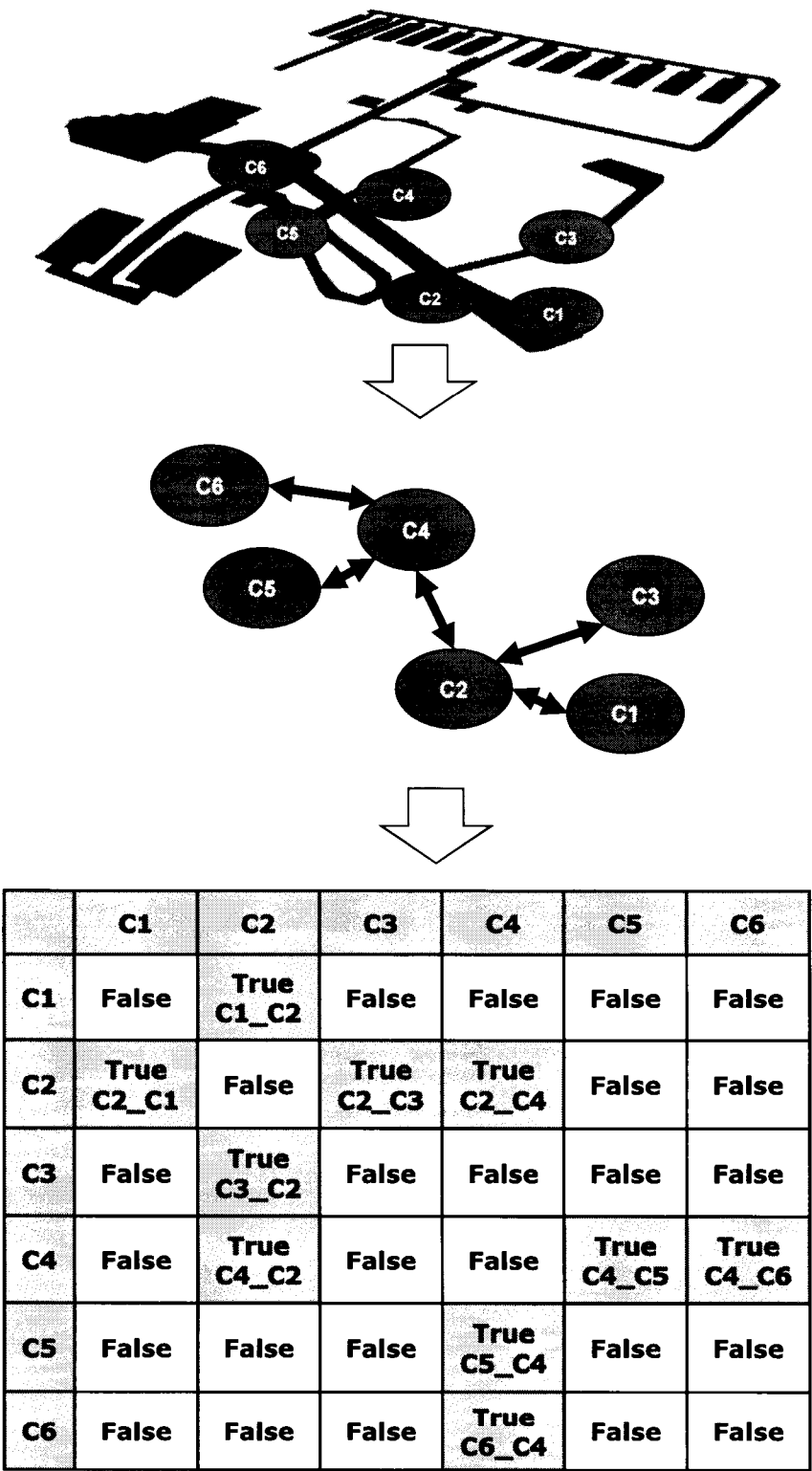


Figure 3

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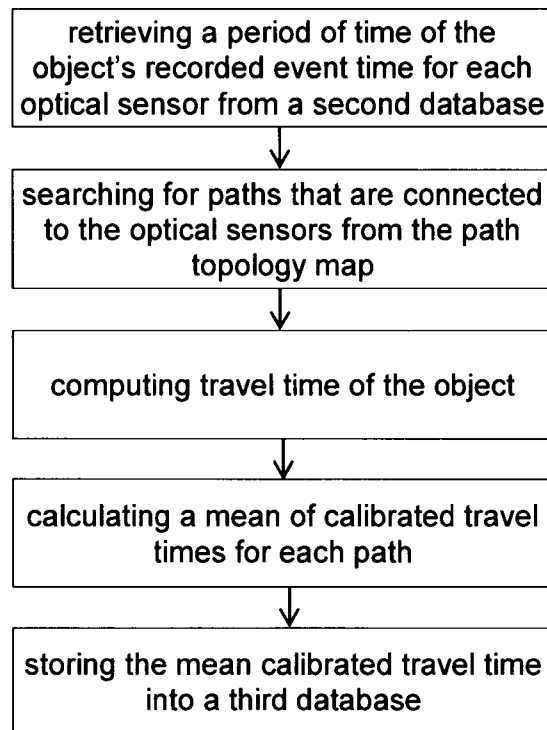


Figure 4

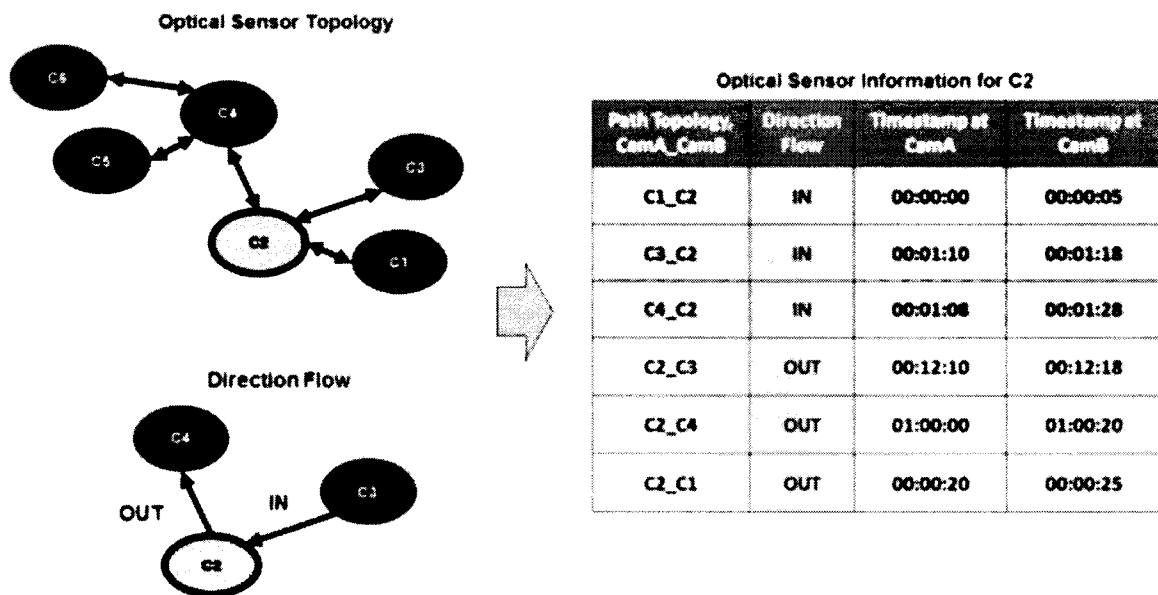


Figure 5

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Calibrated object travel time, T_c

Path Topology	Direction Flow	Timestamp at CamA	Timestamp at CamB	Travel time, T_c
C1_C2	IN	00:00:00	00:00:05	5
C3_C2	IN	00:01:10	00:01:18	8
C4_C2	IN	00:01:08	00:01:28	20
C2_C3	OUT	00:12:10	00:12:18	8
C2_C4	OUT	01:00:00	01:00:20	20
C2_C1	OUT	00:00:20	00:00:25	5

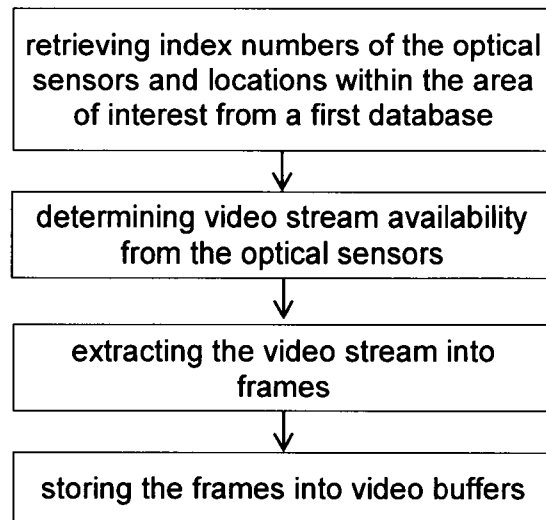
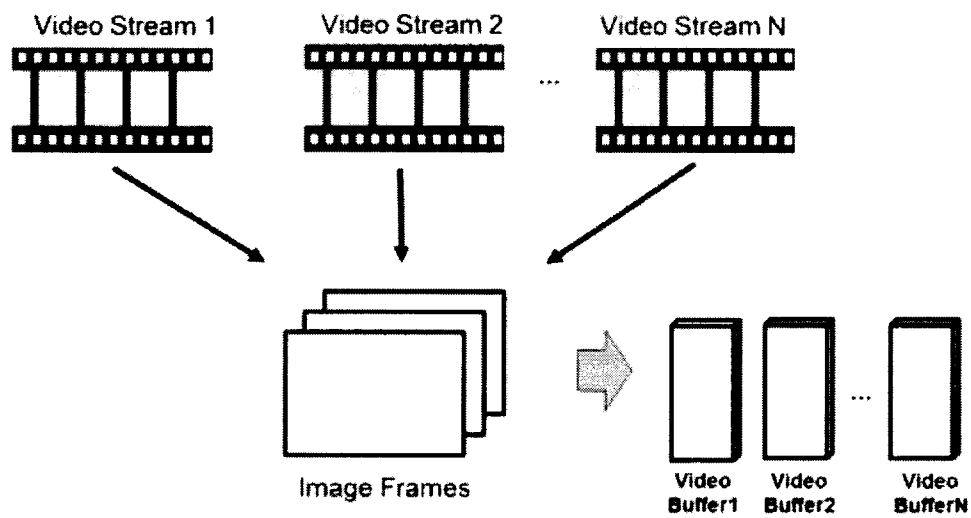
Figure 6

Mean Calibrated Object Travel Time, T_c'

No.	Path Topology	Travel time, T_c	Mean Travel time, T_c'
1	C1_C2	T_{c1}	$T_{c1}' = \sum T_{c1} / N$
2	C1_C2	T_{c2}	$T_{c2}' = \sum T_{c2} / N$
3	C1_C2	T_{c3}	$T_{c3}' = \sum T_{c3} / N$
4	C1_C2	T_{c4}	$T_{c4}' = \sum T_{c4} / N$
5	C1_C2	T_{c5}	$T_{c5}' = \sum T_{c5} / N$
N	C1_C2	T_{cN}	$T_{cN}' = \sum T_{cN} / N$

Figure 7

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**Figure 8****Figure 9**

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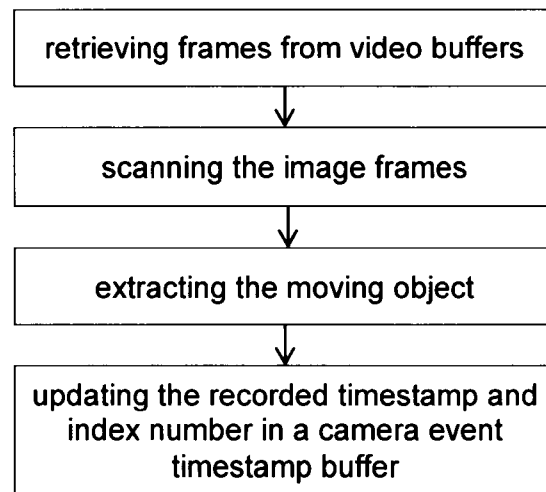


Figure 10

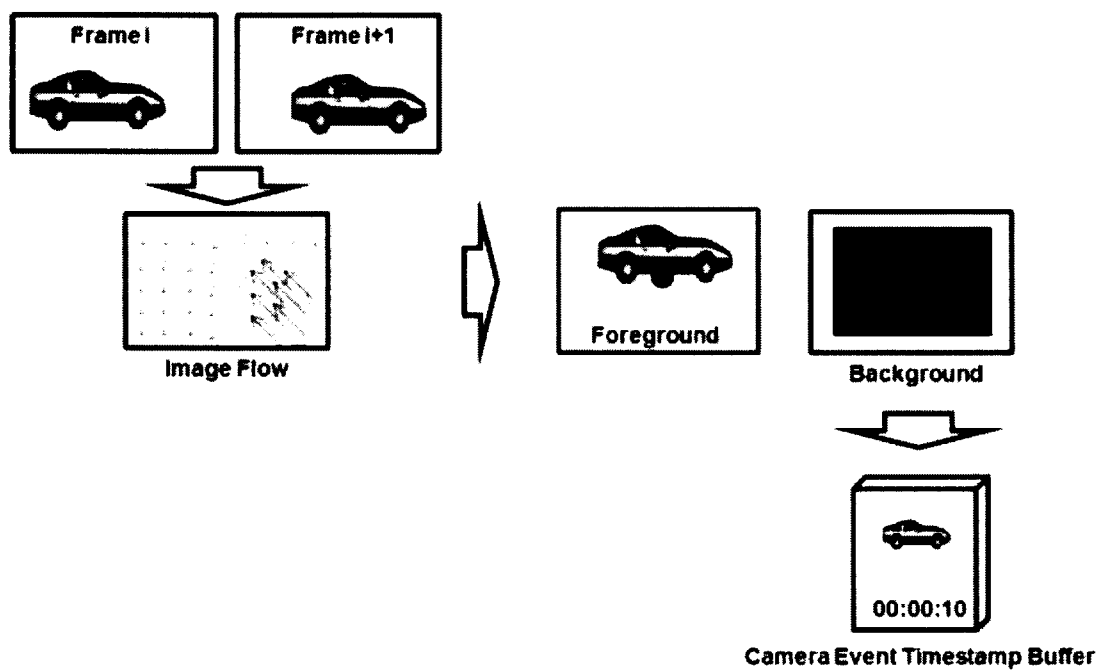


Figure 11

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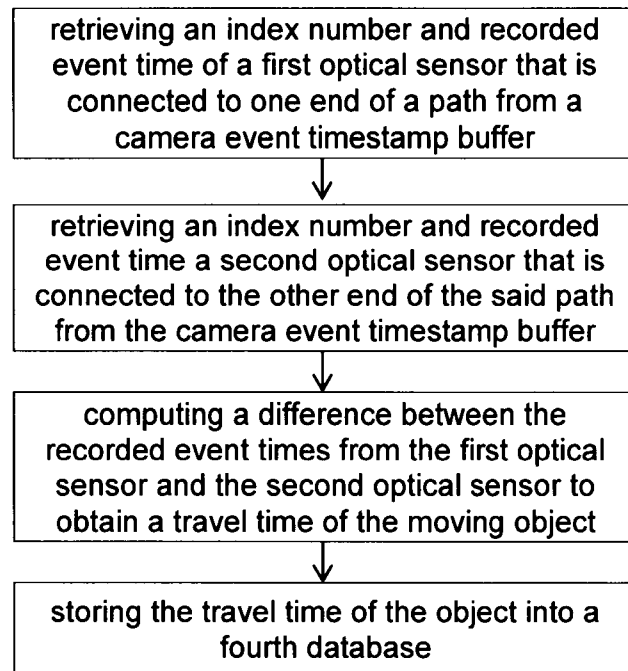


Figure 12

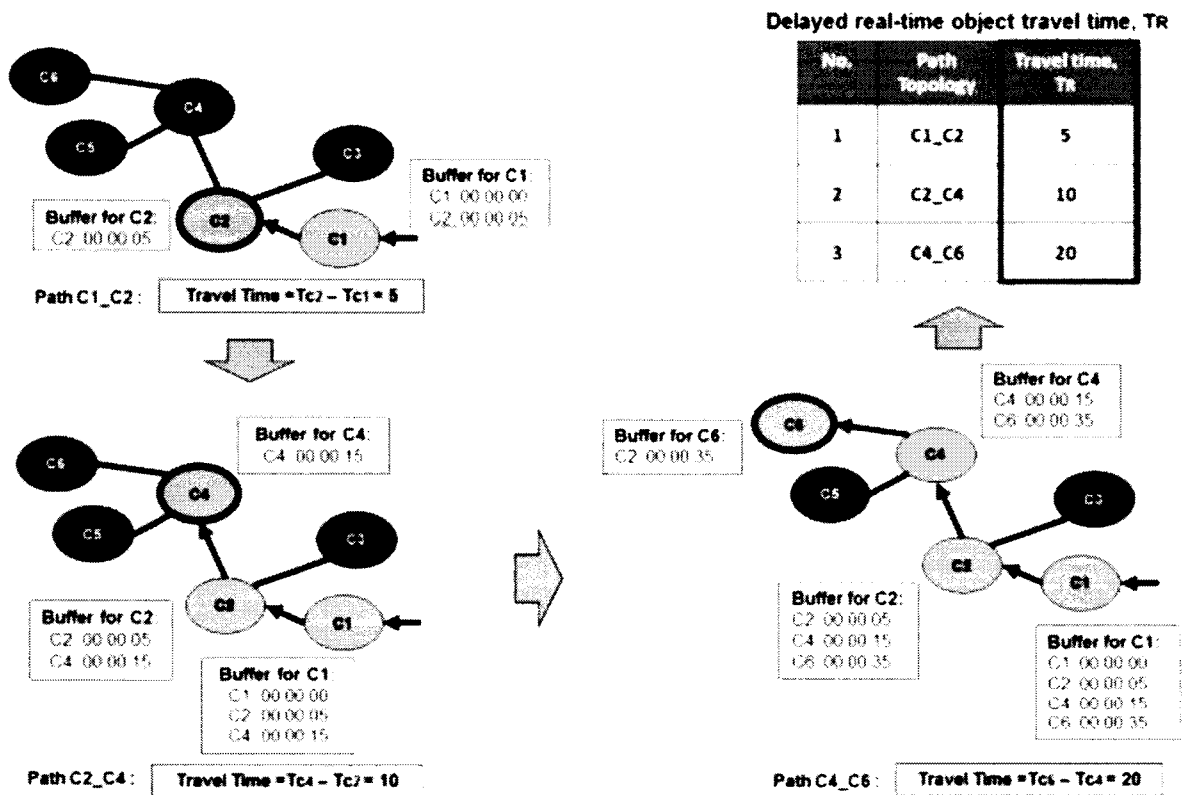


Figure 13

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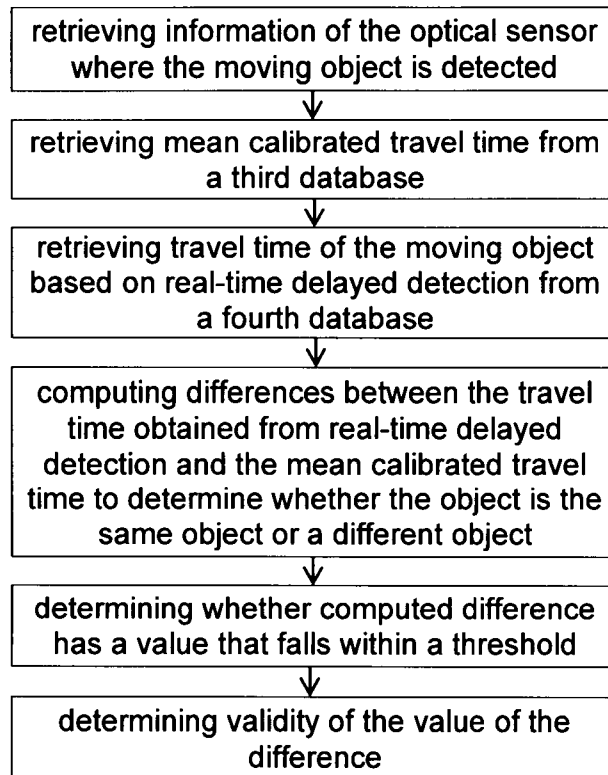


Figure 14

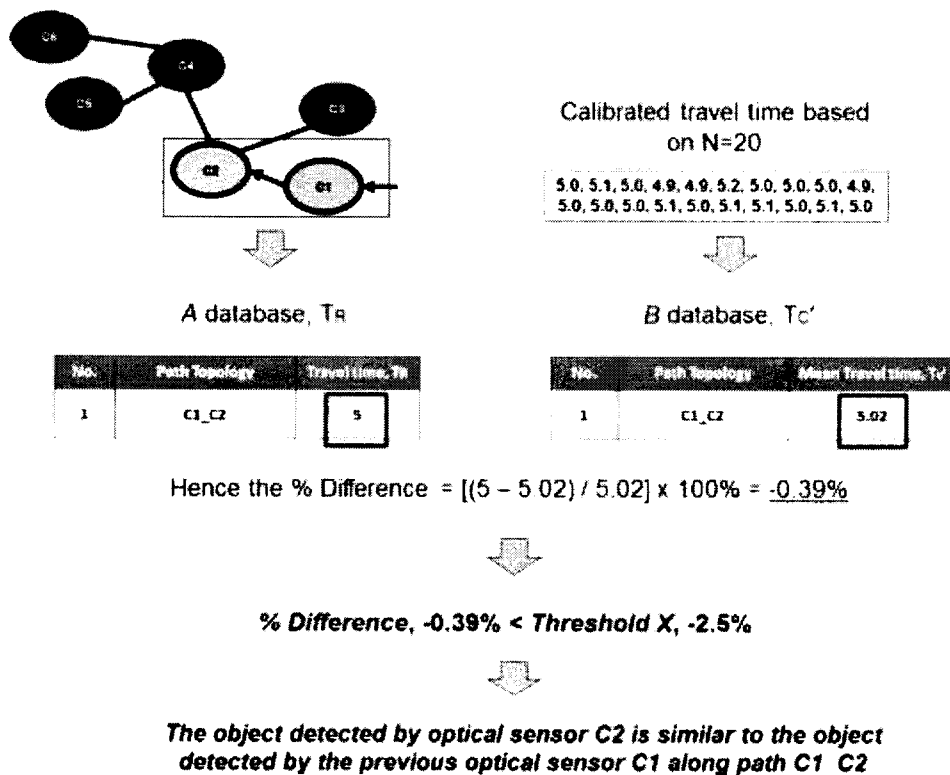


Figure 15

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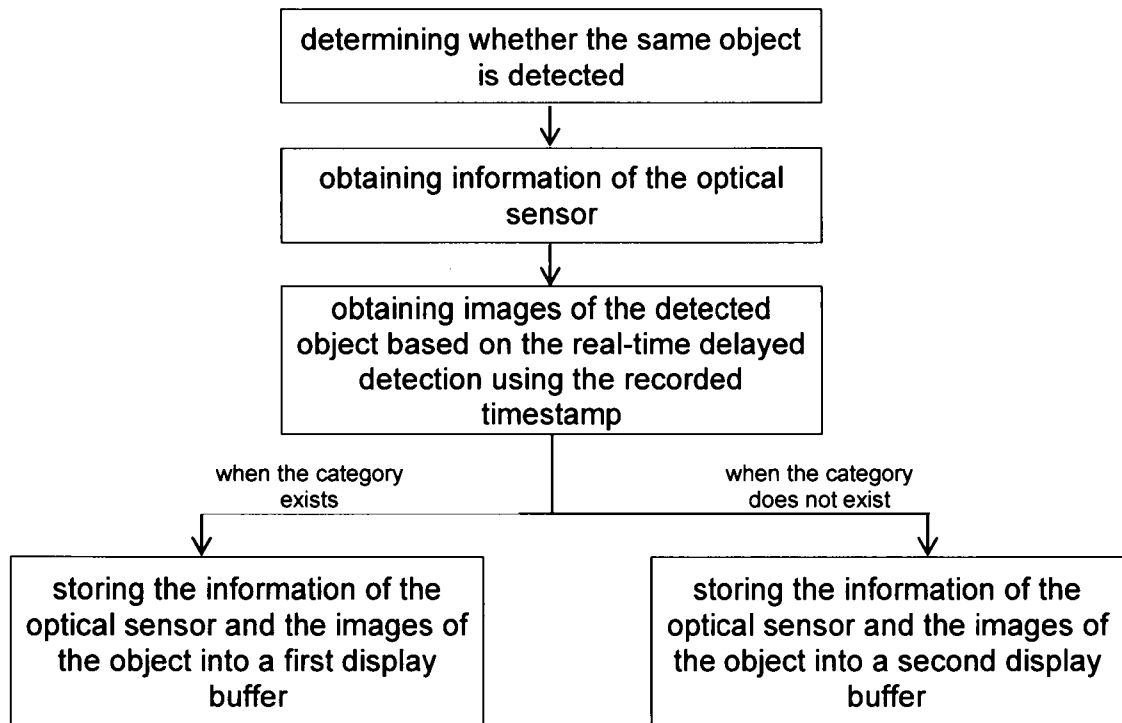


Figure 16

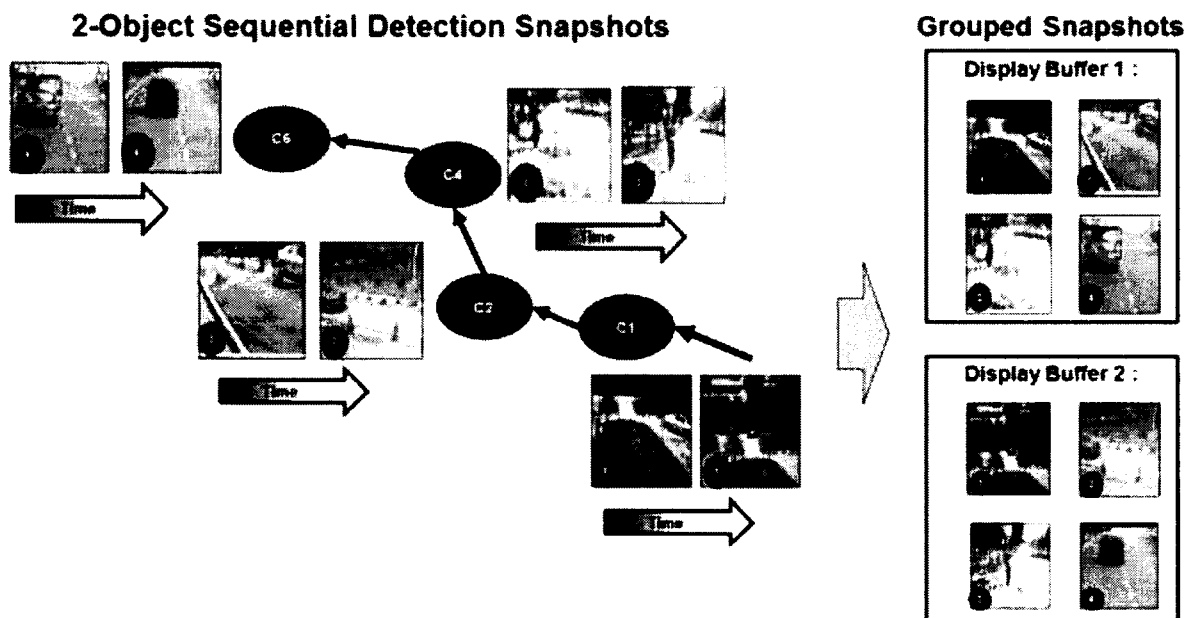
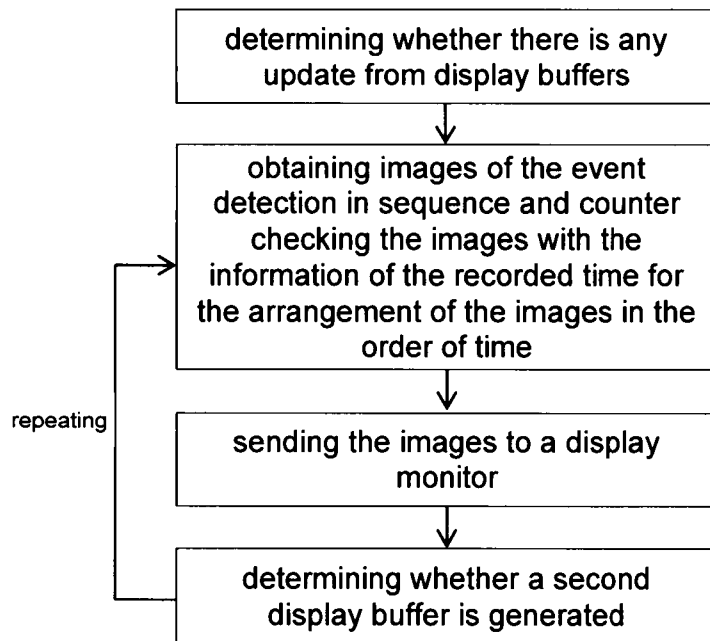
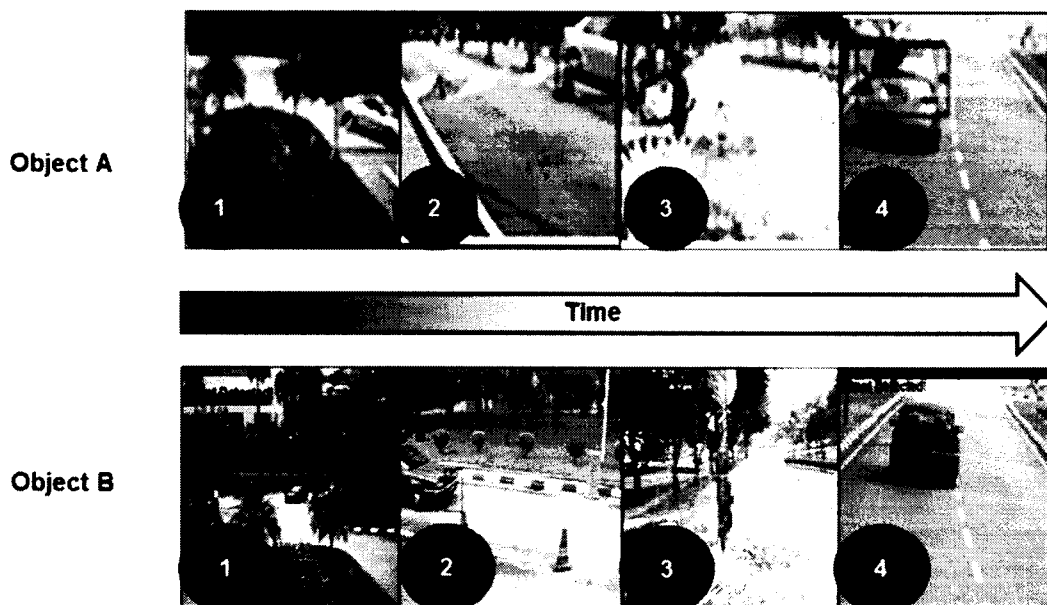


Figure 17

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**Figure 18****Figure 19**

INTERNATIONAL SEARCH REPORT

International application No
PCT/MY2014/000162A. CLASSIFICATION OF SUBJECT MATTER
INV. G06K9/00
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)
G06K

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)

EPO-Internal, PAJ, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	LILIANA LO PRESTI ET AL: "Path Modeling and Retrieval in Distributed Video Surveillance Databases", IEEE TRANSACTIONS ON MULTIMEDIA, IEEE SERVICE CENTER, PISCATAWAY, NJ, US, vol. 14, no. 2, 1 April 2012 (2012-04-01), pages 346-360, XP011436293, ISSN: 1520-9210, DOI: 10.1109/TMM.2011.2173323 sections I, III-VII figures 1-8 ----- -/--	1-11



Further documents are listed in the continuation of Box C.



See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed

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Date of the actual completion of the international search

4 December 2014

Date of mailing of the international search report

15/12/2014

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INTERNATIONAL SEARCH REPORT

International application No
PCT/MY2014/000162

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WANG XIAOGANG ED - CALDERARA SIMONE ET AL: "Intelligent multi-camera video surveillance: A review", PATTERN RECOGNITION LETTERS, vol. 34, no. 1, 20 July 2012 (2012-07-20), pages 3-19, XP028955937, ISSN: 0167-8655, DOI: 10.1016/J.PATREC.2012.07.005 sections 1-7; figures 1-9 -----	1-11
A	ELLIS T ET AL: "Active video-based surveillance system", IEEE SIGNAL PROCESSING MAGAZINE, IEEE SERVICE CENTER, PISCATAWAY, NJ, US, vol. 22, no. 2, 1 March 2005 (2005-03-01), pages 25-37, XP011128091, ISSN: 1053-5888, DOI: 10.1109/MSP.2005.1406473 page 26, right-hand column, line 5 - page 29, left-hand column, line 19; figures 1-5 page 31, left-hand column, line 24 - page 35, right-hand column, line 29; figures 1-9 -----	1-11
A	ZULAIKHA KADIM ET AL: "Video analytics algorithm for detecting objects crossing lines in specific direction using blob-based analysis", ADVANCES IN MOBILE COMPUTING & MULTIMEDIA, ACM, 2 PENN PLAZA, SUITE 701 NEW YORK NY 10121-0701 USA, 3 December 2012 (2012-12-03), pages 306-312, XP058029720, DOI: 10.1145/2428955.2429016 ISBN: 978-1-4503-1307-0 sections 2-3; figures 1-8 -----	1-11