



- (51) International Patent Classification:
G06K 9/00 (2006.01) *G06K 9/46* (2006.01)
- (21) International Application Number:
PCT/MY2011/000128
- (22) International Filing Date:
22 June 2011 (22.06.2011)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
PI 2010005729 2 December 2010 (02.12.2010) MY
- (71) Applicant (for all designated States except US): **MIMOS BERHAD** [MY/MY]; Technology Park Malaysia, 57000 Kuala Lumpur (MY).
- (72) Inventor; and
- (75) Inventor/Applicant (for US only): **LIANG, Kim Meng** [ID/MY]; c/o Mimos Berhad, Technology Park Malaysia, 57000 Kuala Lumpur (MY).
- (74) Agent: **YAP, Kah Hong**; Pyprus Sdn Bhd, Suite 8.02, 8th Floor, Plaza First Nationwide, 161 Jalan Tun H.S. Lee, 50000 Kuala Lumpur (MY).
- (81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ,

[Continued on next page]

(54) Title: METHOD AND SYSTEM FOR TRACKING OBJECT USING ADAPTIVE ATTENTION REGIONS

(57) Abstract: The present invention provides a method of tracking a target object in a scene, where the method is based on the use of the adaptive attention regions of the target object. The method does not use complete profile of the target object, saving computer power. More importantly, the method allows track the target object even when the target object has high similarity with the scene background and other objects in the scene. The present invention also provides a system of automatic tracking a target object in a scene.

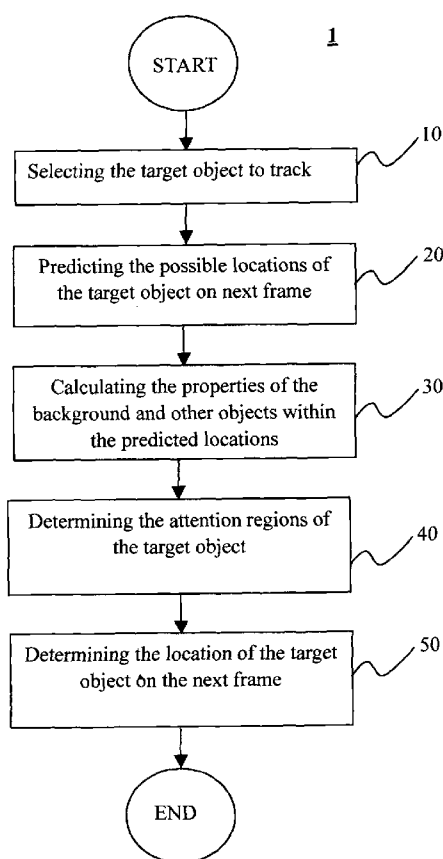


FIG 1



OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG,
SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ,
UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU,
LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK,
SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ,
GW, ML, MR, NE, SN, TD, TG).

(84) Designated States (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK,

Published:

— *with international search report (Art. 21(3))*

METHOD AND SYSTEM FOR TRACKING OBJECT USING ADAPTIVE ATTENTION REGIONS

Field of the Invention

5

[0001] The present invention generally relates to automatic object recognition and tracking technologies, and more particularly to a system and method for automatically tracking a target object based on adaptive attention regions of the target object.

10

Background of the Invention

[0002] Object tracking is an important part of video surveillance and video analysis systems, and is best described as an automatic process to assign to a target object appearing in a scene the same label from the beginning when the target object enters the scene until it leaves the scene, where the target object refers to any object that is to be tracked in the scene.

[0003] Current object tracking systems and methods are diverse. For example, US Patent No 7,684,592 discloses a real-time computer vision system tracks one or more objects moving in a scene using a target location technique which does not involve searching. The imaging hardware includes a color camera, frame grabber and processor. The software consists of the low-level image grabbing software and a tracking algorithm. The system tracks objects based on the color, motion and/or shape of the object in the image. A color matching function is used to compute three measures of the target's probable location based on the target color, shape and motion. The method then computes the most probable location of the target using a weighting technique. Once the system is running, a graphical user interface displays the live image from the color camera on the computer screen. The operator can then use the mouse to select a target for tracking. The system will then keep track of the moving target in the scene in real-time.

[0004] US patent application No 2009/0175500 A1 discloses an object tracking apparatus that tracks an object on image data captured continuously. The object tracking apparatus includes an object color adjusting unit and a particle filter processing unit. The object color adjusting unit calculates tendency of color change in regions on image data

30

and adjusts a color of the object set as an object color based on the tendency of color change to obtain a reference color. The particle filter processing unit estimates a region corresponding to the object on image data based on likelihood of each particle calculated by comparing a color around each particle with the reference color, using particles which
5 move on image data according to a predefined rule.

[0005] It is a still unsolved issue in object tracking where the properties of a target object in a scene have high similarity with the scene background or other objects in the scene. In this case, the known tracking algorithm that is mainly based on the complete profile of the target object to perform tracking will likely predict the wrong location for the
10 target object.

Summary of the Invention

[0006] One aspect of the present invention provides a method of tracking a target
15 object in a scene. In one embodiment, the method comprises selecting a target object that is to be tracked in a scene; predicting possible locations of the target object on next frame; calculating the properties of the background and other objects present at the predicted locations; determining the attention regions of the target object; and determining the tracked location of the target object on the next frame; whereby the method allows to track
20 the target object even when the target object has high similarity with the scene background and other objects in the scene.

[0007] In one embodiment of the method, the step of selecting a target object comprises identifying new motion blobs that are calculated by image differencing technique, where the target object is selected automatically.

25 **[0008]** In another embodiment of the method, the step of selecting a target object comprises manual selection via a graphic user interface (GUI).

[0009] In another embodiment of the method, the step of predicting the possible locations of the target object on next frame comprises using a prediction algorithm based on the history locations of the target object at the previous frames.

30 **[0010]** In another embodiment of the method, the step of calculating the properties of the background and other objects present at the predicted locations comprises predicting other objects in the predicted location where the target object is predicted on the next

frame; determining whether other objects are found in the predicted location; calculating the properties of the other objects at the predicted location, and storing the information of the properties of the other objects into the storage if the other objects are found (Yes) at the predicted location; and calculating the properties of the background at the predicted location regardless of whether other objects are found in the predicted location, and stored into the storage if no other object is found (No) at the predicted location. In a further embodiment of the method, the step of calculating the properties of the other objects at the predicted locations further comprises determining the regions of the other objects that do not overlap with each other at the predicted locations; deciding if non-overlap regions are found; wherein if non-overlap regions are found (Yes), the properties of the non-overlap regions of the other objects are calculated as stored information; and wherein if non-overlap regions are not found (No), the size and bottom position of the overlapped other objects are determined; and identifying the regions that belong to the other objects that are bigger in size and lower in terms of bottom position.

[0011] In another embodiment of the method, the step of determining the attention regions of the target object comprises calculating the color shade properties of the target object; grouping the areas having almost similar color or with the difference of the median color below a predefined threshold together as a similar shade region; calculating the color shades of the overlap other objects and background at the predicted location; and calculating the matching score between each color shade properties of the target object and the color shade properties of the overlap other objects and background; thereby, if the calculated matching score is below the predefined threshold value, the respective color shade properties are extracted as attention regions. In a further embodiment of the method, the color shade properties are calculated based on clustering technique.

[0012] In another embodiment of the method, the tracked location is calculated using appearance modeling, motion modeling or searching methods.

[0013] Another aspect of the present invention provides a system for automatically tracking an object in one scene. In one embodiment, the system comprises a visual information module for acquiring and presenting visual images frame by frame; a microprocessor being electronically coupled with the visual information module; and a graphic user interface (GUI) being electronically coupled with the microprocessor.

[0014] The objectives and advantages of the invention will become apparent from the following detailed description of preferred embodiments thereof in connection with the accompanying drawings.

5

Brief Description of the Drawings

[0015] Preferred embodiments according to the present invention will now be described with reference to the Figures, in which like reference numerals denote like elements.

10 [0016] FIG 1 is a functional block flowchart that illustrates the method of tracking a target object in a scene in accordance with one embodiment of the present invention.

[0017] FIG 2 is a functional block flowchart that illustrates the calculation of the properties of the background and other objects within the predicted locations 30 in accordance with one embodiment of the present invention.

15 [0018] FIG 3 is a functional block flowchart that illustrates the operation of the calculation of the properties of the other objects at the predicted location 33 in accordance with one embodiment of the present invention.

[0019] FIG 4 shows the illustration of calculating the properties of the other objects at the predicted locations.

20 [0020] FIG 5 is a functional block flowchart that illustrates the operation of determining the attention regions of the target object 40 in accordance with one embodiment of the present invention.

[0021] FIG 6 shows a graph illustrating the output of the clustering technique to obtain color shade in accordance with one embodiment of the present invention.

25 [0022] FIG 7 is an exemplary functional block diagram of the system in accordance with one embodiment of the present invention.

Detailed Description of the Invention

30 [0023] The present invention may be understood more readily by reference to the following detailed description of certain embodiments of the invention.

[0024] Throughout this application, where publications are referenced, the disclosures of these publications are hereby incorporated by reference, in their entireties, into this application in order to more fully describe the state of art to which this invention pertains.

5 [0025] One aspect of the present invention provides a method of tracking a target object in a scene that have high similarity with the scene background and other objects in the scene. Here, the target object is the one to be tracked in the scene; the other objects refer to the objects that move within the scene, likely interfering with the tracking of the target object. It is to be noted that the method and system of the present invention are not
10 limited to tracking one object at one time; instead, they are suitable for simultaneously tracking more than one object within the scene. For the sake of brevity, the description of the present invention uses one target object to illustrate the principles of the present invention.

[0026] The method is performed by an algorithm that is stored in a computer
15 executable medium, and the algorithm can be implemented in any computer system for surveillance and visual analysis. In principle, the method of the present invention for tracking a target object is based on the use of the adaptive attention regions of the target object. Briefly, the target object is divided into two more regions based on their color shade properties; then one or more of the regions are adaptively selected in light of the
20 background information and other objects within each frame of the scene; then the adaptively selected regions are used to track the target object within each frame. The selected regions for tracking are designated as attention regions; since the attention regions for each frame are adaptively selected, they are designated as adaptive attention regions throughout this application. Evidently, the method of the present invention does not use
25 the complete profile of a target object to perform the tracking of the target object; it is advantageous in consuming less computing power and more critically reducing or eliminating the tracking errors when the target object has high similarity with the background of or other objects in the scene.

[0027] Now referring to FIG 1, there is provided a functional block flowchart that
30 illustrates the method of tracking a target object in a scene in accordance with one embodiment of the present invention. As shown in FIG 1, after Start, the method of tracking a target object 1 first selects a target object that is to be tracked in a scene (target

object) **10**; then predicts the possible locations of the target object on next frame (predicted locations) **20**, each location within the next frame is referred to an area in which the target object might be present; then calculates the properties of the background and other objects at the predicted locations **30**; then determines the attention regions of the target object **40**;
5 and finally determines the location of the target object on the next frame (tracked location) **50**.

[0028] In one embodiment, the step **10** of selecting a target object is done automatically by for example identifying new motion blobs that are calculated by image differencing technique. In another embodiment, it is done by manual selection via a
10 graphic user interface (GUI). After the target object is selected, its basic properties are calculated and stored, where the basic properties include color shade, texture, edge information and shape.

[0029] In one embodiment, the step **20** of predicting the possible locations of the target object on next frame is done using for example a prediction algorithm based on the
15 history locations of the target object at the previous frames.

[0030] Now referring to FIG 2, there is provided a functional block flowchart that illustrates the calculation of the properties of the background and other objects within the predicted locations **30** in accordance with one embodiment of the present invention. As shown in FIG 2, the calculation of the properties of the background and other objects at the
20 predicted locations **30** first predicts other objects that likely move into the predicted location where the target object is predicted on the next frame **31**; then determines whether other objects are found in the predicted location **32**; if the other objects are found (Yes) at the predicted location, then calculates the properties of the other objects at the predicted location **33**, and stores the information of the properties of the other objects into the storage
25 **34**; if no other object is found (No) at the predicted location, the properties of the background at the predicted location are calculated regardless of whether other objects are found in the predicted location, and stored into the storage **35**.

[0031] Now referring to FIG 3, there is provided a functional block flowchart that illustrates the operation of the calculation of the properties of the other objects at the
30 predicted location **33** in accordance with one embodiment of the present invention. As shown in FIG 3, the regions of the other objects that do not overlap with each other at the predicted location are first determined **321**. At the decision step **322**, if non-overlap

regions are found (Yes), the properties of the non-overlap regions of the other objects are calculated as stored information 323; if non-overlap regions are not found (No), the size and bottom position of the overlapped other objects are determined 324. The regions that belong to the other objects that are bigger in size and lower in terms of bottom position are identified as stored information 325. FIG 4 shows the illustration of calculating the properties of the other objects at the predicted locations.

[0032] Now referring to FIG 5, there is provided a functional block flowchart that illustrates the operation of determining the attention regions of the target object 40 in accordance with one embodiment of the present invention. As shown in FIG 5, the color shade properties of the target object are first calculated 41. In one embodiment, the color shade properties are calculated based on clustering technique. The output of the clustering technique to obtain color shade is illustrated in FIG 6. The areas having almost similar color or with the difference of the median color below a predefined threshold are grouped together as a similar shade region. In the following step 42, the color shades of the overlap other objects and background at the predicted location are calculated. Next 43 is calculating the matching score between each color shade properties of the target object and the color shade properties of the overlap other objects and background. If the calculated matching score is below the predefined threshold value 44, the respective color shade properties are extracted as attention regions.

[0033] The tracked location of the target object on the next frame 50 is determined based on the extracted attention regions. In one embodiment, the tracked location is calculated using appearance modeling, motion modeling and searching methods.

[0034] Another aspect of the present invention provides a system for automatically tracking an object in one scene. As shown in FIG 7, the system 100 comprises a visual information module 110 for acquiring and presenting visual images frame by frame, a microprocessor 120 being electronically coupled with the visual information module 110, and a graphic user interface (GUI) 130 being electronically coupled with the microprocessor. The visual information module 110 may comprise a video camera for recording the images of the scene. The microprocessor 120 comprises a computer executable medium for embedding the programs of automatic tracking and performing the automatic tracking as described above. The GUI can be any screen for displaying the

images and results and receiving inputs from a user. The system **100** can be any device or apparatus for surveillance and visual analysis.

[0035] While the present invention has been described with reference to particular embodiments, it will be understood that the embodiments are illustrative and that the invention scope is not so limited. Alternative embodiments of the present invention will
5 become apparent to those having ordinary skill in the art to which the present invention pertains. Such alternate embodiments are considered to be encompassed within the scope of the present invention. Accordingly, the scope of the present invention is defined by the appended claims and is supported by the foregoing description.

CLAIMS

What is claimed is:

- 5 1. A method of tracking a target object in a scene, comprising:
 selecting a target object that is to be tracked in a scene;
 predicting possible locations of the target object on next frame;
 calculating the properties of the background and other objects present at the
 predicted locations;
10 determining the attention regions of the target object; and
 determining the tracked location of the target object on the next frame;
 whereby the method allows to track the target object even when the target object
 has high similarity with the scene background and other objects in the scene.
- 15 2. The method of claim 1, wherein the step of selecting a target object comprises
 identifying new motion blobs that are calculated by image differencing technique, where
 the target object is selected automatically.
3. The method of claim 1, wherein the step of selecting a target object comprises
20 manual selection via a graphic user interface (GUI).
4. The method of claim 1, wherein the step of predicting the possible locations of the
 target object on next frame comprises using a prediction algorithm based on the history
 locations of the target object at the previous frames.
- 25 5. The method of claim 1, wherein the step of calculating the properties of the
 background and other objects present at the predicted locations comprises:
 predicting other objects in the predicted location where the target object is predicted
 on the next frame;
30 determining whether other objects are found in the predicted location;

calculating the properties of the other objects at the predicted location, and storing the information of the properties of the other objects into the storage if the other objects are found (Yes) at the predicted location; and

5 calculating the properties of the background at the predicted location regardless of whether other objects are found in the predicted location, and stored into the storage if no other object is found (No) at the predicted location.

6. The method of claim 5, wherein the step of calculating the properties of the other objects at the predicted locations further comprises:

10 determining the regions of the other objects that do not overlap with each other at the predicted locations;

deciding if non-overlap regions are found; wherein if non-overlap regions are found (Yes), the properties of the non-overlap regions of the other objects are calculated as stored information; and wherein if non-overlap regions are not found (No), the size and bottom position of the overlapped other objects are determined; and

15 identifying the regions that belong to the other objects that are bigger in size and lower in terms of bottom position.

7. The method of claim 1, wherein the step of determining the attention regions of the target object comprises:

20 calculating the color shade properties of the target object;
grouping the areas having almost similar color or with the difference of the median color below a predefined threshold together as a similar shade region;

25 calculating the color shades of the overlap other objects and background at the predicted location; and

calculating the matching score between each color shade properties of the target object and the color shade properties of the overlap other objects and background;

thereby, if the calculated matching score is below the predefined threshold value, the respective color shade properties are extracted as attention regions.

30

8. The method of claim 7, wherein the color shade properties are calculated based on clustering technique.

9. The method of claim 1, wherein the tracked location is calculated using appearance modeling, motion modeling or searching methods.

- 5 10. A system for automatically tracking an object in one scene, said system comprising:
a visual information module for acquiring and presenting visual images frame by frame;
a microprocessor being electronically coupled with the visual information module;
and
10 a graphic user interface (GUI) being electronically coupled with the microprocessor;
wherein the microprocessor comprises a computer executable medium for embedding the programs of automatic tracking and performing the method of the automatic tracking of claim 1.

1/7

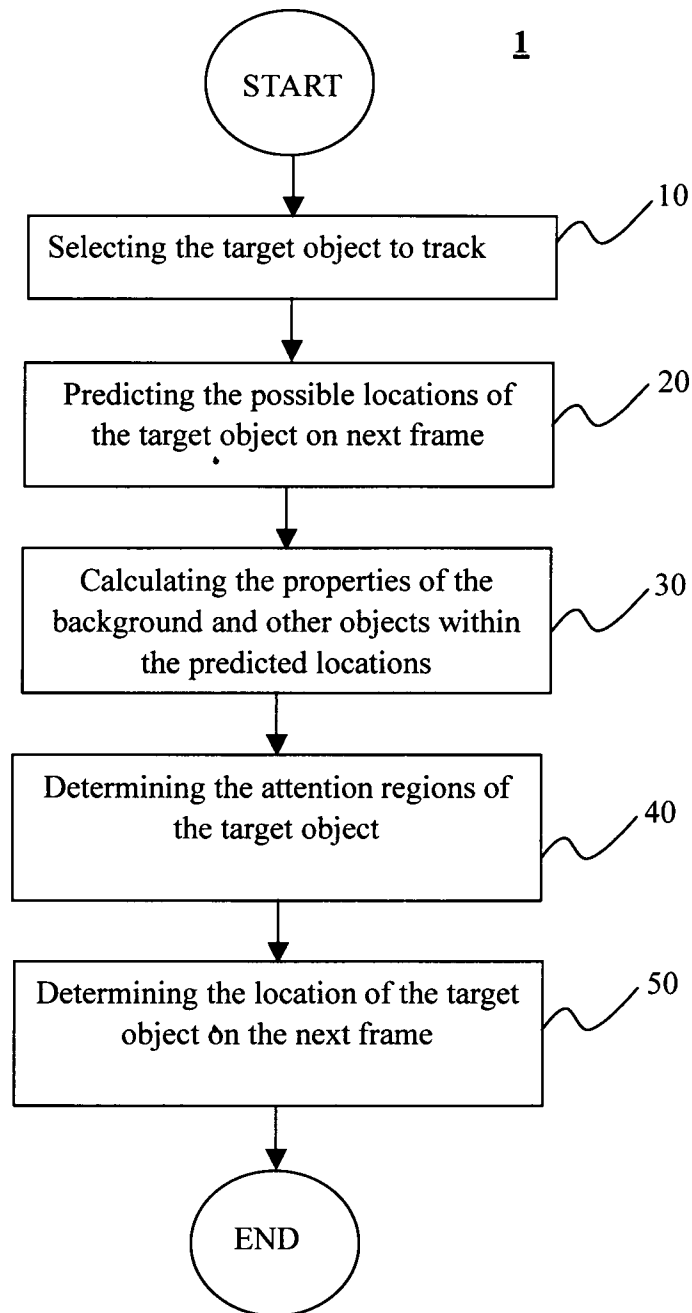
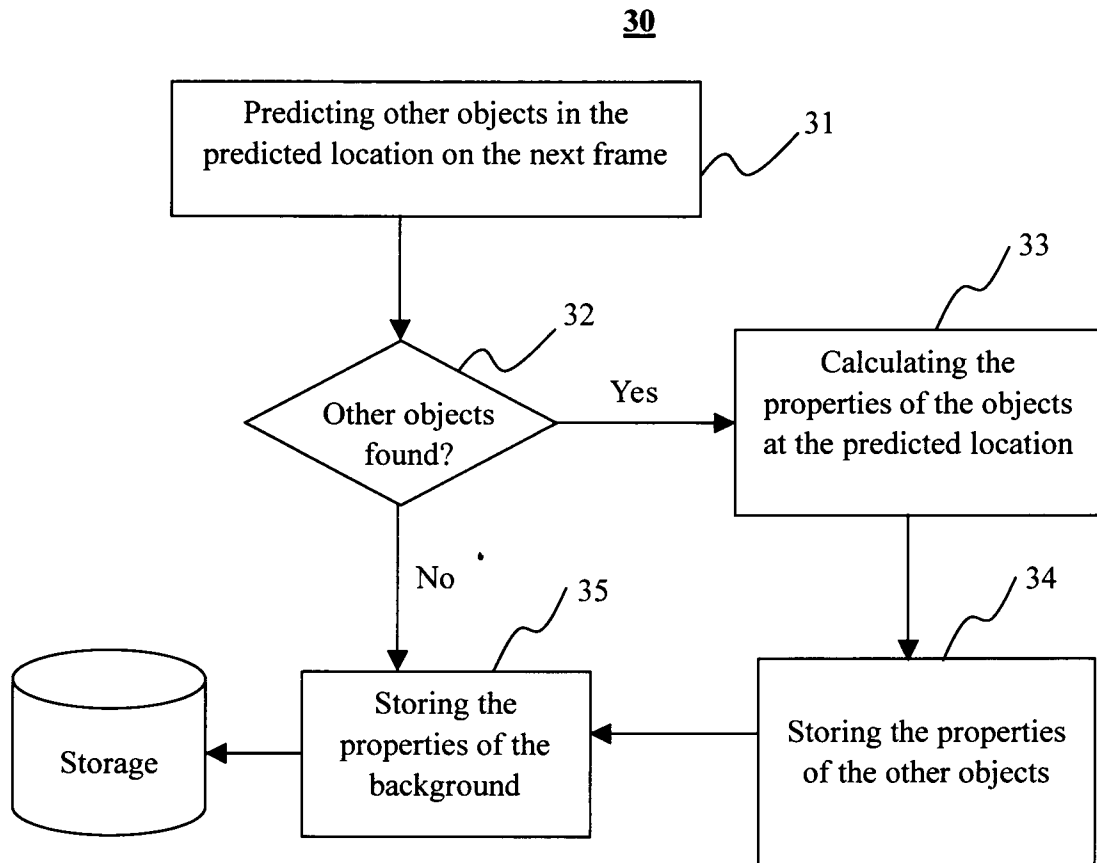
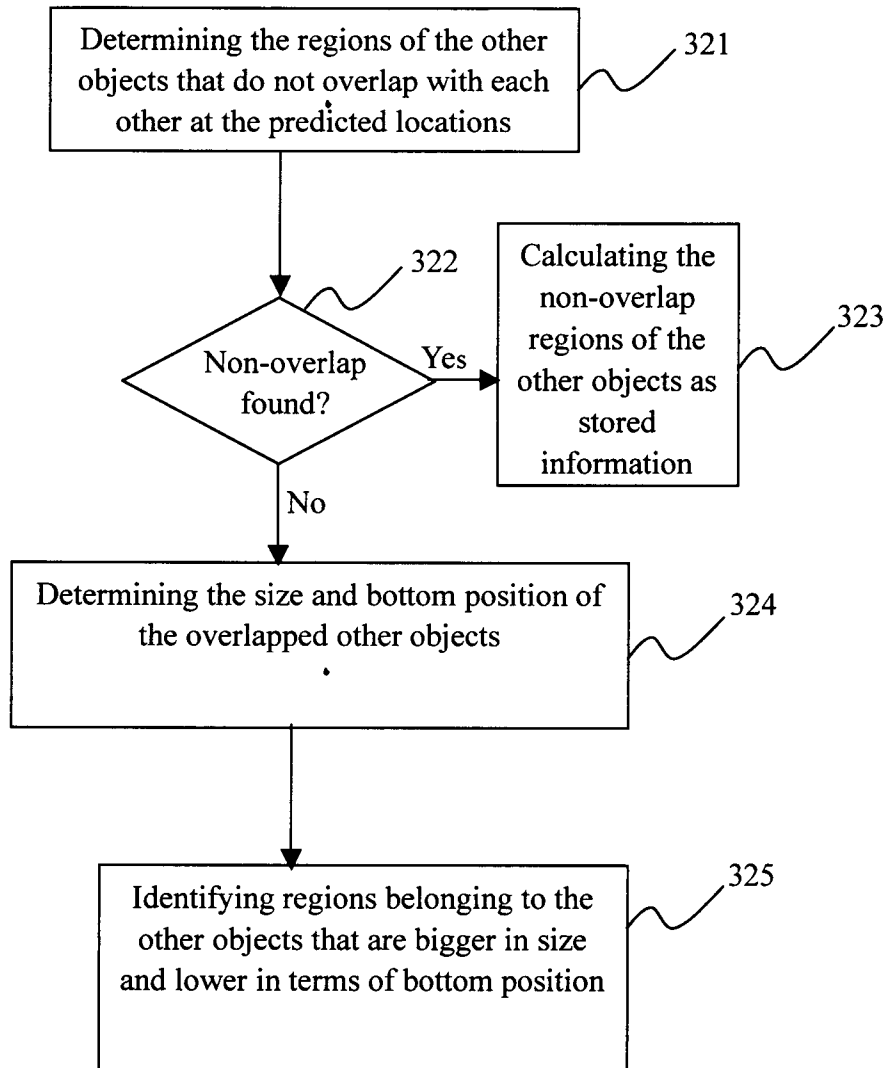


FIG 1

2/7

**FIG 2**

3/7

32**FIG 3**

4/7

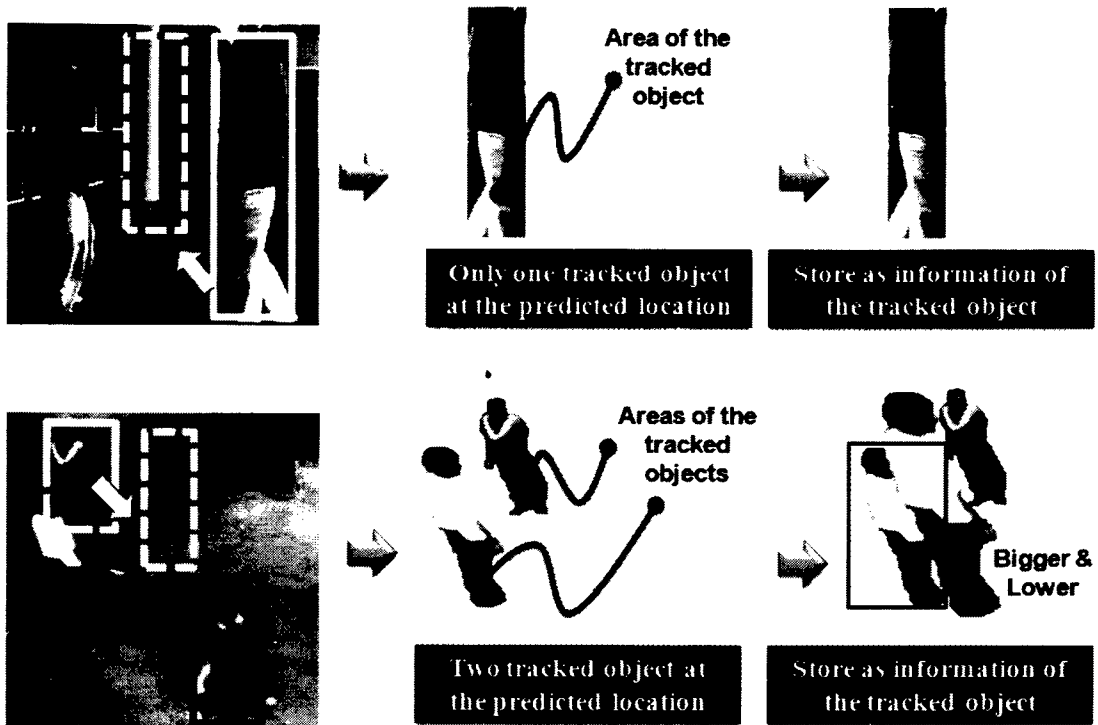


FIG 4

5/7

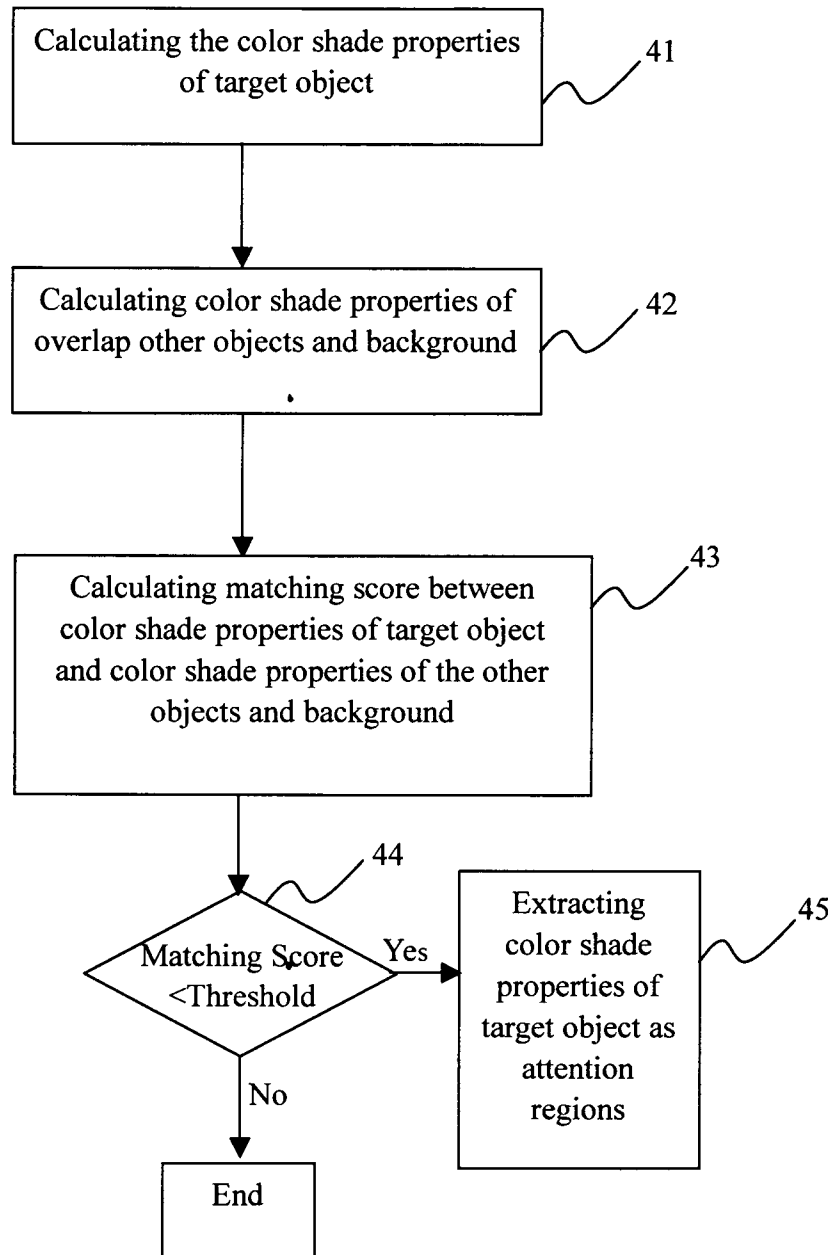
40

FIG 5

6/7

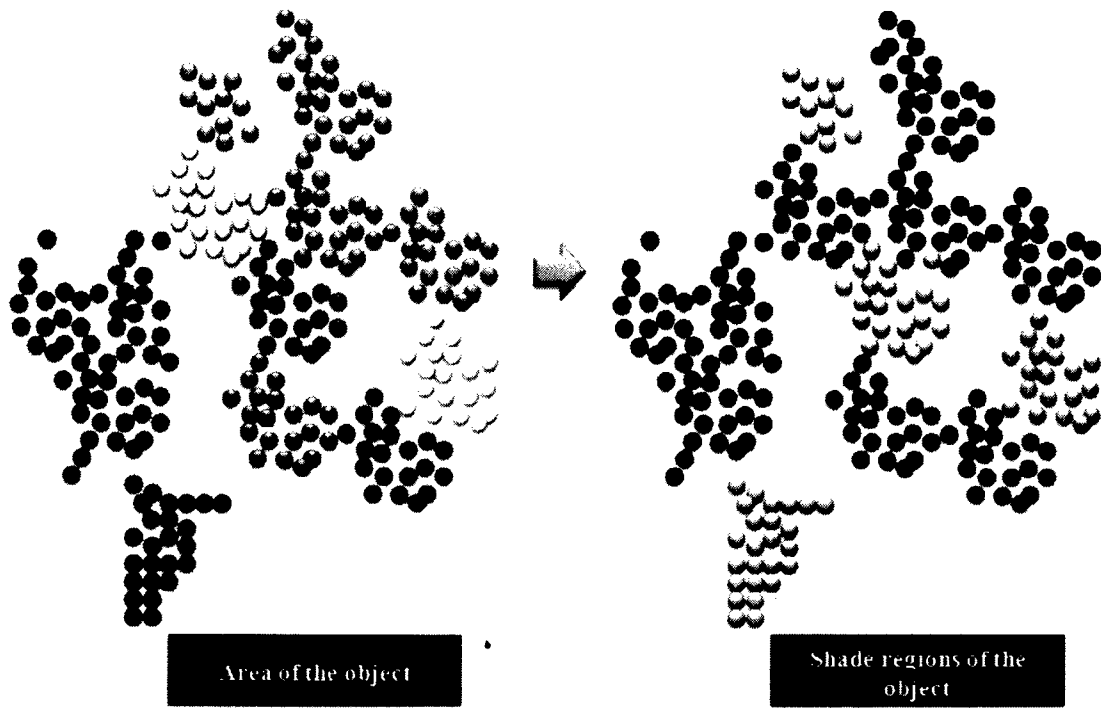
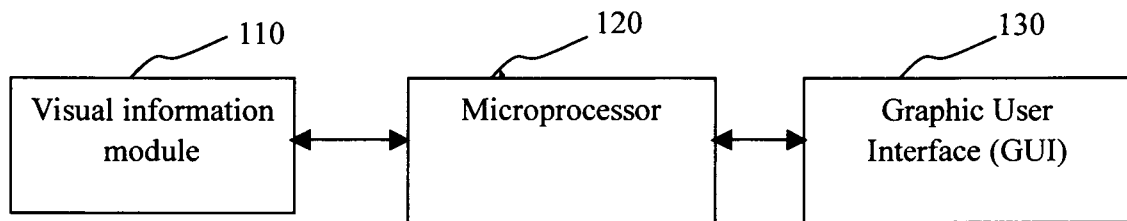


FIG 6

7/7

100**FIG 7**

INTERNATIONAL SEARCH REPORT

International application No.

PCT/MY2011/000128

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.

G06K 9/00 (2006.01)

G06K 9/46 (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)

WPI: target, object, image, pixel, location, position, predict, background and similar terms

Google Patents, Esp@ce: target, object, image, location, predict

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2006/0222205 A1 (PORIKLI et al.) 5 October 2006	
Y	Whole document in particular :Fig. 2; paragraphs [0029], [0043], [0067]; Claim 1	1, 2, 4, 9 3, 10
Y	US 7,684,592 B2 (PAUL et al.) 23 March 2010 Abstract, Fig. 1	3, 10



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		

Date of the actual completion of the international search
16 September 2011Date of mailing of the international search report
28/09/2011Name and mailing address of the ISA/AU
AUSTRALIAN PATENT OFFICE
PO BOX 200, WODEN ACT 2606, AUSTRALIA
E-mail address: pct@ipaaustralia.gov.au
Facsimile No. +61 2 6283 7999Authorized officer
JAMES WILLIAMS
AUSTRALIAN PATENT OFFICE
(ISO 9001 Quality Certified Service)
Telephone No : +61 2 6283 2599

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/MY2011/000128

This Annex lists the known "A" publication level 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 Cited in Search Report				Patent Family Member			
US	2006/222205	CN	101120382	EP	1836683	JP	2008535038
		US	7418113	WO	2006107055		
US	7684592	US	2003138130	US	6681031	US	2001024512
		US	6801637	US	2004161132	US	6950534
		US	7036094	US	2002126876	US	7050606
		US	2002037770	US	7121946	US	2006013440
		US	7460690	US	2009074248	US	7668340
		US	2009116692	US	2001008561	US	2005105772
		US	2006210112	US	2009274339	US	2007066393
		US	2007195997				
Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.							
END OF ANNEX							