PATENT COOPERATION TREATY

From the:
INTERNATIONAL SEARCHING AUTHORITY

To:

Ella Cheong Spruson & Ferguson (Singapore) Pte Ltd
P.O Box 1531
Robinson Road Post Office
Singapore 903031

PCT

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

	Date of mailing *(day/month/year)* 23 OCT 2008
Applicant's or agent's file reference 9900SG112MHK	**FOR FURTHER ACTION** See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/SG2008/000311	25 August 2008	24 August 2007

International Patent Classification (IPC) or both national classification and IPC
Int. Cl.

G06T 7/00 (2006.01) ***G08B 21/00*** (2006.01) ***G08G 5/06*** (2006.01)

Applicant

STRATECH SYSTEMS LIMITED et al

1. This opinion contains indications relating to the following items:

- [X] Box No. I Basis of the opinion
- [ ] Box No. II Priority
- [ ] Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- [ ] Box No. IV Lack of unity of invention
- [X] Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- [ ] Box No. VI Certain documents cited
- [ ] Box No. VII Certain defects in the international application
- [ ] Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

3. For further details, see notes to Form PCT/ISA/220.

Name and mailing address of the ISA	Date of completion of this opinion	Authorized Officer
AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. +61 2 6283 7999		**JYOTI SHAMDASANI** AUSTRALIAN PATENT OFFICE (ISO 9001 Quality Certified Service) Telephone No. 6283 2836

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.

PCT/SG2008/000311

Box No. I Basis of this opinion

1. With regard to the **language,** this opinion has been established on the basis of:

   [X] The international application in the language in which it was filed

   [ ] A translation of the international application into, , which is the language of a translation furnished for the purposes of international search (under Rules 12.3(a) and 23.1(b)).

2. [ ] This opinion has been established taking into account **the rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a))

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of:

   a. type of material

      [ ] a sequence listing

      [ ] table(s) related to the sequence listing

   b. format of material

      [ ] on paper

      [ ] in electronic form

   c. time of filing/furnishing

      [ ] contained in the international application as filed.

      [ ] filed together with the international application in electronic form.

      [ ] furnished subsequently to this Authority for the purposes of search.

4. [ ] In addition, in the case that more than one version or copy of a sequence listing and/or table(s) relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.

PCT/SG2008/000311

Box No. V **Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Statement

Novelty (N)	Claims		**YES**
	Claims	**1-32**	**NO**
Inventive step (IS)	Claims		**YES**
	Claims	**1-32**	**NO**
Industrial applicability (IA)	Claims	**1-32**	**YES**
	Claims		**NO**

2. Citations and explanations:

NOVELTY & INVENTIVE STEP:

1. US 2006/0098843
2. WO 2002055362

Claim 1 is considered to be not novel in light of the above documents each of which discloses all the features of the claimed invention. See D1 under Summary of invention which discloses "a system for detecting an object or abnormality on or near a rail track, the system comprising scanning means for scanning on and near a portion of the rail track; and detection means for determining the presence and location of the object or abnormality on or near the portion of the rail track based on information from the scanning means...camera means for capturing one or more images of the object or abnormality based on information from the detection means and image processing means for processing the images captures by the camera means for deriving detection information." Similarly D2 discloses "a safety system for a railway train comprises means for producing successive sets of data corresponding to successive real-time images of the track ahead of the train as the train advances along its track, a reference store holding sets of data corresponding to forward-view images of the track at successive points it. Comparing means compare the data for the successive real-time images with the data for successive pre-stored images for corresponding positions along the track, to provide an alarm signal....."

Subsequent to above claim 1 is considered to be not inventive either. The objections apply similarly to claim 32 which is a method claim for the system of claim 1.

The appended claims do not add any novel or inventive feature either. For eg. claim 10 defining "image processing system generates a composite background edge map comprising an adaptive background edge map, a previously learned and saved day or night background edge map, and a seasonal marking map generated for a particular for a particular season or weather conditions" is disclosed in D1 paragraph 26.

Claims 1-32 clearly met the criteria set out under Article 33 (4) of the PCT with regard to industrial Applicability.

Claims

1. A surveillance system for detecting a foreign object, debris, or damage (FOD) on a runway comprising:

one or more cameras for capturing images of the runway; and

an image processing system for detecting the FOD on the runway based on adaptive image processing of the images captured by the cameras;

wherein the surveillance system is adaptively operable for FOD detection under both day and night ambient light conditions without assisted illumination such as infrared or laser illuminators.

2. The surveillance system according to claim 1, wherein the image processing system applies image enhancement methods to enhance the captured images.

3. The surveillance system according to claim 2, wherein means for enhancing the captured images comprises a high pass filter, a Sobel X from left_to_right filter and a Sobel X from right_to_left filter, or a Scharr X filter to the captured image.

4. The surveillance system according to claim 3, wherein the image processing system determines if the instant of processing is a day-time or night-time; and detects an abnormal light condition, such as due to aircraft landing or aircraft taking off or ground vehicle movement, from the captured image during night-time.

5. The surveillance system according to claim 4, wherein detecting of the abnormal light condition comprises global histogram and statistical analysis to compare each image with one or more preceding images and identifies the abnormal light condition based on a change in intensity with reference to a threshold value.

6. The surveillance system according to claim 5, wherein images for which the abnormal light condition are detected are ignored from further processing.

7. The surveillance system according to claim 6, wherein the image processing system adaptively estimates one or more threshold values for optimal FOD edge extraction for different environmental conditions; and generates a pixel level edge map using a statistical method based on progressively learned background image edge map

to determine the grayscale lookup table (LUT) to be used to generate pixel level threshold map.

8. The surveillance system according to claim 7, wherein the image processing system further applies temporal filtering to a stack of pixel level edge maps to retain only the robust edge map which consists only of pixels that have accumulated to pass the threshold.

9. The surveillance system according to claim 8, wherein the image processing system further subjects the robust edge map to adaptive background learning, the adaptive background learning comprising:

comparing background edge images obtained at previous instants with current image;

identifying slow-change features on the runway; and

updating the background edge image with the slow changing features.

10. The surveillance system according to claim 9, wherein the image processing system further generates a composite background edge map comprising an adaptive background edge map, a previously learned and saved day or night background edge map, and a seasonal marking map generated for a particular season or weather conditions.

11. The surveillance system according to claim 10, wherein the image processing system further compares the composite background edge map and the robust edge map; and removes background edges to extract a suspected edge map of FOD.

12. The surveillance system according to claim 11, wherein the image processing system further performs edge filtering to filter unwanted edges related to environmental changes from the suspected edge map, and computes edge parameters of FOD from the suspected edge map,

13. The surveillance system according to 12, wherein the environmental conditions include day to night transition, or night to day transition, weather conditions, rain, smoke, cloud or the like.

14. The surveillance system according to claim 13, wherein the image processing further overlays an FOD graphic on a suspected region of the runway on a video display to alarm an operator at a control tower or control room of FOD detection.

15. The surveillance system according to claim 14, wherein one or more of the cameras, or one or more additional cameras are arranged for zooming on to the suspected region for visual verification.

16. The surveillance system as claimed in claim 15, wherein the image processing system further classifies the FOD.

17. The surveillance system according to claim 15, wherein the one or more cameras comprises one or more static cameras, one or more non-static cameras or a combination of both static and non static cameras.

18. The surveillance system according to claim 15, wherein the cameras are placed on one side of the runway.

19. The surveillance system according to claim 15, wherein the cameras are placed on either sides of the runway in a staggered manner.

20. The surveillance system according to claim 15, wherein when one or more cameras fail to function, respective adjacent cameras are operable to cover the areas covered by the failed cameras.

21. The surveillance system according to claim 15, wherein the one or more cameras comprise one or more monochrome cameras, one or more colour cameras or both.

22. The surveillance system according to claim 21, further comprising one or more night vision cameras.

23. The surveillance system according to claim 22, wherein a runway surface is divided into a plurality of segments, and one or more non-static cameras sequentially scan the runway segment-by-segment for FOD detection.

24. The surveillance system according to claim 23, wherein a static camera detects respective locations of aircraft take off and landing on the runway such that a non-static camera is directed to first scan runway segments in the respective locations of aircraft landing or take off to reduce FOD detection time.

25. The surveillance system according to claim 24, wherein the image processing system applies temporal filtering to filter out rain clutter in runway scene images by recognising rain-like characteristics of rain motion clutter and based on the motion clutter due to rain occurring across the entire runway.

26. The surveillance system according to claim 25, wherein the image processing system applies temporal filtering to filter out snow clutter in runway scene images by recognising snow-like characteristics of snow motion clutter and based on the motion clutter due to snow occurring across the entire runway.

27. The surveillance system according to claim 26, wherein the image processing system makes use of markers or runway edge lights located along the longitudinal (horizontal) direction on the runway and on same vertical distance from the side of the runway for runway scene calibration to map pixels on the images of the runway to precise co-ordinates on the real-world co-ordinate frame (such as WGS84 or Airport Grid).

28. The surveillance system according to claim 27, wherein the image processing system makes use of two parallel horizontal runway lines on each side of a runway middle line and the runway middle line to derive two vertical pixel mapping ratios for runway scene calibration to map pixels on the images on the runway to precise co-ordinates on the real-world co-ordinate frame (such as WGS84 or Airport Grid).

29. The surveillance system according to claim 28, wherein the image processing system makes use of monoscopic vision and calibrated runway scene image captured by a monoscopic camera to determine the position and range of the FOD on the runway.

30. The surveillance system according to claim 29, wherein the system makes use of the FOD position and range determined by a static camera and a calibrated runway scene image to automatically control the non-static camera (such as a pan tilt zoom

camera) to pan and/or tilt and/or zoom and/or focus onto a FOD to obtain telephoto images of the FOD with sufficient details to enable the verification of detected FOD or to filter a false alarm

31. The surveillance system according to claim 28, wherein the system makes use of stereo vision using a pair of surveillance cameras to cover the same segment of the runway so that FOD range and position can be computed from the difference image obtained by comparing the two images as captured by the two cameras covering the same area of surveillance (field of view) on the runway.

32. A surveillance method for detecting a foreign object, debris, or damage (FOD) on a runway, the method comprising:

capturing images of the runway;

performing adaptive image processing of the images captured for detecting the FOD on the runway;

wherein the method is adaptively operable for FOD detection under both day and night ambient light conditions without assisted illumination such as infrared or laser illuminators.

Runway Surveillance System and Method

Abstract

A surveillance system and method for detecting a foreign object, debris, or damage (FOD) on a runway. The system comprises one or more cameras for capturing images of the runway; and an image processing system for detecting the FOD on the runway based on adaptive image processing of the images captured by the cameras; wherein the surveillance system is adaptively operable for FOD detection under both day and night ambient light conditions without assisted illumination such as infrared or laser illuminators.

Figure 1A