16242

REMOTE BATTLE DAMAGE ASSESSMENT USING SENSOR FUSION AND 3D IMAGING (U)

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ABSTRACT (U)

(U) It is extremely important to meet the rapid Battle Damage Assessment (BDA) requirement for current and future systems. The proposed technical approach provides the capability to conduct timely BDA utilizing indigenous surveillance systems. The surveillance system consisting of digital visual and IR cameras combined with the real time 3D display is proposed. This system will be integrated and tested under field conditions. The system will support real-time remote BDA by providing images of combat vehicles and their IR signatures. This assessment will allow soldiers to identify combat vehicles that have been damaged or destroyed on the battlefield. The task will be accomplished using the sensor fusion technique for visual and IR imagery. The battle damage assessment with 3D depth perception will be accomplished by using multiple camera views. The 3D images will be displayed remotely using auto-stereoscopic 3D display. This technology was tested in the lab environment for threat recognition, camouflage assessment, and shuttle tile damage assessment. The results of our testing show the benefits of IR imaging and fused imaging techniques for threat assessment. The stereoscopic cameras were used for camouflage evaluation in the field. The benefit of this technique for BDA is in depth perception of the battlefield.

(U) Objective.

(U) Sensing, assessing, and reporting the success or failure of battle damage (e.g. disabled, damaged, destroyed) of combat vehicles and targets is essential for successful mission accomplishment. BDA must be reported to the commanding authority for evaluation and response decision, such as reattack. Maintaining situational awareness, dynamic surveillance, and target development is important for the warfighter. This task may be accomplished through sensor acquisition, data fusion and 3D visualization. The proposed integrated sensor system will support real-time BDA by providing images of combat vehicles with IR signatures. It will enable identification of vehicles that have been damaged or destroyed. The battlefield will be accessed remotely using a 3D display with depth perception capability for accurate BDA. It will expand the warfighter's perception, situational awareness, and knowledge of the battlefield situation beyond the limits that were available through visual and other sensory perception.

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(U) Warfighter payoff is the real time damage assessment of combat vehicles, dynamic surveillance, data fusion and 3D visualization. It would be necessary to leverage / adapt existing programs to provide the capability to conduct timely BDA utilizing indigenous surveillance capabilities at our disposal. The aim of this approach is to utilize joint intelligence estimates provided by a layered sensors approach to develop BDA to support all fires missions, line of sight (LOS), non-line of sight (NLOS), beyond line of sight (BLOS) and joint assets. An integrated sensor system will support real-time BDA by providing images of combat vehicles with IR signatures. It will enable identification of vehicles that have been damaged or destroyed. The battlefield will be accessed remotely using a 3D display with depth perception capability for accurate BDA. This technology was tested in the lab environment for threat recognition, camouflage assessment, and NASA's space shuttle tile damage assessment.

(U) Prove of Concept: Shuttle Tile Damage Assessment.

(U) The remote access capability using IR and fused imagery enhanced our capability of space shuttle damage assessment. The damage of the wing edge and tiles of the NASA's space shuttle Columbia during it's take off resulted in catastrophe. Space shuttle tile damage assessment is part of a Space Act Agreement between NASA's Kennedy Space Center and TARDEC. Work done under this agreement will support NASA's Return to Flight effort. Visual, infrared (IR), and near IR imaging techniques are being evaluated by TARDEC for NASA's space shuttle tile damage assessment needs. The experiments have shown there are advantages in using IR and near IR imaging in addition to visual light imaging. The 3D histograms of visual, IR and near IR images of shuttle tiles are obtained using Matlab Version 6.0 software with the Image Processing toolbox.

(U) The Experiment.

(U) Three imaging systems were used for the shuttle tile damage assessment: the visual high resolution 36 bit color Nikon D1 digital camera; the FLIR FSI digital automatic camera and the Sony Digital 8 Handycam DCR-TRV240.

> (U) We used the high resolution 36 bit color Nikon D1 digital camera for imaging in the visual part of the spectrum. The sensor resolution was 2,000 x 3,000 pixels. Visual images of the used and new shuttle tiles of are shown in Figure 1. The 2D histograms of these visual images are shown in Figure 2.

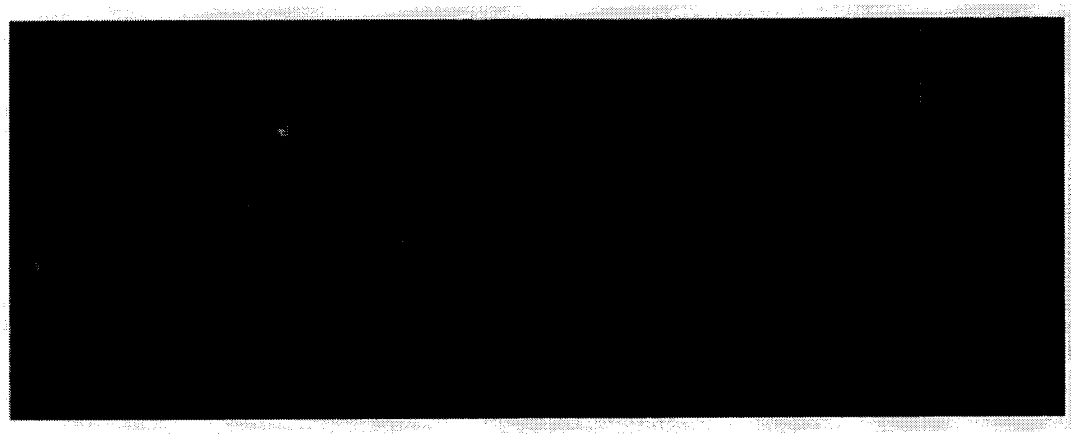

Figure 1. (U) Visual images of the used and new shuttle tiles.

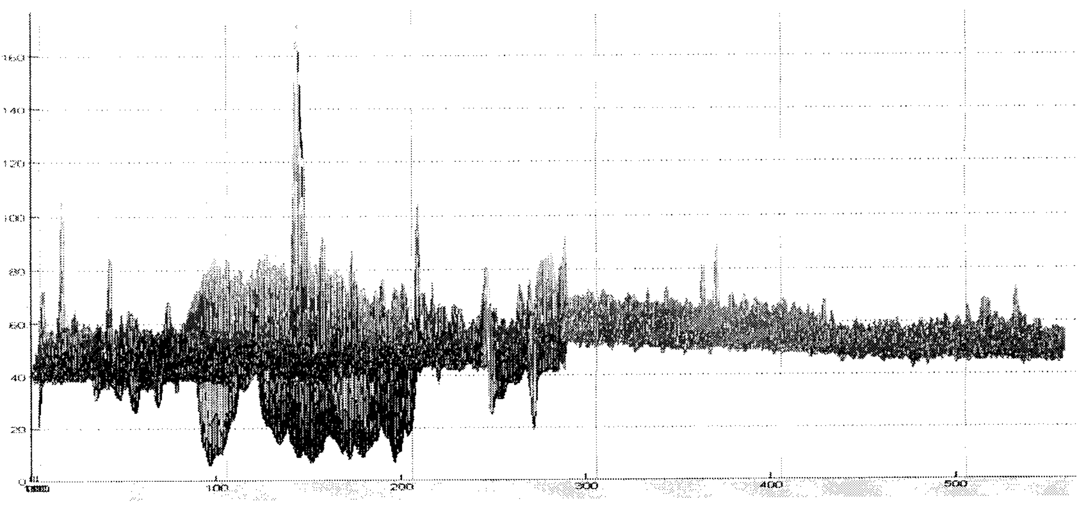

Figure 2. (U) The 2D histograms of the used and the new shuttle tiles.

(U) The Sony Digital 8 Handycam DCR-TRV240 camera was used to capture images in the near IR part of the spectrum with light wavelength ranging from 0.2 to 2 microns. The near IR images of the new and used shuttle tiles are shown in Figure 5. The 3D histograms of the near IR images of the new and used shuttle tiles are shown in Figure 6.

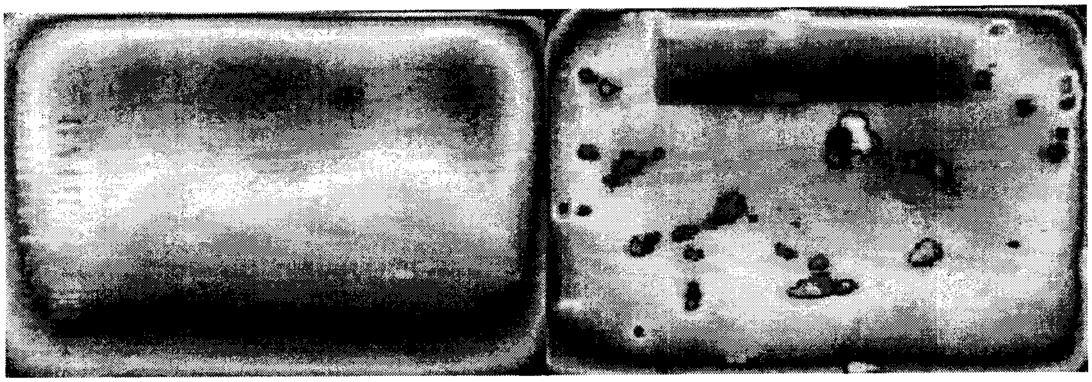

Figure 3. (U) The IR image (8 - 12 microns) of the new and used shuttle tiles.

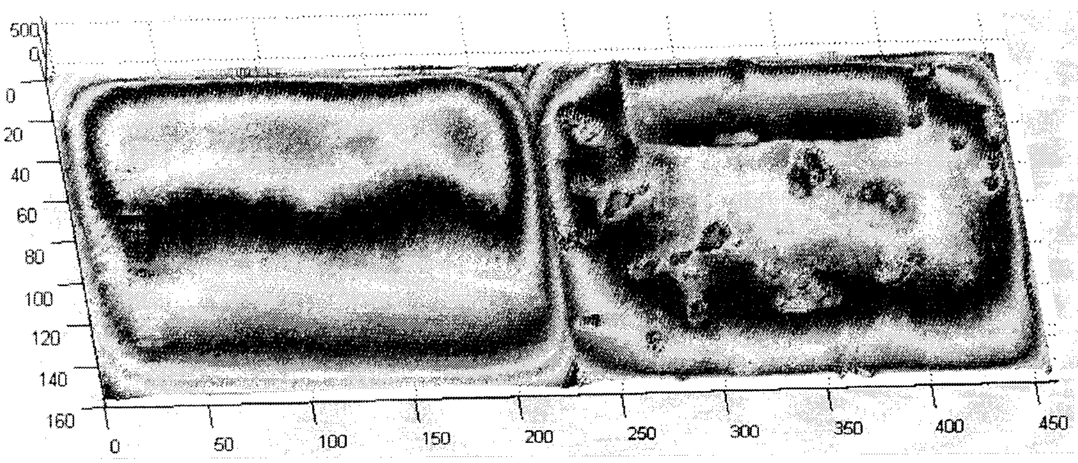

Figure 4. (U) The 3D histograms of IR images of the new and used shuttle tiles.

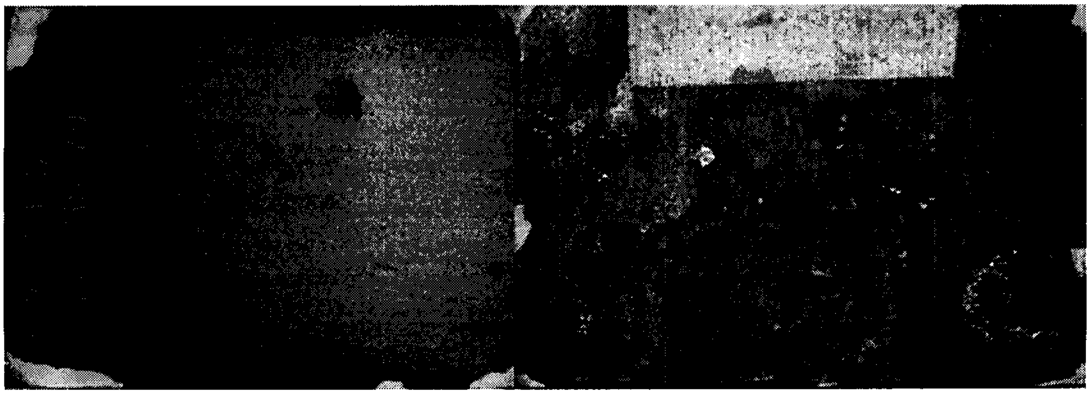

Figure 5. (U) The near IR images (0.2 - 2 microns) of the new and used shuttle tiles.

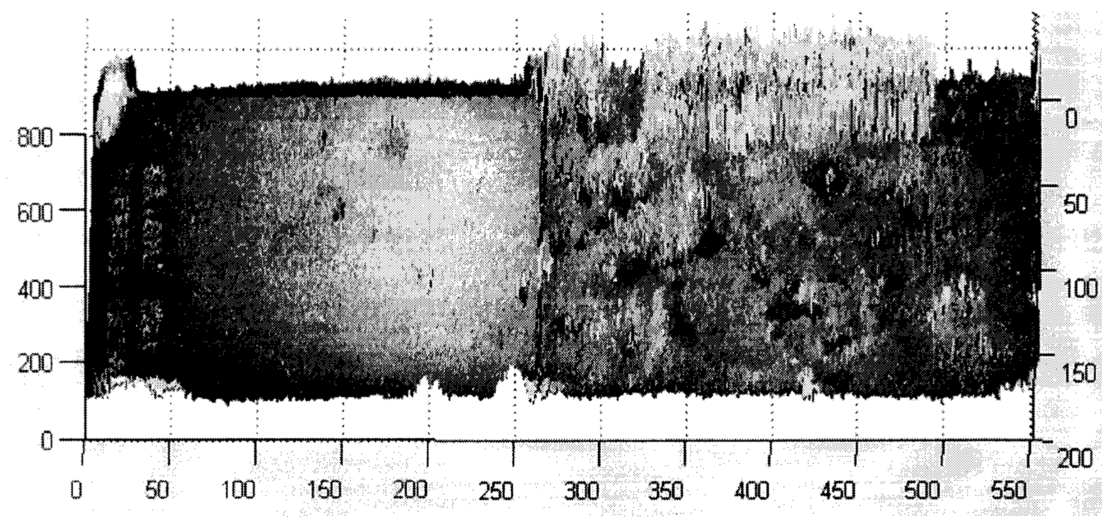

Figure 6. (U) The 3D histogram of the near IR images of the new and used shuttle tiles.

(U) Conclusion.

(U) Maintaining situational awareness, dynamic surveillance, and target development is important for the warfighter. This task will be accomplished through sensor acquisition, data fusion and 3D visualization. The implementation of the integrated sensor system will support real-time BDA by providing images of combat vehicles with IR signatures. It will enable identification of vehicles that have been damaged or destroyed. The battlefield will be accessed remotely using a 3D display with depth perception capability for accurate BDA. It will expand the Warfighter's perception, situational awareness and knowledge of the battlefield situation beyond the limits that were available through visual and other sensory perception. New IR cameras for defense applications are being developed by the DRS Corporation. The high-speed IR camera by DRS is being implemented by the US Navy and the Air force. The AF/256 is a super sensitive thermal imaging camera developed by FLIR Corporation. This system is ideal for medium to long range detection. The unit has the capabilities of detecting a human up to 8 Kilometers in total darkness and in adverse conditions. The heart and soul of the AF/256 is an Indium Antimonide infrared FPA detector which offers ultra sensitive imaging and is widely utilized by the United States and NATO countries. This is an ultimate system for BDA, airfield, harbor and critical installation surveillance. The proposed new technologies will utilize joint intelligence estimates provided by a layered sensors approach and will develop BDA to support all fire missions and joint assets. Warfighter Payoff will be the real time damage assessment of combat vehicles, dynamic surveillance, image based sensor fusion and 3D visualization. The new wrap-around video system with implemented visual and infrared sensor fusion is presently being tested in the Visual Perceptions Lab (VPL) of TARDEC. This video system will be implemented in light armored vehicles and commercial trucks.