ABSTRACT

DIGITAL AREA CORRELATION AND AIM POINT TRACKER USING IMAGE REGISTRATION ALGORITHMS

Tracking an area of a scene for reconnaissance applications or tracking an area around an aimpoint on the target, either for target designation or for autonomous fire and forget missiles to home-on, are the potential applications of present and futuristic weapon systems. The scene of interest or the area on the target to be tracked, generally may not have prominent features or high contrast. Therefore, conventional methods such as contrast trackers or feature based trackers can not be used. Pixel level based area correltion tracking is an effective method for these applications.

Future applications envisage the use of leading edge technology imaging sensors such as staring Focal Plane Array (FPA) infrared imaging sensors. These sensors have a problem of Fixed Pattern Noise (FPN) due to non-identical response of the detectors of FPA. FPN will pose additional problems in tracking the scene which have to be addressed.

The idea of using area correlation tracking techniques has been around for a long time. The major weakness of these methods and the reasons for more failures than successes in the past is that they are inherently susceptible to false matches leading to gross errors and wasted weapons. But, other methods of tracking are not suitable for these applications.

It is in this context that a methodology has been evolved to theoretically analyse the performance of pixel level based image matching algorithms with respect to image parameters such as SNR, variance, gain and offset variations. Mathematical equations are derived to predict the worst case performance criteria function of the algorithms with respect to each image parameter. Theoretical results were compared with computer simulated results using real world images. The results are in good agreement. Probability studies have also been carried to compare the relative performance of the algorithms. Based on theoretical and practical results, correlation coefficient algorithm (CCA) algorithm has been selected for hardware implementation. Computer generated images were used in testing the algorithm and the hardware. A new approach for tracking an aimpoint on the target has been suggested and implemented. A number of new confidence measures to detect false registration and to improve the probability of correct registration have been proposed, implemented and found to be effective.

The hardware realized for area correlation and aimpoint tracking was successfully tested in the laboratory and in the field. The highlights of this work are evolving the theoretical analysis in selecting a suitable image matching algorithm, validation of theoretical results by computer simulation results, hardware implementation, hardware realization implementing correlation algorithm, new approaches for aim point tracking and new suggestions on confidence measures.

KEY WORDS

Area correlation, image registration, image matching, correlation coefficient algorithm, mean absolute difference algorithm, criteria function, image tracking, image simulation, aim point, confidence measures, centroid tracking.