A Novel Image Enhancement Algorithm for a Small Target Detection of Panoramic Infrared Imagery

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SUMMARY A novel image enhancement algorithm that can efficiently detect a small target of panoramic infrared (IR) imagery is proposed. Image enhancement is the first step for detecting and recognizing a small target in the IR imagery. The essence of the proposed algorithm is to utilize the independent histogram equalization (HE) separately over two sub-images obtained by decomposing the given image through the statistical hypothesis testing (SHT). Experimental results show that the proposed algorithm has better discrimination and lower false alarm rate than the conventional algorithms.

key words: panoramic infrared imagery, small target detection, statistical hypothesis testing, histogram equalization

1. Introduction

The autonomous detection of a small moving target using an electro-optical sensor (IR sensor) imagery is required for the several defense applications. Such as IR Warning System (IRWS), IR Search and Tracking system (IRST), and etc are necessary for those military applications to warn the incoming small targets, such as aircrafts and helicopters of enemy, from a distance [1]-[3]. Recently, the IRWS and the IRST have been widely for the panoramic IR imagery which uses the 1-dimensional multi-array infrared sensor by rotating two or three times per second. Figure 1 shows two examples of the panoramic images acquired the IRWS. Since those IR images generally have a low signal to noise ratio and a narrow dynamic range, it is difficult to detect and recognize the small targets without the enhancing of IR signals. Thus, lots of researches have been centered on the contrast enhancement of the IR images to detect the small targets. Histogram stretching (HS) is a simple image enhancement algorithm that attempts to increase the dynamic range from the narrow dynamic range in an image by using linear transformation [4]. The linear transformation has a steep gradient in the region of many pixels of the image and a slow gradient in the rest region. In other words, the contrast enhancement in the background region has a better than that of the target region. When the contrast in the background region is increased, the background noises (or clutters) are also increased simultaneously by the characteristic of the linear transformation. Histogram equalization (HE) is the one of the well-known algorithm for enhancing the contrast of the given images in accordance with the sample distribution of an image [4],[5]. In spite of its high performance in enhancing the contrasts of a given image, it is rarely employed in the IR image viewing system since histogram equalization changes the original brightness of an input image, deteriorates visual quality, and produces some serious artifacts. In order to overcome such drawbacks of the histogram equalization, the plateau equalization was proposed by V. E. Vickers [6]. The plateau equalization is a general class of histogram-based mapping from the raw signal levels to output display value, and a class that includes the histogram projection and the histogram equalization as extreme cases. The effect of this method is to limit the influence of many pixels hav-