26PA1 **TARGET DETECTION IN TERRAIN BACKGROUND BY IMAGING LASER RADAR**

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1. INTRODUCTION

An autonomous detection, recognition, and tracking capability of the targets among the complex surface (terrain) background is strongly desired for the next generation on-board optical sensors of the brilliant tactical guided weapons (missiles, bombs, submunitions, etc.) [1]. So far, the brightness image acquired by the passive optical sensors such as visible/infrared scanning or staring camera has been adversely used in order to detect the target and guide the missiles among the relatively simple background such as sea or sky. However, we frequently encounter the difficulties that those passive optical sensors hardly can detect the targets autonomously among the complex terrain background. This is because, in the terrain background, there are a lot of clutters which apparently have almost same the brightness and size as the targets in both wavelength regions of visible and infrared. Hence, in fact, solely using the passive optical sensor, the autonomous guidance of the missiles to the targets in the terrain background is not considered to be realizable. On the other hand, under such a high clutter conditions, the range image, i.e., the three dimensional mapping of the target and background is more effective to detect the target than the brightness image, because there are few natural objects which actual shape and dimensions are very similar to the man-made targets [2]. Moreover, if we use both the range and brightness information by fusing them on the pixel or image level, the much more precise and autonomous target detection can be expected than only using each information [2].

An imaging laser radar is an active optical sensor which is able to simultaneously acquire the brightness and range image, which corresponds to the reflectance of the targets and background, and the two way transit time between targets and transmitter, respectively . Besides, in recent years , due to the development of the LD pumped solid state laser transmitter, its size and efficiency have been dramatically reduced and increased, respectively. Therefore, the imaging laser radars are considered to be one of the most promising candidate for the near future on-board optical sensors of the brilliant guided weapons.

In order to experimentally investigate the target detection features of the range and reflectance images of these imaging laser radars, we measured the several those images of the man-made targets in the actual field by using newly developed imaging laser radar. Then, we segmented the target region from each image.

2. EXPERIMENTAL APPARATUS

Figure 1 shows the schematic drawing of the newly developed imaging laser radar for acquiring the range and reflectance images in the field. Since all the optics including laser oscillator are compactly set up on the light-weighted optical bench, this device is very portable and field worthy. The 2-axes scanning mirror is positioned at the exit of the receiver and transmitter optics to steer the laser beam in raster fashion on the scene at the minimum step of 0.1 degree. The transmitter is a Q-switched LD pumped ND:YLF laser which peak power and beam divergence are 10 kW and 2.6 mrad (FWHM), respectively. The receiver consists of 50 mm dia. clear aperture collecting lenses, an interference filter, and an InGaAs photodetector. The resultant FOV of the receiver is 3.0 mrad (FWHM). The peak power and the two way transit delay time of the reflected laser pulse measured by the digital oscilloscope are transmitted to the 486 personal computer (PC) through GPIB and stored in it. It takes about one second to transmit those data to the PC for one pixel. The PC controls the time events of the mirror scanning, laser triggering, and the data transmission, and also produces and processes the range and reflectance images by using several software packages.

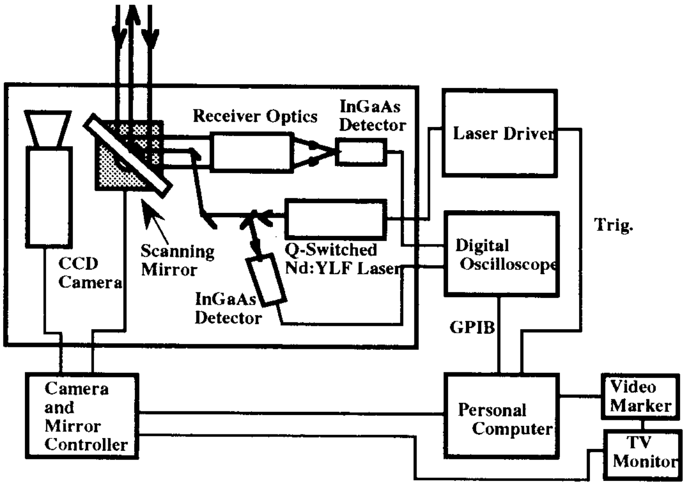
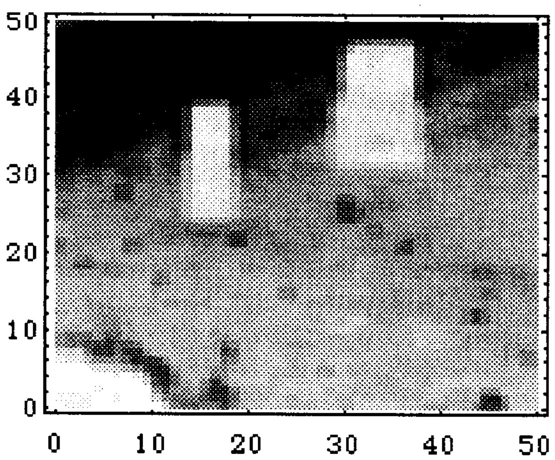


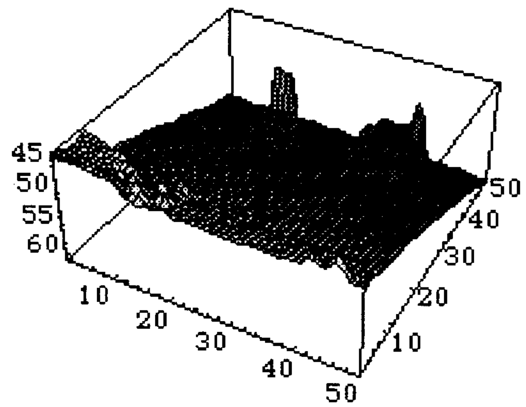
Figure 1 Schematic of imaging laser radar.

3. FIELD TEST RESULTS

Figure 2 shows the 2500 pixels reflectance and range images of the two paper boxes in the open grass field, which were measured from the 13.6 m height building roof. Both images were filtered by 2x2 median filter to reduce the high frequency noise. We can see clearly, in the photographic reflectance image, two bright regions of the targets (paper box). The additional bright region at the left and bottom corner is the grass slope on this side of the targets. On the other hand, it can be easily understood by the range image where two targets and the grass slope are positioned. By using the range and reflectance histograms[2], we segmented the two target regions from range and reflectance images, respectively, and quantitatively compared the target segmentation characteristics between them.



(a) Reflectance image



(b) Range image

Figure 2 The 2500 (50x50) pixels reflectance and range images of two paper box targets in the open grass field.An viewing angle of one pixel is about 0.1 degree. These images were measured by imaging laser radar at 13.6 m height building roof.The depression angle and the range to the center of two targets are about 16.3 degree and 55 m, respectively.

4. REFERENCES

1) R. L. Gustavson and T. E. Davis, Proc. SPIE vol.1633, p21(1992).
2) J. E. Baum and S. J. Rak, Proc. SPIE vol.1416, p209(1991).