Performance evaluation of image enhancement techniques on night vision imagery

Judith Dijk*, Piet Bijl§, Adam W.M. van Eekeren*

* TNO Defence, Security and Safety, P.O. Box 96864, 2509 JG, The Hague, The Netherlands
email: Judith.Dijk@tno.nl

§TNO Defence, Security and Safety, P.O. Box 23, 3769 ZG, Soesterberg, The Netherlands

ABSTRACT

Recently new techniques for night-vision cameras are developed. Digital image-intensifiers are becoming available on the market. Also, so-called EMCCD (electro-magnified) cameras are developed, which can also record imagery in dim conditions. In this paper we present data recorded with both types of cameras (image-intensifiers and EMCCD cameras) in dim light conditions, and present the results of image enhancement on this data. The image enhancement techniques applied are noise reduction, super-resolution reconstruction and local adaptive contrast enhancement. Comparing the results from both cameras indicates that the image intensifier performs better at the dim conditions and the EMCCD camera performs somewhat better at the bright conditions.

Keywords: Image enhancement, super-resolution, contrast enhancement, image-intensifiers, EMCCD cameras, TOD

1. INTRODUCTION

For all military operations, situational awareness is of great importance. This situational awareness can be obtained using cameras. The current trend is that more and more operations are shifted from daytime to night. This increases the need for night-time imagery. Low light levels are normally not sufficient to see details of the scene with standard CCD cameras. Therefore, in night time operations other types of cameras are used. Thermal infrared cameras can be used in complete dark environments, as they visualize thermal differences in the scene. Image-intensified cameras and EMCCD cameras use light from the stars or the moon to obtain an image under low-light conditions. The advantage of these cameras with respect to infrared cameras is that they allow for visual identification. This image enables the soldier to interpret his environment. Traditionally, image-intensifiers are carried by the individual soldier. An advantage of EMCCD cameras is that also the color of the scene can be recorded. The drawback of recording colors is that the sensitivity of the camera is lower. In this paper we present only data recorded with a grey-value EMCCD.

The quality of the imagery is a topic of interest. In this paper we present data recorded on an image intensifier and a grey value EMCCD camera. One of the main characteristics of these cameras is their noise behavior. This noise can be modeled as Poisson noise, with its characteristic peaks. This results in individual pixels with a high value. This effect can be reduced by the use of image enhancement.

In 2009 we presented the performance of image enhancement techniques on image-intensifed cameras.[1] In this paper, we present also data from a grey-value EMCCD cameras. The results of both cameras are compared. The image enhancement techniques applied are described in section 2. The evaluation is done using the TOD method. Some details about this method are given in section 3. The experimental setup including details about the recordings is given in section 4. The results of the experiments are presented in section 5. Conclusions and directions for further research are presented in section 6.

2. IMAGE ENHANCEMENT TECHNIQUES

Image enhancement can be applied to an image or a sequence of images. The purpose of these techniques is to improve the quality of the images presented to an observer. In this paper we evaluate the benefits of three image enhancement techniques: temporal noise reduction, super-resolution reconstruction and local contrast enhancement. An advantage of these algorithms is that they can be implemented on hardware, as well in a real-time software application.

Infrared Imaging Systems: Design, Analysis, Modeling, and Testing XXI, edited by Gerald C. Holst, Keith A. Krapels,
Proc. of SPIE Vol. 7662, 766207 · © 2010 SPIE · CCC code: 0277-786X/10/$18 · doi: 10.1117/12.853396