Real-Time Target Detection Using Infrared Camera

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Abstract

Infrared (IR) cameras are often used in a vehicle based multi-sensor platform for landmine detection. Additional to thermal contrasts, an IR polarimetric sensor also measures surface properties and therefore has the potential of increased detection performance. This paper describes all the steps to reach detection performance. The first step is the acquisition of the polarimetric IR image data. The next step is the pre-processing to (re)construct polarimetric images. A subsequent segmentation step is made to identify objects. Features, like intensity, reflectivity and shape, of these objects are measured. For independent performance analyses, the data set is divided into a training and evaluation section. A classifier is trained on the training section and evaluated on the classification section.

Keywords: *Infrared camera; Infrared thermography; Data analysis; Image Processing, Thermograhy processing.*

1. Introduction

1.1 Computer Vision and Surveillance

Many current surveillance systems consist of cameras and monitors with human dependence to analyze and report possible problems. This type of system is not hardware expensive system, however the human requirement to monitor 24 hours per day is expensive and source of inaccuracy. Some of the systems may include recording media to capture all the events for a later viewing. The problem with this is it turns the surveillance system into a forensic tool to solve a possible robbery or illegal action that has already happened nowadays.

Instead, a better solution is to have real-time continuous and automated surveillance systems to detect and alert a potential threat in progress. The need for automated surveillance is very important in medical, commercial, law enforcement and transportation.

The computational power required for a real-time video processing is large. The field of computer vision is taking advantage of the computational power available and monitors the applications into real-time automated surveillance for reasonable cost. As the fields of computer vision continues to grow, new technologies will make it possible for reliable and cost effective means of implementing better smart surveillance systems.

1.2 Purpose and Objectives

For this research, we have done several experiments to achieve a few objectives. The objectives are the system should be able to detect any movement object in real-time. As far as we concern, any movement detect by the camera could be in fast or slow motion. If the image taken while the object is moving fast, the image could be blur or hardly been seen.

Therefore the objectives, we are proposing a method to overcome such problem. Whenever we use such technique of the image processing, it is guaranteed that the image after going through image processing, the image produce will be in better result. In image processing we can't run from detecting edges. Therefore the proposed method will also has the ability to detect edges precisely to easily recognize the object taken whether in fast or slow moving object. Beside, it is also feature one of the important techniques in image processing, which is filtering. The filter use will be able to sharpen the image taken.

2. Image Processing

2.1 Edge Detection

In this research, the method proposed for edge detection is using the Canny Edge Detection Method. In this method, there are three issues that an edge detector must be address.

1. **Error rate** – The edge detector should respond only to edges, and should find all of them; no edges should be missed.
2. **Localization** – The distance between the edges pixels as found by the edge detector and the actual edge should be as small as possible.
3. **Response** – The edge detector should not identify multiple edge pixels where only a single edge exists.

2.2 Filtering

To sharpen the blur image taken we propose a new method in filtering which used the capability of Gaussian equation to filter images. In one dimension, the response of the filter f to an edge G is given by a convolution integral:

$$H = \int_{-W}^{W} G(-x) f(x) dx$$

The Canny detector method attempts to find the filter *f* that maximizes the product SNR x localization subject to the multiple-response constraint, and while the result is too complex to be solve analytically, an efficient approximation turns out to be the first derivative of a Gaussian function. Recall that a Gaussian has the form:

$$G(x) = e^{-x^2 / 2\sigma^2}$$

The derivative with respect to x is therefore:

$$G'(x) = \left(-\frac{x}{\sigma^2}\right) e^{-\left(\frac{x^2}{2\sigma^2}\right)}$$

In two dimension, a Gaussian is given by:

$$G(x, y) = \sigma^2 e^{-\left(\frac{x^2+y^2}{2\sigma^2}\right)}$$

and G has derivatives in both the *x* and *y* directions. The approximation to Canny's optimal filter for edge detection is G', and so by convolving the input image with G’, the result obtain is an image E that has enhanced edges, even in the presence of noise, which has been incorporated in to the model of the edge image.

A convolution with two- dimensional Gaussian can be separated into two convolutions with one-dimensional Gaussian, and the differentiation can be done afterwards. Indeed, the differentiation can also be done by convolutions in one dimension, giving the two images: one is the *x* component of the convolution with *G’* and the other is the *y* component.

2.3 Difference Picture Technique

The most obvious method of detecting edges between the two frames is to directly compare the corresponding pixels of the two frames to determine whether they correspond to the same pixels value. In the simplest form, difference picture $DP_{jk}(x, y)$ between frames $F(x, y, j)$ and $F(x, y, k)$ is obtained by:

$$DP_{jk}(x, y) = |F(x, y, j) - F(x, y, k)|$$

where x, y are the spatial coordinates in the frame, j and k represent frame j and frame k taken at different time sequence. In our experiment, $DP_{jk}(x, y)$ output is displayed as indicator for motion study. After a differentiate checking using detection of edges and pixel luminance comparison, we managed to differentiate whether the output is moving object or noises.

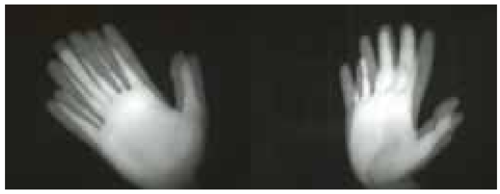

Figure 2.1: Image taken in two frame of different time

However, we purposely did not remove the noises as necessary information is obtained, in order to save time computing. As long as we achieved the required goal, extra computing process should be eliminated to save time computing and moving detection in real time required immediate response. Illumination changes can possibly give an error results in detecting changes.

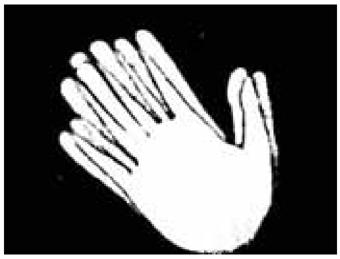

Figure 2.2: Image after going through edge detection

3. Conclusion

Infrared (IR) cameras are often used in a vehicle based multi-sensor platform for landmine detection. Additional to thermal contrast, an IR polarimetric sensor also measures surface properties and therefore has the potential of increased detection performance. This paper describes all the steps to reach detection performance. The first step is the acquisition of the polarimetric IR image data. The next step is the pre-processing to reconstruct polarimetric images. A subsequent segmentation step is made to identify objects. Features like intensity, reflectivity and shape, of these objects are measured. For independent performances analyses, the data set is divided into a training and evaluation section. A classifier is trained on the training section and evaluated on the classification section.

Utilizing a desktop PC and a infrared thermal imaging camera, a real-time vision system was able to detect and collects targets within the field of view of the camera. Using fast image processing tools the system detects regions of heat and collects attributes about the objects. Using this information about each object overlay graphics are drawn on the image as rectangles around the object. The implementation of this project is in Visual C++ with all functions for image processing and real-time detection. Beside the method of Canny Edge Detector is proposed in this research. It implies the way to detect edges of the image more relevant and effective. The speed of the application allows real-time computation and functionality with the capability for integration with a larger surveillance system in the capacity of target detection with or without human interaction.

There are so many directions to take this to develop a new system for automated surveillance applications. This application of the thermal imaging camera could be integrated with other CCD camera. Once the infrared and system like this detects and marks potential region of heat, it could trigger the activation and position of these cameras to continue with the analysis. Such a system would integrate the different hardware technologies for a more complete automated computer vision based surveillance system.

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