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Using Enhanced-Color Mapping Algorithm for Object Boundary Segmentation

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Abstract

Image segmentation and object extraction boundaries in thermal images are fundamental approach in digital image processing in obtaining pattern recognitions and alike. A method like the Otsu, improves the image segmentation effect from the thresholding process of separated objects in the background image. This proposed algorithm integrates the three significant outputs: the extracted high thermal threshold value from the original thermal image, and the two outputs from the inverted Otsu method which processed by Canny edge detection and color mapping. Also, this paper is synthesized with Xilinx Zync 7000 ZED ZC702. The experimental results show that the separated objects can easily be detected from its background and shows a significant distinguishable features in terms of edge and color far better against the conventional thermal image.

Keywords: thermal image, Otsu thresholding, image segmentation, object boundary, color mapping

INTRODUCTION

Face detection and image analysis defines a lot of application especially in the field of pattern recognition and computer vision. Since this image analysis is important in recognizing objects categories like in 3D scene, and variety of shaped information which is contained in the boundaries between surfaces in the scene, are in the boundaries of occlusions between two objects occurrence. These exclusion boundaries are valuable sources of information in the scene structures and shape of objects. In able to achieve this shape information, and to use the boundary information in parts of the image interpretation process, reliable ways of detecting the boundary fragments is necessary.

The technique of image segmentation is widely used in many images and video applications. The process is to subdivide the image into various parts or regions. The category is define into two properties: the discontinuity and the similarity [1]. These properties are classified as Edged and region based segmentation. The segmentation methods that are based on discontinuity property of pixels and considered as boundary or edges-based technique. There are two main edge based segmentation methods: the gray histogram based and the gradient based method [2]. On the other hand, the region based segmentation is used in partitioned image into regions that are similar according to its predefined criteria. Each pixel in a region is similar with respect to some characteristic or computed property such as color, intensity and/or texture.

The shape of any image is a powerful visual part for recognizing objects, segmenting images into regions corresponding to individual objects and it can help us to understand certain image structures. In able to address the existing problems of image segmentation, a wide range of principles is necessary. There have been some techniques proposed in order to overcome these difficulties.

This project investigates possible solutions to those existing problems above. Moreover, it explores different ways to reliably detect the occluding boundaries and to focus on the question of combining motion cues with appearance cues for better detection of occlusion boundaries.

Additionally, thermal imaging system helps us to improve the visual spectrum of digital images. The advantage of thermal image do not affect by any illumination variation and, it even works properly in dark condition. However, images can be difficult to interpret with erratic temperatures. Accurate temperature measurements are hindered due to different emissions and reflection with certain surfaces.

The goal of this paper is to develop an approach to achieve a better shape information, edge images, and to have a highly efficient method, and a process that runs in real-time. This method utilizes the inverted Otsu thresholding method, this is the basis for object to background separation process. The developed algorithm can easily managed the object separation from its background and processed any color mapping and Canny edge detection. Moreover, to overcome existing drawbacks in thermal images.

The rest of this paper is organized as follows. In Section 2, we give the discussion of some related works in our proposed algorithm. Section 3 presents our proposed algorithm and its description. Experimental results and implementations are

provided in Section 4. Finally, in Section 5, we conclude this paper.

REVIEW OF RELATED WORKS

In this section, we briefly consider some of the related work that is most relevant to our approach: color mapping technique [3-5], Otsu method [6-9] and Canny edge detection [10-12]. The thresholding process is the simplest segmentation method [13] that change a multilevel image into a binary image. The method selects a proper threshold, and divide image pixels into different regions and splits it from the background based on their level of distribution. It turns all pixels below some threshold to zero and all pixels about that threshold into 1. The thresholding technique is categorized into Global and Local thresholding. The Global Thresholding is divided into traditional (Otsu method), iterative (Triclass) and multistage (QIR) [14]. The Otsu thresholding method depends only on the gray value of the image. It requires a computing on a gray histogram level before processing. The principle is based on the selection of threshold that the gray-level for which the between class variance is maximum or within class variance is minimum [15]. In this proposed algorithm, the inverted Otsu method's output was subjected to color mapping and Canny edge detection that resulted on a better image segmentation.

The paper presented in [16] is a simpler method for image thresholding and simulated in MATLAB, however, there is no detailed description of the iterative and custom approach in this algorithm. While in [17], presented about the uses of edge direction and magnitude called edge mapping and the result is far better in using edge magnitude alone. Reference [18], discussed about several schemes of color mapping. And an optimized algorithms and heuristics but merely an extension method of [19]. While the purpose of edge detection is significantly reducing the amount of data in an image and preserves the structural properties such as for further medical image processing and alike [20].

Lastly, in [21] presented a paper about an algorithm for face detection utilizing thermal images however, the experiments conducted were merely more on simulation and no actual hardware set-up. Reference [22] published a review paper on thermal imaging of electrochemical power systems. The review describes the application thermal imaging and related techniques to the study of electrochemical power systems with the primary focus on fuel cells and batteries. And in [23] shows some relevant application of thermal image especially for the medical field. Moreover, this paper shows some significant process that leads to motivate us in doing our proposed method. The temperature variation really affects the performance of the thermal camera.

This proposed paper presented a method that outperforms other existing techniques in color mapping and edge segmentation. It also maximized the output of the inverted Otsu method.

PROPOSED ALGORITHM

The proposed algorithm is an effective and a different approach in which the original thermal image is processed using the inverted Otsu method. This thermal image is fed as input between color mapping and Canny edge detection techniques and there were incorporated into the red color mapping scheme from the high-value thermal threshold.

Figure 1 shows the proposed algorithm. The original input thermal image will id fed into 3-channel R-G-B to 1-channel gray scale threshold using a 240-pixel value to extract the red portion for red color mapping. The inverted Otsu thresholding method's output image is subjected to Canny Edge detection. The three outputs: the output from red color mapping, the raw inverted Otsu image, and from the Canny Edge detection is combined together to achieve the enhanced output.

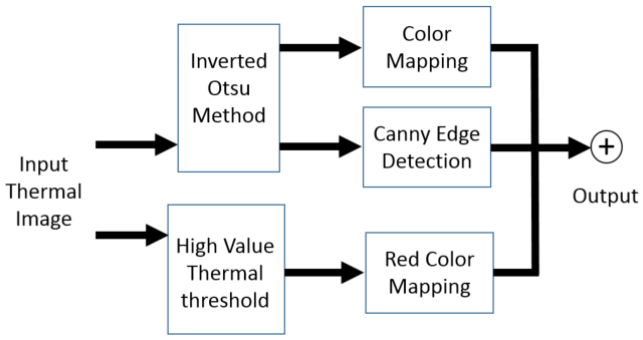

Figure 1: Algorithm of Enhanced-Color Mapping Algorithm

EXPERIMENTAL RESULT

To validate the proposed algorithm, it was synthesized with Xilinx Zynq 7000 ZC702 board. Likewise, to facilitate the testing and simulation, an actual set-up was constructed for real time validation. The set-up includes a thermal camera, FPGA board, pc for program configurations and samples like pictures and videos. Figure 2 shows our set-up during the experiment conducted. Moreover, to compare the results with the other existing methods, a number of experimental testing were carried out. The camera will capture certain video or image and be translated using the FPGA board that has been programmed for this proposed algorithm and the output can be visualized from the PC monitor as it shown in this figure. Figure 3 shows the stages of our proposed algorithm. Figure 3(a) is the raw thermal image that was tested using the inverted Otsu thresholding and a high-value thermal thresholding to be fed into different stages. Figure 3(g) shows the output of our proposed method. It shows that the important object boundaries can easily be segregated from their respective backgrounds.

CONCLUSIONS

In this paper, we have discussed some existing methods for edge segmentation and color mapping. The inverted Otsu thresholding method served as the foundation for establishing the necessary image information. Our proposed algorithm aimed our targets, especially in boundary segmentation. This information partitioned the thermal images into multiple segments that can be applied into a lot of image processing application especially in pedestrian detection and to locate objects in satellite images. The results are directly relevant to a wide range of applications.

Moreover, the project also contributed to the development of more reliable category recognition algorithms based on shape representations, that can be applied in health care, human-computer interaction, image retrieval and data mining, industrial and personal robotics, manufacturing, scientific image analysis, surveillance and security, and transportations.

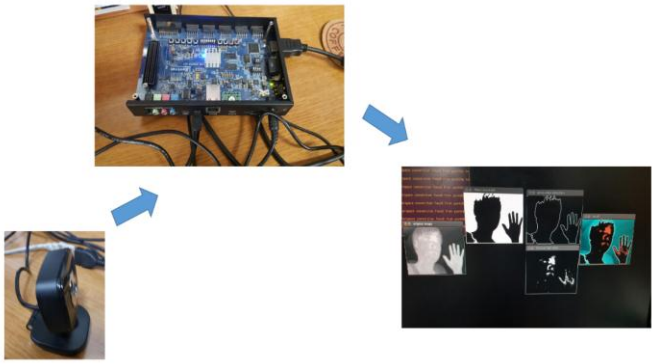

Figure 2: Hardware Set-up

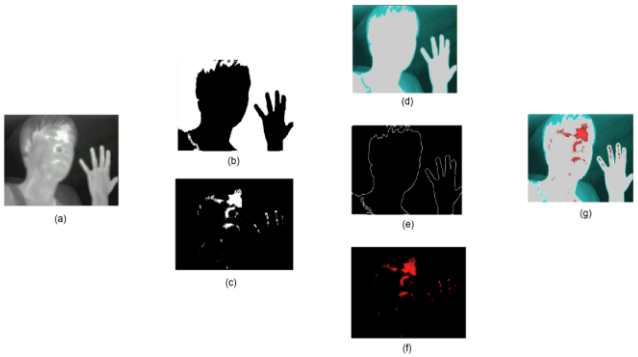

Figure 3: Output presentations

(a). thermal image, (b). the output of the inverted Otsu Method, (c). high thermal threshold image,

(d). processed from color mapping, (e). Canny Edge Detection Output, (f). processed from red color mapping

(g). proposed algorithm output

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