Determination of Threshold Value in Canny Algorithm for Road Crack Detection

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ABSTRACT: In order to ensure the success of intelligent transport systems, several studies have concentrated on automated image-based crack detection as a substitute for manual inspection based on the experience and expertise of the specialist. Furthermore, edge detection is the main in major image processing because to process an image, information such as their edge is important for the image's feature. Canny algorithms have been commonly used in scientific research and practical engineering projects among the various edge detection algorithms because of outstanding performance. Threshold selection is an important factor that determines the output of the Canny algorithm. There will be two fixed global threshold values to clear out the false edges in the conventional Canny edge detection algorithm. However the global threshold values are manually calculated by experiments in the conventional process, leading to calculation complexity when it is required to deal with a large number of different images. To overcome those situations, this paper will propose an improvement to the conventional Canny edge detection by determining all possible threshold values from the histogram of grey level from each image. Then, compare the possible threshold values globally for each image and proposed the algorithm for modification of the Canny edge detection method. In this work, standard image dataset for segmentation from Berkeleys and road image dataset from CrackForest were used for the experiment. The results show that the proposed work gives more meaningful results to apply in the detection crack for road image.

Keywords: *Machine Vision; Edge Detection; Threshold Values; Modification Of Canny Algorithm*

1. INTRODUCTION

Due to the many advantages it provides to manufacturers, machine vision technology has been growing rapidly, such as automating quality control and offering the value of a more detailed assessment system recently. For this purpose, the application of computer vision techniques in the automated identification and assessment of patches, potholes and road pavement cracks has been shown to be especially useful for the transport and highway departments.

In traditional Canny algorithm, the thresholds are not appropriate to edge detection as the image becomes more complex because it is a man-made threshold[1]. The selection of thresholds is a crucial part since the edge of the image is determined by both high and low thresholds. Unfortunately, the traditional Canny algorithm is unable to set the threshold adaptively and makes the algorithm's robustness weak. The true characteristics of the image cannot be shown as the threshold determined is not reasonable. This may cause the missing edge problem and detecting the false edge. As a result, the performance of Canny algorithm will be affected[2].

Several proposed solutions are found to overcome the fixed threshold problem of the traditional Canny algorithm. First, propose a new improved adaptive threshold Canny operator by inherits the merit from the Otsu method and probability model method to get threshold values adaptively. Second by using subtraction histogram method and lastly finding threshold based on minimum cross entropy[3].

A detailed discussion of the materials and methods will be discussed in part 2. It will be used for results and discussions in part 3, as well as the conclusion of the study carried out will be given in part 4 of this paper.

2. METHODOLOGY

Here, the enhancement of the existing threshold values from conventional Canny algorithm will be proposed. By referring to[3] where the use of histogram subtraction to obtain the threshold value. Threshold value ($\boldsymbol{T}$) obtained by subtracting minimum value, $\boldsymbol{H_{min}}$ and maximum value, $\boldsymbol{H_{max}}$from image histogram, as in equation

$$\boldsymbol{T = H_{min} - H_{max}} \quad (1)$$

$\boldsymbol{T}$ is the value for lower threshold and the value for higher threshold was set to $\boldsymbol{5 \times T}$.

In this proposed work, the new way on finding low thresh by using the existing Canny threshold was proposed. New low threshold ($\boldsymbol{TL_1}$) value by subtract high threshold value ($\boldsymbol{TH}$) with low threshold value ($\boldsymbol{TL}$) from existing threshold value obtained from Canny algorithm. $\boldsymbol{TL_1 = TH - TL}$ (2)

Furthermore, new high threshold value ($\boldsymbol{TH_1}$) obtained by $\boldsymbol{TH_1 = 5 \times TL_1}$ (3)

Since proposed equation (2) and (3) shows a success for the proposed algorithm, we tried to get the best result of the experiment. We found that, increases of threshold value are the factor of the good result obtained. Thus, the modification made by focusing to increase both threshold value. Hence, new high threshold ($\boldsymbol{TH_2}$) by

$$\boldsymbol{TH_2 = TL + 3TH} \quad (4)$$

and for new low threshold ($\boldsymbol{TL_2}$) approach from recent work [4] was applied which is

$$\boldsymbol{TL_2 = \frac{1}{2}TL} \quad (5)$$

The proposed modification of threshold values in this work can be summarized using the following Algorithm 1. In this algorithm the proposed enhancement of threshold values involved in step 5 which either using $\boldsymbol{TL_1}$ and $\boldsymbol{TH_1}$ or $\boldsymbol{TL_2}$ and $\boldsymbol{TH_2}$ (refer equation (2) until (5).

Algorithm 1: Proposed work on Canny Algorithm Modification

Input: Image from dataset;
Output: Generation of edge image ;
Start

1. Smooth image with Gaussian Filter*;*
2. Select the intensity gradients of the image;
3. Get rid of false response to edge detection with non-maximum suppression;
4. Find the
5. new TL_1 or TL_2 and TH_1 or TH_2 values using the proposed work;
6. Track edge by hysteresis (removed all weak edges);

End

3. RESULTS AND DISCUSSION

Here, the experiment will be conducted using the steps are shown in Algorithm 1 section 2 will be used. By using the proposed method, F-Measure value

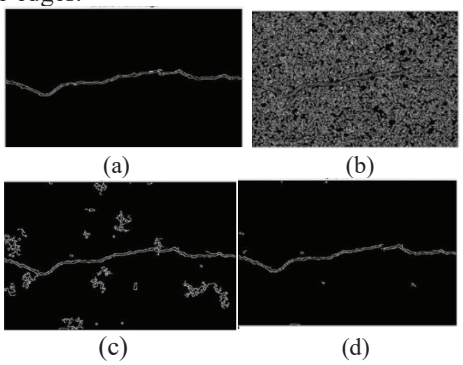
$$\text{F-Measure} = \frac{2\times\text{recall}\times\text{precision}}{\text{recall}+\text{precision}} \quad (6)$$

was obtained from one image in CrackForest dataset [5] as shown in Table 1 below. It is shown that by using proposed TL_2 and TH_2 gives high F-Measure value compared to Canny algorithm and proposed TL_1 and TH_1.

Table 1 F-Measure obtained from CrackForest dataset

Method	F-Measure
Canny	0.091345
Proposed TL_1 and TH_1	0.17175
Proposed TL_2 and TH_2	0.33745

Figure 1 shows edge image generated, the proposed method with TL_2 and TH_2 values is the most approximate the ground truth image provided. The edge image from conventional Canny algorithm had produced more noise or false edges.



(a) (b) (c) (d)

Figure 1 Edge image from(a) Ground truth image (b) Canny algorithm and proposed (c) TL_1 and TH_1 (d) TL_2 and TH_2

From result obtained from CrackForest dataset, the success of this experiment is depending on the threshold value of the image. This has been proven by several images that shared the same threshold value which is (TL_2, TH_2) = (0.0688,0.1719) have the best result compared to other images that has different threshold value. Thus, for CrackForest dataset, value of threshold is the main factor of the success to the experiment.

4. CONCLUSIONS

The proposed algorithm had been tested with road crack image from CrackForest dataset. All possible threshold values from grey level of 20 images from Berkeleys datasets and 110 images from CrackForest datasets have been successfully determined. Each threshold values of the images are compared to the threshold value from conventional method. The result shows that the proposed enhancement by using $\boldsymbol{TL_2}$ and $\boldsymbol{TH_2}$ outperform the other method. This proposed value can generate the values that detect less noise and similar to the ground truth provided by detecting the values in the middle area of the histogram image.

ACKNOWLEDGEMENT

We are grateful to Universiti Teknikal Malaysia Melaka for the assistance and funding to support this work.

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