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Corner Point Detection for The Map of Kariah Kg. Bukit Kapar

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ABSTRACT

Corner point detection are the important technique for many image processing applications including image enhancement, object detection and pattern recognition. The purpose of this study is to detect the corner points of a map of Kariah Kampung Bukit Kapar image by using Harris Corner Detector. Corner points in an image represents a lot of important information of the image. Detection of corner points accurately is significant to image processing, which can reduce much of the calculations. In this study, the initial technique is smoothing the image and extract the boundary of the image. Then, Harris Corner Detector is used to detect the corner points by considering the amount of corner point detection and run time processing. This study proposed the Harris Corner Detector which can detect 154 points with 12.9552 second.

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1. Introduction

A corner can be described as the intersection of two edges, where the edges are a sharp change in image brightness [1]. The corner points are very important in the image processing techniques such as reconstruction of a curve and surfaces. The technique in corner points detection is implemented in several stages. A different technique is used in order to collect the result for every stage.

This study is focus on the corner detection for an image of a map. An original image used for this study is a map of Kariah Kampung Bukit Kapar which is a two-dimensional image. A new

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technique is proposed in corner detection process for a map with an efficient approach of boundary extraction and corner detection.

This paper presents the study that used Harris Corner Detector to detect the corner points. Corner points of an image can describe the contents of the image and extract certain kinds of characteristics within the used computer vision systems. According to [2], corner detection process is the main kernel for various procedures of image processing containing a motion detector and pattern recognition. They are among the most important role in the analytic of visual big data. Corners are the most interesting characteristic extracted from visual images. Corner point detection is still an open problem even though it has been investigated for decades in computer vision.

Researchers in [3] proposed a new technique of corner detection based on KD curvature for a discrete curvature estimation. They also introduced a new concept, corner strength in order to control detection precision. The result shows that the KD curvature method overcomes the current detection in computational flexibility and efficiency of corner detection.

2. Literature Review

A noise reduction and boundary extraction of the image are the initial processes in this study before the corner point detection process is implemented. The first process is to reduce the noise of the image then the boundary of the map of Kariah Kampung Bukit Kapar is extracted. The noise reduction and boundary extraction process are the important techniques in order to get the best result of detection corner point. Based on [4], noise is difficult to prevent without obscuring both object edges and speedily moving structures. The researchers introduce a novel filtering framework to reduced blurring and realized better preserved edges. The three methods are used which are Bayesian Compressive Sensing (BCS), Orthogonal Matching Pursuit (OMP) and the Bregman iterative algorithm.

According to the article by [5], ultrasound speckle reduction method has been used in this research. SUSAN detection used local information to find the features of image from pseudo-global perspective. SUSAN detection produces better structure preservation properties and noise insensitivity. The different Fully Formed Speckle (FFS) region proposed for log-compressed ultrasonic images and envelope-detected speckle images. The result showed the proposed method is better than other methods in noise reduction and detail preservation. Since SUSAN algorithm detected all noise points but not isolated noise points, researchers in [6] used the optimization of original edges response formulation to improve this method by imposing constraint condition. The result showed that salt-and-pepper noise and Gaussian noise improved the SUSAN algorithm in view of sensitivity to detection and noise of edges.

Noise removal is the common problem of image that never been solve completely. Poisson noise is signal dependent noise. Additive noise removal techniques are useless to remove noise. But, bilateral filter, Non-local mean filter and BM3D algorithms produce better removing additive noise. BM3D algorithms and Non-local mean filter are modified to reduce Poisson noise nevertheless it needed extra time to remove the noise. A spatial domain filter is suggested by [7] to modified bilateral filter framework. The advantage of suggested filter is simplicity, edge preserving ability and non-iterative nature. The filter produced more quality of image compared to other method. Besides, the modified bilateral filter required less time than other method.

The boundary of the image is an important technique that can help the researchers to identify the corner points. According to [8], boundary extraction is the extraction edges of digital image process from a binary image and the basic used for extracting edges on grey and color scale image. An original image is converted to a binary image, which is a black and white image [9]. A binary image is an image in which every pixel assumes one of only two discrete values. The morphological operations are used on the binary image. Morphology is a broad set of binary image operations that process images based on shapes.

Furthermore, the researchers of [10] proposed a simple boundary extraction method by creating a new where-to-go approach for irregular pupil boundary localization that extracts the irregular pupil's boundary points from the edge map. This method is a simple boundary extraction technique that can extracts the pupil boundary point perfectly.

In addition, another study from [11] examined Modified Active Shape Model (MASM) technique to boundaries extraction of the book in the scanned book images and assumes the book page corners are provided and two of the pages are included in scanned images. This method introduces one set of landmark points in the idea of book shape which is a sampling from book boundary.

Corner detection is the main kernel for various types of image processing procedures containing motion detection and pattern recognition. Therefore, researchers from [12] proposed effective shape corner point detection and a framework that contains smoothing and corner point localization nonlinear anisotropic diffusion filter. The points are characterized by maximum curvature value. The detection is very important in some applications including object recognition and motion tracking.

Based on [13], the determination of the position of the lesions and segmentation of the blood vessel are very important to detect the location of the optic disc in computer-aided diagnosis of retinal images. They proposed an algorithm of optic localization to improve corner detection algorithm by using the features in order to avoid the failure of the location of the optic disc.

The article from [14] represented a robust approach to corner point detection and tangent vertices in parametric cubic curves of the stroke for additional radius function calculation called Tangent and Corner Vertices Detection (TCVD) approach. The approximated piecewise curves are calculated using radius function to obtain curves that cause a lot of noise-free than discrete radius calculation. Besides, a study from [15] enhanced the detection accuracy by comparing the Harris corner detector and the sub pixel corner detection approaches. They found cornerness map in x-axis and y-axis separately by fitting quadratic curve using orthogonal vectors theory and iteration process coordinates.

There are a lot of studies in noise reduction, boundary extraction and corner point detection. Various techniques have been used for this study in order to get accurate result of boundary extraction and corner point detection.

3. Methodology

This study involves several processes in order to achieve the objectives. The processes are started with getting the original image and the next processes as shown Figure 1 below.

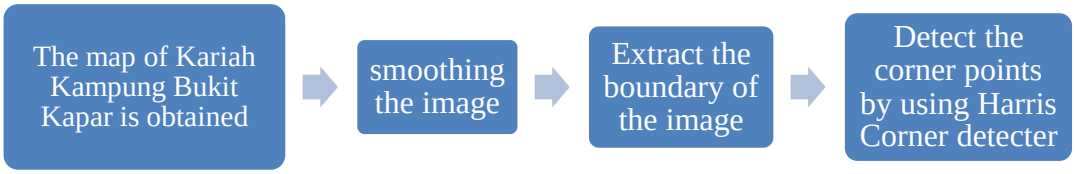

Figure 1 The processes in detecting corner points

In the first step, a two-dimensional image was obtained from the website infobukitkapar.blogspot.com with the title of 'Pelan Sempadan Kariah Kampung Bukit Kapar, Klang, Selangor'. The original image is shown in Figure 2.

Figure 2 The original image

Adobe Photoshop CS6 Software was used to remove the noise of the image and by using Gaussian filter, the image converted to be smoother than the original. This study applied morphology operation to extract the boundary image by using erosion operation. Morphology is a broad set of binary image operations that process images based on shapes. Erosion is an operation that 'shrinks' or 'thins' objects in a binary image. The original image is converted to the binary image and the Erosion operation is applied to extract the boundary of the image. Boundary extraction is the outline extraction of a digital image from a binary image. Boundary extraction is the process to develop the information and understand the feature of an image.

For the corner detection process, Harris Corner Detector is used in this study. The formula of Harris Corner Detector is given as in Equation (1).

$$E(u,v) = \sum_{x,y} w(x,y)[I + (x+u, y+v) - I(x,y)]^2 \quad (1)$$

where $\sum_{x,y} w(x,y)$ is the window function, $I + (x+u, y+v)$ is shifted intensity and $I(x,y)$ is the intensity.

Harris Corner Detector design a local detecting window to detects feature points inside the image. The average variation in pixel intensity will determine the different direction in small amount of window shifting. The center point of the window is called the corner point. Thus, the large amount of variation in pixels intensity will be seen if the window shift in any direction. If a flat region appears, no change is seen in pixel intensity when the window is shifted in any direction. The edge region will be detected when the pixel intensity is not change along the direction of edge. Therefore, the corner was detected in pixel intensity when there were significant changes in every direction.

In mathematical approach, Harris Corner Detector will determine whether the region found is edge, corner or flat. This operation will detect a greater number of features in image.

4. Results and Analysis

The result of boundary of image as shown in Figure 3 was extracted by using the Erosion operation.

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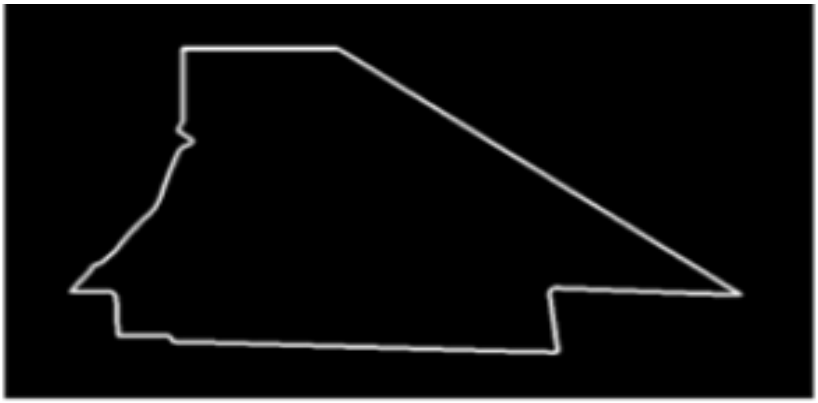

Figure 3 Boundary extraction

Then, Harris Corner Detector that has been applied on the image resulted to produce corner point detection as shown in Figure 4.

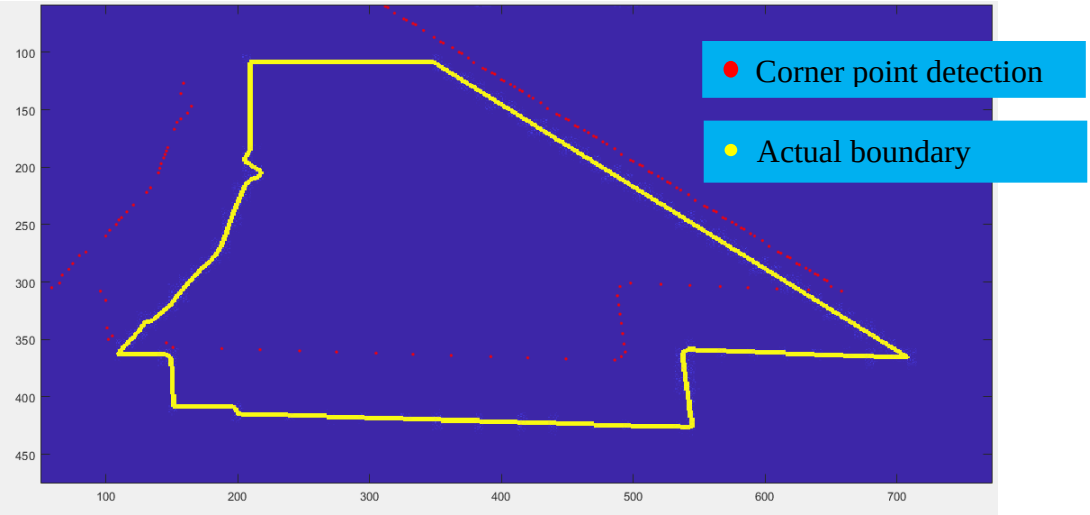

Figure 4 The corners point detected by Harris Corner Detection algorithms

The corner points are showed by the red dots. The yellow line is the actual boundary of the image. The result of total corner points detected by the corner detector are shown in Table 1.

Table 1. The total corner points detected and the run time of Harris Corner Detector

Algorithm	Corner Point detection	Run Time (sec)
Harris Corner Detection	154	12.9552

Harris Corner Detector is a mathematical approach algorithm that can detect the corner points by using a simple concept of image gradient. It designs a local detecting window to detects feature points inside the image. Besides, the large amount of variation in pixels intensity will be seen if the window shift in any direction. Therefore, this can give an idea for the researchers to choose the accurate corner detector.

5. Conclusion

The most important element in image processing is to enhance the quality of image and perform features extraction and classification. The initial technique for this study should provide a good result in basic technique such as boundary extraction and corner point detection. Harris Corner Detector is a proposed method for the researchers in order to detect the corner points of an image given by 154 point with 12.9552 second. For further recommendation in this study, there are several proposed methods that can be tested such as Features from Accelerated Segment Test (FAST) corner detector or Moravec corner detector.

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