CARS DETECTION IN STITCHED IMAGE USING MORPHOLOGICAL APPROACH

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JOSELYN JOK

A dissertation submitted in partial fulfillment
of the requirements for the degree of
Bachelor of Engineering (Hons)
in Electronics (Computer)

Faculty of Engineering
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Dedicated to my beloved family and friends

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ABSTRACT

The techniques of image processing which capable to be implemented in object detection and classify accurately plays an important role in developing better computer vision applications such as visual surveillance for behavior analysis and image analysis. This project presents a method to detect cars in panoramic or stitched images which taken from top view angle. Image stitching is basically a process to align and combine few images to produce a panoramic view of the particular scene. The method use to stitch the image is Scale Invariant Feature Transform (SIFT) which perform more accurate matching compared to Speeded Up Robust Features (SURF). Related algorithms using mathematical approach such as alpha blending will be implemented in the project to enhance the image stitching method for a better quality stitched image. There are many type of researches on the topic of car detection are investigated in term of noise elimination at the initial part of the project to get the region of cars. The main functions of the car detection system in this project are capable to recognize and count the number of cars in the aerial type of stitched image by using morphological method which enhanced by using median filtering and convolution. The method is improved by using algorithm which removes noise by sizes. The methods integrate with bounding box to count the number of the cars. The performance of the proposed cars detection algorithm could detect the cars fairly accurate. In addition, this project could be a solution to detect trapped cars in a flood to provide useful information to the rescue department where the image sequences of the flood scene could be stitched together to get a wider view of the flood without zooming the view of the scene to get the whole view of the flood. At the end of the project, some future recommendation for the system's development will be presented.

ABSTRAK

Teknik-teknik pemprosesan imej yang mampu melaksanakan proses pengesanan objek dan pengelasan yang tepat memainkan peranan yang penting dalam pembangunan aplikasi visi komputer yang lebih tepat seperti pengawasan visual untuk menganalisis tingkah laku dan imej. Projek ini membentangkan kaedah untuk mengesan kereta dalam imej panorama atau imej dijahit yang diambil dari sudut pandangan atas. Jahitan imej pada dasarnya adalah proses untuk menyelaraskan dan menggabungkan beberapa imej untuk menghasilkan pemandangan panorama tempat kejadian tertentu. Kaedah yang digunakan untuk menjahit imej adalah 'Scale Invariant Feature Transform (SIFT)' yang melaksanakan proses penjahitan dengan lebih tepat berbanding 'Speeded Up Robust Features (SURF)'. Algoritma yang berkaitan dengan menggunakan pendekatan matematik iaitu pengadunan alfa atau dikenali sebagai 'alpha blending' akan dilaksanakan dalam projek ini untuk meningkatkan kaedah jahitan imej untuk menghasilkan imej jahitan yang lebih berkualiti. Terdapat banyak kajian mengenai topik pengesanan kereta telah dikaji dari segi penghapusan elemen yang tak diingini di peringkat awal projek untuk mendapatkan elemen kereta. Fungsi utama sistem pengesanan kereta dalam projek ini mampu untuk mengenalpasti dan mengira bilangan kereta dalam imej jenis satelit yang dijahit dengan menggunakan kaedah morfologi dan dipertingkatkan dengan menggunakan penapisan median dan fungsi konvolusi. Algoritma ini juga dipertingkatkan dengan menggunakan kaedah penghapusan elemen yang tidak diingini mengikut saiz. Kaedah tersebut digabungkan dengan kaedah 'Bounding box' untuk mengira bilangan kereta. Algoritma pengesanan kereta tersebut dapat mengesan kereta dengan agak tepat. Di samping itu, projek ini boleh menjadi penyelesaian untuk mengesan kereta yang terperangkap dalam kawasan banjir dan memberi maklumat yang berguna kepada pasukan penyelamat di mana urutan imej tempat kejadian banjir tersebut boleh dijahit untuk mendapatkan pandangan yang lebih luas tanpa mengambil pemandangan tempat kejadian dari tempat yang sangat tinggi untuk mendapatkan keseluruhan pemandagan kawasan banjir tersebut. Pada akhir projek ini, beberapa cadangan akan dikemukan untuk pembangunan sistem tersebut.

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LIST OF ABBREVIATIONS

SIFT	-	Scale Invariant Feature Transform
PCA	-	Principal Component Analysis
SURF	-	Speeded Up Robust Features
DoG	-	Difference of Gaussian
RANSAC	-	Random Sample Consensus
RGB	-	Red, Green, Blue
UNIMAS	-	Universiti Malaysia Sarawak
FSS	-	Faculty of Science Social
FEB	-	Faculty of Economic Business
FLSCS	-	Faculty of Language Studies and Communication Studies
FENG	-	Faculty of Engineering
CTF	-	Centre of Training Facilities

CHAPTER 1

INTRODUCTION

1.1 Background

During the last few years, object detection has been used in many applications such as robotics, security surveillance, photo management, transportation and etc. All of these applications has different requirements, including processing time, robustness to occlusions, invariance to rotations and detection under pose changes. However, most detection methods are commonly used to detect the object from video or static, single image. Hence, this research project proposed method to detect objects such as cars in stitched image. The stitched image is an aerial, panorama type of image which is a combination of few images extracted from video frames captured by the drone.

During the image acquisition process, many problems might occur which could affect the error in detecting the feature of the cars. For examples, the output stitched image of cars in the captured images by the moving drones may have uncertainties of brightness due to weather conditions and distortion effects on the cars. Furthermore, the output of image stitching could have the error where the images overlap with each other due to uncertainties in recorded video rotation, height and angle since the movement of the drone could easily be disrupted by the flow of wind.

In this project, three methods has been selected to detect the car in the stitched image which are Scale Invariant Feature Transform (SIFT) which enhanced by alpha blending for the image stitching process, morphological method which enhanced by

median filtering and noise removal by sizes to detect the cars and bounding box to count the detected cars.

Image stitching is generally a process to combine few pictures taken from different view of the same particular scene to generate a large panoramic image of the scene without overlapping. Stitched images are used in applications such as defense documentary photos, glob map and space research images, etc. [1] In image stitching method, there are three important steps to produce a high resolution panoramic image which are image registration, image calibration and image blending.

Image registration is a process of overlaying the images taken on a particular scene from different viewpoints. This process is useful in the alignment of the desired input image, a time series of images of the same scene, or the separate bands of a composite image (co-registration) [2]. Furthermore, the technique of image calibration is used to minimize the differences which happened between an ideal lens model and camera lens model. It also could reduce some optical issues such as distortion and exposure differences. [3] Image blending is a technique to smooth the transaction between the stitched images. [4] Without image blending, there will be a few obvious seam lines appeared at every transaction of the image.These obvious seam lines could cause errors occur in detecting the image features and reduce the quality of the stitched image. In addition, direct technique and feature based technique for image stitching will be discussed in the literature review section.

Scale Invariant Feature Transform (SIFT) method is selected to implement the image stitching process because it is more accurate than SURF in term of key features matching in the image. Speeded Up Robust Features (SURF) method has disadvantage in identifying the key features where it detects fewer matching key features compared to SIFT. [5]

In many computer vision systems, object detection is performed to obtain further information regarding the detected object. Once the object has been detected, it is possible to obtain further information to further analyzed it such as recognizing and counting the object. In this project, the object detection is more focus on aerial type of image. According to Tao Zhao and Ram Nevatia [6], aerial images have been well studied in computer vision over the years. However, due to the complexity of the

background and variance type of object presence in the aerial image, a robust and efficient detection is still considered as a challenging problem.

In this project, a method called 'morphological' will be used and implemented in the stitched image to detect the cars. Before implementing morphological algorithm, median filtering is applied on the stitched image to reduce undesired noise and enhance the image data. Then, morphological filtering is applied to further reduce the noise, merge separate blobs and separate the merge blobs associated with each object. After that, the convolution of image is applied to further enhance the image data. The algorithm is improved by a method that removes the unwanted elements by defining the smallest and largest size areas which do not belong to the interest object which is car. Then, the detected object is recognized and count by using the bounding box.

1.2 Problem Statement

Object detection system is one of the technologies that has been available worldwide for years and has been implemented in various type of application. Although it is a kind of matured technology, most object detection techniques were implemented in video or a single image. Detecting object in stitched image (panoramic image) has not been done by any researchers. Implementing object detection algorithm in stitched image could be quite challenging since it depends on the output of the image produced by the image stitching process.

The scene of the stitched image was taken from top view angle by using the drone. It is quite challenging because of the cars' various sizes, color, the level of brightness due to different weather, overlapping images and distortion in the stitched image. Therefore, the problem is encountered by selecting the extracted image by visual inspection to ensure good quality of stitched image in which could reduce the errors in detecting the objects.

1.3 Objectives

The main objectives of this project are:

1) To develop the algorithm for object detection in stitched image system and enable object detection method which particularly for cars.

2) Integrate the algorithm with object recognition and counting algorithm.

3) Evaluate and compare the performance of the object detection in few stitched images of different parking lots scenes.

1.4 Scope of project

The objects used as the sample for object detection in this project are limited to cars. What makes this project different from other research works is the object need to be detected in a stitched image where the images are extracted from the video recorded by a drone from a far distance, top view angle. The camera of the drone is set to 90 degree, pointing downward. Since the object detection sample is cars, the most suitable area to implement the project is at the parking lot area as shown in figure 1.1. The chosen parking lot area need to be within Universiti Malaysia Sarawak (UNIMAS) area due to the restriction applied by Department of Civil Aviation (DCA) Malaysia upon the usage of flying the drone. Flying drone within UNIMAS are is considered as one of the research activity. Meanwhile, flying the drone outside the campus area could be consider as illegal without proper permission from the higher authority.

Figure 1.1: Image taken by drone at Science Social faculty's parking lot, UNIMAS

1.5 Expected Outcomes

This project is based on the simulation program developed using MATLAB. This project also uses hardware which is a camera attached to the drone, to record the video of the parking lot scene. Then, the images are extracted from the video are process through the image stitching algorithm to produce stitched image which will be used as the input image of cars detection algorithm. The type of drone used in this project is DJI Phantom 3 Standard attached with high resolution camera which could capture up to 2.7k aerial video.

The expected outcome of this project is to develop a system that can detect cars in stitched image by using image processing technique in MATLAB. Hence, it is expected that the knowledge and theories of the cars detection and the image stitching algorithms are explored and studied. Furthermore, the detection system which develop by using Matlab application is expected to be able to recognize and count the detected cars from few stitched images of different parking lot scenes in order to analyze the performance of the object detection algorithm in the stitched images.

1.6 Project Outline

This project is organized into five chapters which include the Introduction, Literature Review, Methodology, Result and Discussion, and Conclusion. The chapters are arranged respectively from Chapter 1 to 5. Chapter 1 gives an overview of the content of the project, problem statement, objectives and the expected outcome of this project.

In Chapter 2, some recent relevant works and researches that had been carried out by others are reviewed with explanation to give a clear understanding of the project.

Chapter 3 discusses about the methodology of the process to obtain the result, the analysis process and the methods selection which will be used in the project including the mathematical algorithm approaches. Furthermore, it also outline the object detection algorithms and describe the terminology of the software used, which is MATLAB.

Chapter 4 evaluates the overall performance of the system and simulation result of the image stitching and object detection. In addition, this chapter also demonstrates and explains the result obtained including the discussion of the project.

In Chapter 5, the finding obtained throughout the final year project is summarized. This chapter will conclude the overall process of this project. Moreover, future works and recommendations which can be implemented on this project for further improvement in the future will be suggested in this chapter.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview

The literature review discuss the finding of the theories and related information regarding the image stitching and object detection. In this chapter, related works on image stitching and object detection from various researches will be explained in this chapter. Besides that, this chapter also describes the feature detection such as corner detection and blob detection. Furthermore, the scale space theory and techniques of image blending also been discussed in this chapter. The morphological method, median filtering, noise removal and cars detection algorithm are also discussed in this chapter.

2.2 Image Stitching

Image stitching or Mosaicing is generally a process of aligning and combining multiple overlapped images which taken from various viewpoints to construct a wide view of panoramic image with high resolution [7]. Image stitching is widely used in surveillance application, panorama photography [8] and medical training, [9]. There are three main components to implement image stitching process which are registration, calibration and blending as shown in figure 2.1.