MULTIPLE FACE DETECTION FOR SURVEILLANCE SYSTEMS

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This report is submitted in partial fulfilment of the requirements for the degree of Bachelor of Electronic Engineering with Honors

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I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Bachelor of Electronic Engineering with Honours.

Signature	:	……
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Date	:	……

DEDICATION

Dedicated to my family and friends for their caring and encouragement.

ABSTRACT

Surveillance system is observing a scene by using electronic equipment such as closed-circuit television (CCTV) camera. Pan-tilt-zoom (PTZ) camera is a camera with the ability of changing the position of the scene by pan and tilt features. The downside of the camera is unable to capture the face clearly as it focuses on the static point of the lens. Thus, the goal of the project is to develop a surveillance system that is capable to detect face within the camera view. This project was developed by using LabView and Microsoft Visual Studio. The data from camera and navigation system were implemented by using LabView whereas the face detection system was done by using both LabView and Microsoft Visual Studio. The performance of the face detection was examined by conducting various kind of experiments, which include facial orientation, movement of the face, obstruction on face and light conditions. The accuracy was achieved at 89% and the system able to detect minimum 10 faces in a view of a scene.

ABSTRAK

Sistem pengawasan memantau keadaan pada tempat permerhatian dengan menggunakan peralatan electronik sperti kamera litar tertutup (CCTV). Kamera pan-tilt-zoom (PTZ) adalah kamera yang mempunyai keupayaan menukar kedudukan tempat pemerhatian melalui ciri-ciri pan dan kecondongan. Kelemahan kamera adalah sukar untuk menangkap wajah dengan jelas disebabkan statik lensa pada kefokusan kamera. Oleh itu, tujuan projek ini adalah memajukan sistem pengawasan yang mampu mengesankan wajah dalam pandangan kemera. Projek ini memajukan dengan menggunakan LabView dan Microsoft Visual Studio. Data dari kamera dan pengawalan kamera dilaksanakan dengan menggunakan LabView, manakala sistem pengesanan wajah dilaksanakan dengan menggunakan LabView dan Microsoft Visual Studio. Pretasi pengesanan wajah telah diuji melalui beberapa eksperimen, termasuk orientasi wajah, pergerakan muka, halangan pada muka dan kecerahan pada pandangan kamera. Ketepatannya dicapai pada 89% dan sistem ini dapat mengesan sekurang-kurangnya 10 muka dalam satu pandangan yang ditangkap dalam kamera.

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LIST OF SYMBOLS AND ABBREVIATIONS

CCTV	:	Closed-Circuit Television Camera
DVR	:	Digital Video Recorder
NVR	:	Network Video Recorder
LAN	:	Local Area Network
IP	:	Internet Protocol
PTZ	:	Pan-Tilt-Zoom
CNN	:	Convolutional Neural Networks
GPU	:	Graphics Processing Unit
ELM	:	Extreme Learning Machine
FOV	:	Field of View
LPF	:	Low Pass Filter
VI	:	Virtual Instrument
DLL	:	Dynamic Link Library

CHAPTER 1

INTRODUCTION

This chapter is briefly explained about the background of this project and three problems will be included in the problem statement. Besides that, objectives and scope of the project will be covered in this chapter as well. Furthermore, the thesis outlines are briefly explained the overview of every chapter.

1.1 Background

Surveillance system is the monitoring of the behavior or activities with the purpose of influencing, managing, directing or protecting people. It can be used to observe the scene from a distance by using electronic equipment such as closed-circuit television (CCTV) camera. CCTV is a television system that is not used for broadcasting but is connected by cables to selected monitors. The security camera can be functioned in analogue or digital and send the signals to a storage device such as

video tape recorder or computer. Analogue camera is recorded by a video tape recorder, and the tape need to be operated continuously at a slow speed. Analogue signals also able to convert into a digital signal to store the digital recordings in computer or digital video recorder (DVR). As for digital camera, it can save the data directly into computer instead of using a video tape or video capture card to record the data. Digital cameras have lesser cables to connect network video recorded (NVR). Besides that, there is no limitation in distance between camera and NVR as they are connected by local area network (LAN).

An IP (Internet Protocol) camera, also referred as network camera is a type of digital video camera often used for surveillance which can transmit and receive the data through a computer network and Internet. An IP camera with the ability of pan, tilt and zoom is known as PTZ (pan-tilt-zoom) camera. This camera offers a wide range of area to be captured at multiple angles and views. PTZ camera provide a remote viewing software that the camera can be controlled from smart phone or laptop computer. It also can be set into an automatically move when action is detected. Most of the cameras can have more than 300 degrees pan and up to 180 degrees tilt. The movement of the camera can reduce the blind spot around the camera. The quality of the image may be reduced as it magnifies the existing image.

As the common security camera and PTZ camera have similar functions which is monitor the area, but there are some differences between the cameras. A common security camera has a fixed position to monitor a specific area. This limit the monitoring area as it unable to move the position of the camera. However, a PTZ camera can cover larger areas to monitor as it able to pan, tilt and zoom. Both pan and tilt can be remotely controlled, manually or automatically to change the angle of the camera. By the functions of PTZ, it able to reduce the number of fixed cameras to

monitor the specific areas. A common security camera required a DVR or NVR to record the data that has been observe. Cables are needed to make a connection between camera and DVR or NVR. A PTZ camera is a wireless surveillance camera which allow to place the camera anywhere. As it is wireless camera, it can be controlled by using a device through internet. Yet, PTZ cameras are less durable than common security cameras because there are individual motors to perform pan, tilt and zoom. The parts are often in motions are easily leads the camera to spoil.

1.2 Problem Statements

Surveillance camera often unable to capture individual face clearly while recording the scene. This is because there is an issue at the focus on the static point of the lenses. This leads to the playback getting blurry and unable to identify the person. There are some studies which facing the similar issue of detection on the face, but none of them is focusing on using PTZ camera for surveillance system. The implementation of algorithms in PTZ camera is needed to control the observing area in clearer view. Among all, the most prominent method for face detection in real time is using Viola-Jones method. In our study, Viola-Jones method will be used on PTZ camera to detect on the face. The accuracy of the performance is important as it can be used as evidence in unexpected events.

1.3 Objectives

The goal of this project is to develop a surveillance system that is capable to focus on the detected face within the camera view. In order to achieve that, the listed objectives need to be completed:

i. To configure the PTZ IP camera or manual navigation.

ii. To apply the face detection algorithm in the camera view.

iii. To evaluate the system performance for accuracy and reliability.

1.4 Scope of Project

This project mainly focuses in the implementation of the camera by using LabView. The application focuses on the implementation of face detection by using Viola-Jones method and develops autofocus feature. The facial features will be trained to increase the accuracy of face detection.

1.5 Thesis Outlines

The thesis is divided into five chapters. Chapter 1 introduces an overview of the surveillance system, PTZ camera to the reader. It also included background, problem statement, objectives, scope of project and thesis outlines.

Chapter 2 explains the theories related to the face detection and auto focus method. The related researches with similar aim, problems or design are briefly explain and compared.

Chapter 3 shows the overall flow of the project by using a flowchart. The working principle of the suggested system is explained in detail.

Chapter 4 shows the result of the performance of the camera. Issues related to the precision is also discussed in this chapter.

Chapter 5 conclude the project development on the current stage. Some recommendations for future improvement are also added.

CHAPTER 2

BACKGROUND STUDY

This chapter included the knowledge and previous research work from the articles, journals and websites. In addition, it also discusses about face detection methods between Viola-Jones detection and Convolutional Neural Network.

2.1 Face Detection

Face detection is a computer technology that able to identify human faces in digital images in real-time environment [1][2]. Nowadays, a security camera with the ability of face detection is common as it is an effective way to detect the appearance of human in the scene. Human face is easy to recognize by camera by locking the features of eyes, nose and lips [3][4]. The system will try it best to track down the face when a face is detected. However, the detection lock will stop when part of the face is unable to be found. Hence, the detection capability to tracking the face is improved by

reducing the limit to only one part of the face. Also, there are some camera detection modes that able to detect several faces at once [5] and focus the one that is closest to the camera. This mode can be abolished by selecting the face manually. Face detection is a challenging task because it needs to consider various parameter in facial expression, facial orientation, lighting as well as high computational complexity [1][6].

2.1.1 Viola-Jones Method

The Viola-Jones method is mostly widely used algorithm due to its relatively high speed, precision and efficient in detecting face on the scene [7]. A face can be detected by scanning a sub-window ability in a given input image or scene as it is the basic principle of the method. According to researches [8][9][10][11], the face detection begins with reading a face image captured by camera. From the captured image, it will undergo the image processing in the Haar-like feature step. The image with Haar-like feature is then used integral image on a different scale into small units of pixel values. The pixels value will sum up from the top left to bottom right. After that, a machine learning method, known as AdaBoost is used to select the specific Haar-like feature. AdaBoost creates a strong classifier by combining the weak classifiers. AdaBoost will filter the image to detect the presence of the face. The next stage is Cascade Classifier. The weight given by AdaBoost decide the order of filters on the cascade. The larger weighted filter will process first to eliminate the non-face image area as fast as possible. Lastly, the image will show the result of the face detection. The block diagram of Viola-Jones procedure is shown in Figure 2.1.

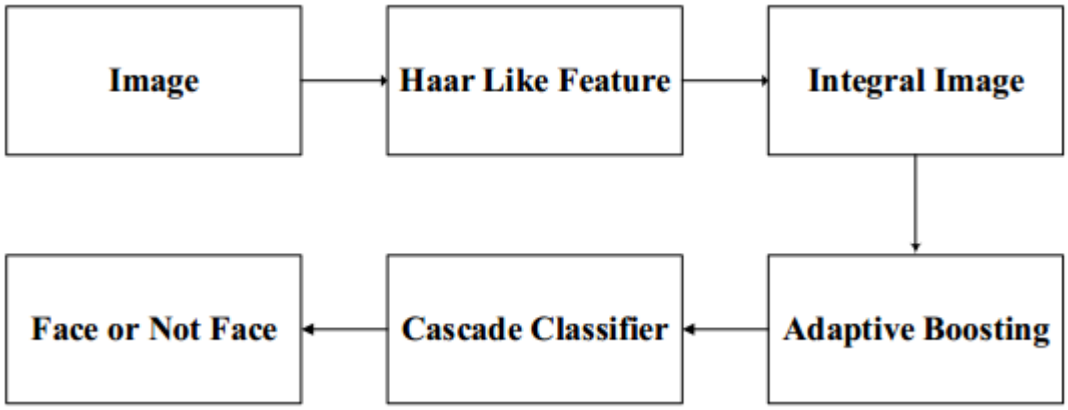

Figure 2.1:The block diagram of Viola-Jones procedure.

2.1.1.1 Haar-like Feature

The Viola-Jones face detection begins with transform the input image into integral image. This can be done by constructing the pixels balance to the entire sum of all the pixels. This is shown in Figure 2.2.

1	1	1
1	1	1
1	1	1

Input image

1	2	3
2	4	6
3	6	9

Integral image

Figure 2.2: The Integral Image

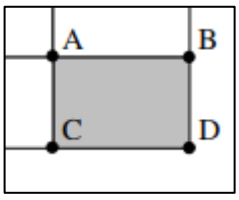

Figure 2.3: Finding the sum of the shaded rectangular area.

Any given rectangular required four values of the pixels to obtain the sum of the calculation. In Figure 2.3, the formula to compute the sum of the grey rectangular area in the image as shown:

$$\text{Sum of grey rectangle} = A - (B + C) + D \quad (1)$$

Where points A, B, C and D belong to the integral image shown in Figure 2.3. As the sum of pixels within the rectangles of random size can be calculated in constant time, four different types of features are used to analyze the face characteristics and able to be determined at high speed at any scale and location [7]. The different types of features are demonstrated in Figure 2.4. The base resolution of the detector is 24x24 which is explained by Viola-Jones, and features are extracted at all possible locations and scales [7]. Although these features may seem simple to perform complicated mission such as face detection, but they able to compute the image efficiently.

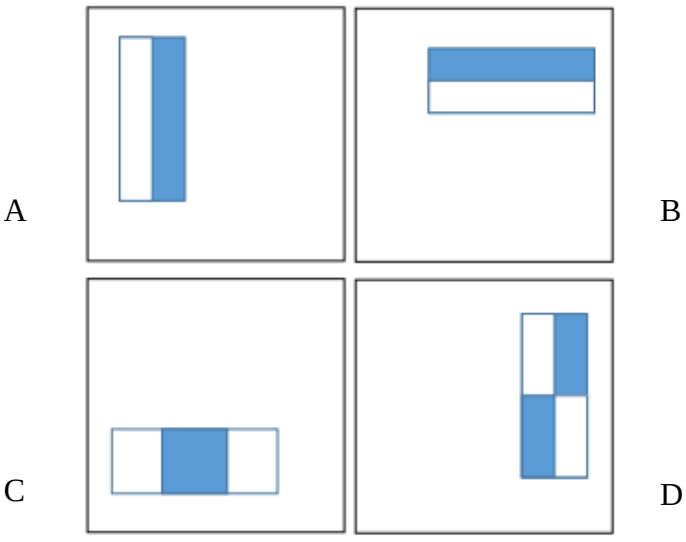

Figure 2.4: The four different types of features. Two-rectangle features are shown in (A) and (B). Three-rectangle feature is shown in (C) and (D) is a four-rectangle feature.