UNIVERSITI PUTRA MALAYSIA

WEB CAMERA APPLICATION FOR MOTION DETECTION

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WEB CAMERA APPLICATION FOR MOTION DETECTION

By

KOAY SU YEONG

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia in Fulfilment of the Requirements for the Degree of Master of Science

April 2003

DEDICATION

To

My father : Koay Chew Bin

My mother : Teh Poh Gek

My sisters : Koay Si Hui and Koay Si Wei

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirements for the degree of Master of Science

WEB CAMERA APPLICATION FOR MOTION DETECTION

By

KOAY SU YEONG

April 2003

Chairman : Hj. Abdul Rahman Ramli, Ph.D

Faculty : Engineering

Motion detection is the ability to recognize the presence of movements. There are many different ways to detect motion. The conventional way is by using either active sensor or passive sensor. The new method to detect motion is "vision motion detection". It is the artificial way of machine vision system compared to human's vision in detecting motion. Motion detection is the most important feature in digital video surveillance system. It gives the camera the capability to capture when needed rather than capture all the time and this leads to huge reduction in storage space. Alarm can also be triggered when unexpected motion is detected. This relieves the personnel in monitoring at all time.

This thesis presents the design and implementation of a low cost security system. The system consists of only a web camera and a personal computer, which is incorporated with motion detection capability. The motion detection capability is using the concept of "motion detection by vision". Therefore no hardware sensors like active sensor and passive sensor are required. The motion detection capability provided in this system is derived from image subtraction method.

This thesis project consists of three main stages, namely hardware setup, simulation and implementation. The first stage is setting up the system of which consists of PC and web camera. The web camera is only operable with the web camera driver installed in the PC. In the second stage, simulation done on the frame images using Matlab with Image Processing Toolbox as simulation tool to investigate the possibilities of motion detection algorithm on images captured by web camera. In the third stage, implementation process is done by coding the motion detection software using Microsoft Visual Basic 6.0. The algorithm that was successfully simulated is used as the reference for forming the working mechanism in creating motion detection software. This self-created motion detection software is then installed and run on the PC to function as a complete intelligent motion detection system.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia untuk memenuhi keperluan untuk ijazah Master Sains

APPLIKASI KAMERA WEB UNTUK PENGESANAN PERGERAKAN

Oleh

KOAY SU YEONG

April 2003

Pengerusi : Hj. Abdul Rahman Ramli, Ph.D

Fakulti : Kejuruteraan

Pengesanan pergerakan merupakan kebolehan untuk mengesan kehadiran pergerakan. Terdapat pelbagai cara yang berbeza untuk mengesan sesuatu pergerakan. Cara biasa ialah dengan menggunakan pengesan sama ada penderia jenis aktif atau penderia jenis pasif. Kaedah baru untuk mengesan gerakan ialah dengan "pengesanan pergerakan dengan penglihatan". Ia merupakan sistem penglihatan mesin secara buatan manusia berbanding dengan penglihatan manusia dalam pengesanan pergerakan. Pengesanan pergerak merupakan ciri yang paling penting di dalam sistem pengawasan video digital. Ia memberi keupayaan kepada kamera untuk merekod ketika perlu membanding dengan merekod setiap masa dan mengurangkan banyak ruang penyimpanan. Penggera juga dapat dicetuskan ketika pergerakan tidak dijangka

dikesan. Ini mengurangkan beban kakitangan dalam kerja mengawas pada setiap masa.

Tesis ini menyampaikan rekabentuk dan pelaksanaan satu sistem keselamatan kos rendah. Sistem ini hanya terdiri daripada satu kamera web dan sebuah komputer peribadi, yang mempunyai daya keupayaan untuk mengesan pergerakan. Keupayaan pengesanan pergerakan ini menggunakan konsep "pergerakan pengesanan melalui penglihatan" .Maka, tiada penderia aktif atau pengderia pasif yang diperlukan. Keupayaan pengesanan pergerakan yang terdapat di dalam sistem ini adalah diterbitkan daripada kaedah "penolakan imej".

Projek tesis ini terdiri daripada tiga peringkat utama, iaitu penyusunan perkakasan, simulasi dan pelaksanaan. Peringkat yang pertama ialah menyediakan perkakas yang mana terdiri daripada komputer dan kamera web. Kamera web hanya boleh berfungsi dengan pemacu kamera web yang dipasang dalam komputer. Pada peringkat kedua, simulasi imej daripada video dijalankan dengan menggunakan perisian Matlab dengan *Image Processing Toolbox* untuk menyiasat kemungkinan algoritma pengesanan pergerakan. Dalam peringkat ketiga, proses pelaksanaan dilakukan dengan pengekodan perisian pengesanan pergerakan dengan *Microsoft Visual Basic 6.0*. Algoritma yang berjaya dalam simulasi digunakan sebagai rujukan untuk membentuk mekanisme perlaksanaan dalam pengekodan perisian pengesanan pergerakan. Perisian ini kemudian dipasang dan berfungsi sebagai suatu sistem cerdik yang lengkap dengan keupayaan pengesanan pergerakan pada komputer.

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Last but not least, I would also like to thank my parents and family members for all their supports. Without their unlimited support in many ways, I will not be able to complete this thesis.

I certify that the Examination Committee has met on April 2003 to conduct the final examination of Graduate Student on his Master of Sciences thesis entitled "Web Camera Application for Motion Detection" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulation 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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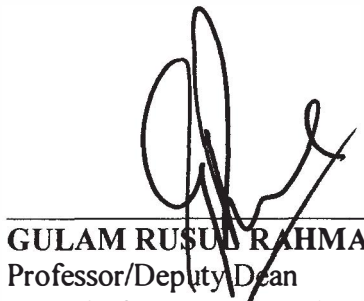

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The Thesis submitted to the Senate of Universiti Putra Malaysia has been accepted as fulfillment of the requirements for the degree of Master of Science. The members of the Supervisory Committee are as follows:

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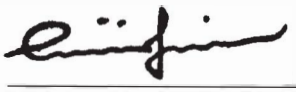

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DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations, which have been duly acknowledged. I also declare that it has not been previously or con-currently submitted for any other degree at UPM or other tertiary institution.

KOAY SUYEONG @ GUO SI-YONG

Date : 26 SEP 2003

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LIST OF ABBREVIATIONS

2 D	:	Two Dimension
3 D	:	Three Dimension
AVI	:	Audio Video Interleave
BMP	:	Bitmap image
fps	:	Frame per second
GIF	:	Graphics Interchange Format
JPG or JPEG	:	Joint Photographic Experts Group
PC	:	Personal Computer
RGB	:	Red, Green, Blue
TGA	:	Targa Graphics Adaptor
USB	:	Universal Serial Bus

CHAPTER I

INTRODUCTION

1.1 Motion Detection

Motion detection includes detecting and recording the whole movement process. The purpose of motion detection is to provide an automatic detection in the region of interest. The task for motion detection is to detect motion in a region of interest. This region is always embodied in a region of awareness or in terms of the camera geometry is called the field of view. It is also defined as a portion of environment being monitored. The region of interest in the present case is the environment with moving object and activity. A region of interest can be therefore a person, an animal or an artifact, circumscribed with the term moving object. For simplicity and generality, recognition based detection is not assumed. An appropriate algorithm does the detection of moving object.

1.2 Web Camera

Web camera or more precisely should be named as PC camera. It is the type of computer-based camera that can only function when it is connected to PC. It is more commonly being known as webcam. This is a small and compact type of digital video camera. Most of the web cameras currently in market are using standard Universal Serial Bus (USB) but the old type was using PCI computer connections.

Web camera has a wide variety of usage in many different fields. It was used in astronomical observation and photography, animal observation, robotic webcam (Web Cam World 2001), recreation of 3D modeling (3D Webcam 2003), weather observation in Alaska (Alaska Climate 2003) and many others. Generally, its usage can be classified according to its function and place where the web camera is installed, e.g. scenery cam, personal cam, weather cam, building cam, etc. For different usage objectives and purposes, different supporting hardware and software may be required (Churchill 2001). New application of web camera is developed every now and then. The new applications of web camera require software or both hardware and software to achieve the desired function.

1.3 Background

Video surveillance and security systems have become very common in modern days. This kind of system can easily be found in places like retail stores, banks, supermarkets, airports, commercial buildings and even private premises. There are two kinds of video surveillance and security systems: analogue system and digital system. In traditional systems for security operations, cameras are used to deliver analogue video images to monitors or time-lapse videocassette recorder (VCR). Although many local image processing functions are possible to improve the system application, this requires a lot of processing resources and high-power-consuming hardware. Although digital video surveillance and security system is widely used, analogue system still serves as a cheaper alternative. Charge coupled devices (CCD) camera and digital camera one among the most popular cameras used in the system.

Digital surveillance systems are mostly specifically designed for commercial use and it has always been out of reach for other users. The cost for CCD cameras, networking devices and the software designed for this system has made it inaccessible and unpractical for home users with moderate requirements. Also, not all the existing product has the motion detection function.

Most of the video surveillance and security systems in the market does not issue alarms in real time, manual monitoring system are costly in term of manpower.

This can be overcome by a real time motion detection system with the ability to automatically analyze the video images and archive the images with moving objects.

Similar products are available in market but the price is expensive. The price of similar software can range from RM 120 to RM 200 excluding the camera. Certain motion detection is bundled with the whole security system. The security system is customized for any security purpose and the cost for the system may range from RM 20,000.

1.4 Objective

The main objectives of this thesis project are as stated in the following:

i. To investigate if motion detection is possible for web camera.

ii. To develop a low cost security system using web camera.

iii. To develop software with motion detection function algorithm.

This project aims to achieve web camera application system with automatic motion detection capability. The main idea is to develop a low cost surveillance system using web camera, which runs the software that is incorporated with motion detection algorithm. It uses the concept of "motion detection by vision" to achieve motion detection capability where no hardware sensors are required. The

automatic motion detection capability helps to reduce archive space and monitoring manpower. The system would be a simple "do-it-yourself" system, which means anyone can just setup by himself/herself.

In this project web camera is chosen as it is low cost captured to other capture devices. It is used as video capture device for the motion detection in surveillance purpose. Only a web camera and a PC required for this purpose and therefore it is cheap instead of sophisticated surveillance system that involves Charge Coupled Devices (CCD) camera or digital camera.

Compared with a conventional camera, images taken with a web camera have lower resolution due to the mapping of large field of view to the small camera lens in web camera and its sensor limitations. The image has generally non-uniform resolution and the resolution cannot be better than the cameras with standard imagers and is often inferior for most parts in an image due to bigger pixel size (Esensual Studios 2001). Hence, in this project investigation need to be done to check if motion detection is possible with such a low-resolution images by simple simulations.

The flaws of existing surveillance and security system would be overcome by a real time motion detection system with the ability to automatically analyze the video images and archive the images with moving objects. Therefore, a digital surveillance system based on web camera and targeted for small-scale user is developed.

1.5 Thesis Organization

This thesis is organized in six chapters. Chapter I is the introduction of this thesis project and states the objectives of this thesis project. Chapter II provides the literature review of motion detection systems. Technical specifications of EC-300 webcam used in this thesis project and its explanation are also included. This chapter also reviews the existing motion estimation systems. The background theories of all the methodology used to achieve motion detection is explained in Chapter III. In Chapter IV, the methodology of setting up a low cost motion detection system is discussed and followed by software implementation on web camera. Simulations for images captured by web camera are done using MATLAB with Image Processing Toolbox. In Chapter V, all the results and discussions from simulation are presented. The results also include motion detection software compiled using Visual Basic 6.0. In the last chapter, Chapter VI is the conclusion for this thesis project. Some recommendations for the future work are included as well.

CHAPTER II

MOTION DETECTION SYSTEMS REVIEW

2.1 Overview

According to biological study in vision system, all biological vision systems are always evolving to cope with the changing world. The same thing applies to machine vision system, which also developed in the same way. For a computer vision system, the function and its applications are becoming more and more complicated. The requirement for the system to have the ability to cope with moving and changing objects, changing illumination and changing viewpoint is essential to perform several tasks (Shapiro and Stockman 2001).

Motion imaging is an interesting and challenging topic starting from the middle of 50's. During 60's and 70's, static scene analysis received a lot of attention. In the 80's dynamic scene was becoming a popular topic in the research. The development is followed by the development of camera devices. In the 70's camera was becoming more and more popular whereas in the 80's video was blooming up and the requirement for dynamic scene was increased. Although in the early years, computer vision systems were concerned primarily with static scenes, computer vision