UNIVERSITI PUTRA MALAYSIA

REAL TIME FACE-TRACKING AND IRIS LOCALIZATION

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By

HUSNIZA BINTI RAZALLI

Thesis submitted to the school of Graduate Studies, Universiti Putra Malaysia, in Fulfillment of Requirement for the Degree of Master of Science

Nov 2009

DEDICATION

I want to dedicate this thesis to my dearest family, especially my beloved husband, Mr. Shah Rizan Mahad, My parent, Mr Razalli Abu Bakar and Mrs. Selmiah Hussin and My Siblings for their care, patient and love throughout my studies.

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

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Nov 2009

Chairman: Rahmita Wirza O. K. Rahmat, PhD

Faculty: Computer Science and Information Technology

Robust, non-intrusive human eye detection problem has been a fundamental and challenging problem for computer vision area. Not only it is a problem of its own, it can be used to ease the problem of finding the locations of other facial features for recognition tasks and human-computer interaction purposes as well. Many previous works have the capability of determining the locations of the human eyes but the main task in this thesis is not only a vision system with eye detection capability. Our aim is to design a real-time, robust, scale-invariant face tracker system with human eye movement indication property using the movements of iris based on localization technique indicate from image processing and circle fitting technique. As a result, our eye tracker system was successfully implemented using non-intrusive webcam with less error.

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

PENGESANAN MUKA DAN PENENTUAN LOKASI ANAK MATA DI MASA SEBENAR

Oleh

HUSNIZA BINTI RAZALLI

Nov 2009

Chairman: **Rahmita Wirza O. K. Rahmat, PhD**

Faculty: **Sains Komputer dan Teknologi maklumat**

Masalah sistem pengesanan mata yang terperinci tanpa sebarang gangguan adalah satu isu yang penting dan mencabar di dalam visi bidang perkomputeran. Masalah ini bukan hanya mengurangkan masalah dalam carian ciri-ciri paras rupa untuk proses pengecaman tetapi juga boleh digunakan untuk memudahkan tugas pengenalpastian dan interaksi antara manusia dan sistem komputer. Walaupun kebanyakan hasil kerja terdahulu telah pun mempunyai keupayaan menentukan lokasi mata manusia tetapi tugas utama rencana ini adalah bukan tertumpu kepada pengesanan mata sahaja. Objektif kami adalah untuk merekabentuk sebuah sistem masa sebenar dan terperinci iaitu sistem pengesanan muka berskala dengan ciri-ciri indikasi pergerakan mata berdasarkan pergerakan anak mata (iris) dengan mengunakan teknik penempatan indikasi daripada teknik pemprosesan imej dan penyesuaian bulatan. Hasil daripada kajian ini sistem pengesanan mata ini telah pun berjaya diimplimentasikan menggunakan kamera web dengan ralat yang minima.

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With that, best wishes and good health to all, sincerely from me, and thank you once again.

I certify that a Thesis Examination Committee has met on 23 November 2009 to conduct the final examination of Husniza Binti Razalli on her thesis entitled "Real Time Face-Tracking and Iris Localization" in accordance with the Universities and University Colleges Act 1971. and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

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

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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 concurrently submitted for any other degree at UPM or other institutions.

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HUSNIZA BINTI RAZALLI

Date:

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LIST OF ABBREVIATIONS

ASL	Applied Science Laboratories
HCI	Human Computer Interaction
HMM	Hidden Markov Model
HS-Space	Hue, Saturation Space
HSV	Hue, Saturation and Value
IR	Infrared
NIR	Near Infrared
RGB	Red, Green and Blue
YCbCr	Luminance Chrominance
PAL	Phase Alternating Line
NTSC	National Television System Committee
ROI	Region of Interest
TM	Telekom Malaysia
WWW	World Wide Web

CHAPTER 1

INTRODUCTION

1.1 Research Background

Face tracking and iris localization using computer vision techniques have the potential to become an important component in future perceptual user interfaces. So by this motivation designing a real-time face tracking and iris localization software compatible with a standard PC environment is the main aim of this research.

In general, the term "*face detection"* is widely used when static face images are of concern and the main aim is to find the face region which contains both eyes, and "*face tracking*" term is used referring to the process of continuously detecting face regionin video sequences which contains only unconstraint images. And "*iris localization*" is the process to extract the position of the circular iris in eye region images (Z. Savas, 2005). In this research the term "*face tracking and iris localization*" means real-time, continuously detection of human face individually and extraction the position of the iris features with scale invariance property and without making the assumption that the image sequences contain only face images. And "*Real-time face tracking and iris localization*" means detect the human face and localize the position of the iris features in a real time environment, where there is

a continual input, process and output of data and the data has to be processed in a small stipulated time period (real time).

The most accurate, but least user-friendly technology uses physical attachment to the front of the eye. A non-slipping contact lens is ground to fit precisely over the corneal bulge. Another popular common technology is based on non-contacting, special equipment aided vision techniques such as illuminating the eye with a barely-visible infrared light source. These methods are obviously practical only for laboratory studies, as they are very awkward, uncomfortable for practical approaches. In this thesis a more practical real-time approach for simultaneously tracking and iris feature extraction of individual eyes is implemented using a web camera based vision technique without using the special equipment given above.

The eye tracker sits in a several meters range to the camera and head motion is restricted only to the extent necessary to keep the face, eye region and pupil of eye within view of the camera. The eye tracker provides data about the location of the face and iris of the eye. The *x* and *y* coordinates data of both eyeball areas, outline of the eye area and the position of the iris are detected using image processing techniques.

The developed technique is aimed to be a fast and easy to operate real-time method although work with image processing method, thus, suitable for ordinary user settings outside the laboratory environment although it is not thought to be as accurate as equipment based techniques given above.

1.2 Problem Statement

Human face image analysis, detection and recognition have become some of the most important research topics in the field of computer vision and pattern classification. The potential applications involve topics such as face detection, face identification and recognition, and facial expression analysis. Among these research topics, one fundamental but very important problem to be solved is automatic eye detection. The eye is the most significant and important feature in a human face, as extraction of the eyes are often easier as compared to other facial features. Eye detection is also used in person identification by iris matching. Only those image regions that contain possible eye pairs will be fed into a subsequent face verification system. Localization of eyes is also a necessary step for many face classification methods. For comparing two faces, the faces must be aligned. As both the locations of eyes and the inter-ocular distance between them are relatively constant for most people, the eyes are often used for face image normalization (T. Rajpathak, R. Kumar, E. Schwartz, 2009).

Based on understanding of the previous research, following are identified problems that exist in this research:

i) Difficulties to identify criteria of automatic face detection method in cluttered background images.

ii) Difficulties to process a framework related on the eye detection an iris localization method with low resolution image.

iii) Complexity to have a suitable real-time system for face tracking and iris localization with collaborations of both detections.

In this research, identification of face tracking and iris localization techniques derived from automatic face detection process in cluttered background images are examined. Therefore, a real-time tracking system will be able to develop for automatic localize the position of the iris and automatic detect face area from cluttered background images, just only using non-intrusive web camera and also work with low resolution images.

1.3 Research Objective

The objective of this research is to design and implement a real-time face tracking and iris localization program based on combination of;

- Face detection in complex background images using feature invariant approach for skin color segmentation based on HS-space skin color segmentation.
- Iris localization based on circular hough transform method for edge points detection in normal illumination

1.4 Research Scope and Limitation

Upon the successfully of face region detection, there is some limitation that we need to consider in order to obtained a better detection result. This research work is based on image processing technique and focused on detection of the face region in cluttered background images. The images capture using normal web camera with

320×240 resolutions; consequently the extraction of eye region and iris localization of was made from the same data. We assume that the persons that we use as a sample wearing a different color hair scarf with their skin. The samples also consist of the person who did not wearing spectacles. And we as well suppose that the sample's face region is in the view of the camera.

1.5 Contributions of Research

We can split the contributions of this research into three parts:

i. Tracking algorithm

A new framework is designed which provides flexibility to users to detect face region in cluttered image and track the movement of the human eye accordingly.

ii. Iris localization

We localize the position of the iris using Hough circle algorithm instead of projection function.

iii. Real-time Application

A new real-time eye tracking and iris localization system proposed based on the properties of the eye.

1.6 Research Methodology

In carrying out this research, we need to have a methodology used in order to ensure that the research will be done successfully. The detailed information about the methodology part is stated in chapter 3.

1.6.1 Problem Identification

We started this research with identifying the problem by doing some literature reviews on the related matter. Since this research is about tracking and detection of human face and eye in real-time environment, therefore the study focused on understanding techniques done by previous researchers in generating them. Based on the review made, we chose a technique that resembles the closest to what we are proposing to do to be used as the guideline.

1.6.2 Data Requirements

The next step involves capturing data to recognize the face and eye region, after that calculate and obtain the position of the iris during the movement of the eye. This can be acquired through a web camera. For our purposed, we used normal web camera with 320x240 resolutions.

1.6.3 System Design

Based on the requirements and the detailed analysis, the conceptual framework of real-time eye tracking and iris localization system is designed based on our proposed objective. In this phase, the flow of the program is clearly defined. Contributions made for this research are stated as well, which consist of three major parts, namely the face detection algorithm, localization technique and also the real-time eye tracking and iris localization.

1.6.4 Coding and Implementation

After designing the new framework, the whole framework system is required to be converted into computer understanding language. It is an important stage where the defined procedures are transformed into control specifications by the help of a computer language.

1.7 Organization of the Thesis

The thesis is organized in accordance with the standard structure of the thesis and dissertations at Universiti Putra Malaysia. The thesis has seven chapters, including the introductory chapter that covers the background information that leads to an idea of furthering in detail the concepts of face tracking and iris localization problem.