DEVELOPMENT OF SMART MIRROR-BASED PERSONAL ASSISTANT BY USING RASPBERRY PI

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BACHELOR OF COMPUTER ENGINEERING TECHNOLOGY (COMPUTER SYSTEMS) WITH HONOURS.

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A report submitted
in fulfillment of the requirements of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Computer Engineering Technology (Computer Systems) with Honours.

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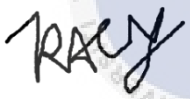

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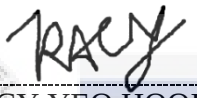
Signature : 

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APPROVAL

I hereby declare that I have checked this project report and in my opinion, this project report is adequate in terms of scope and quality for the award of the degree of Bachelor of Computer Engineering Technology (Computer Systems) with Honours.

Signature : .....

Supervisor Name : TS ZAHARIAH BINTI MANAP

Date : 17-Feb-2021

DEDICATION

To my beloved parents, my sisters(Brenda & Daphine) and my family.

ABSTRACT

Smart mirror systems are among the key features in the home of Internet of Things (IoT). A smart mirror-based personal assistant is a two-way mirror which has two functions. The front side of the glass has a reflection feature like a normal glass, while the back side is embedded with an electronic display that displays several information such as meeting schedule, weather, time and news updates. The current issue of the ordinary mirror is that it only shows any object in front of the mirror. People waste a lot of time standing in front of the mirror for washing, makeup and wearing clothes. Therefore, a smart mirror that displays several information is necessary to encourage efficient time management. The aim of this project is to develop a smart mirror-based personal assistant by using Raspberry Pi. In this project, a special feature of voice command is implemented to allow the users interact with the smart mirror without touching the screen. The system consists of a microcontroller (Raspberry Pi), sensors (Pi-camera, microphone), speaker, two- way mirror and LCD monitor. The pi-camera is used to recognize the registered users before the users are authenticated to use the system. A set of test case is conducted to make sure all the widgets or features are available to meet the functional requirements. The result of the test case shows that the system able to display all the features at the specified layout on the LCD Monitor. The accuracy of the voice and face recognition is analyzed through a series of real testing. Word Error Rate is the calculation used to analyse the accuracy of voice recognition. The results shows that the Word Error Rate is 5% in noisy room while 1.67% in silent room, which are in reasonably accurate as the system misinterpret the input speech. The average response time of Google Assistant is 2.61 seconds which are relatively quick to perform real-time transcription. The accuracy of the face recognition for known and unknown faces are 90% and 80% respectively but the accuracy of the face recognition is affects by the illumination problem. This is based on the result that shows 90% of faces recognized by the system in a bright while only 30% of faces recognized in dark room. To conclude, the developed system can accurately recognize the users and perform the voice commands as required. This project has potential to be installed in hotel lobby, bathroom and living room as well as can be integrated with modern virtual or augmented reality system. Example application of virtual reality system is virtual fashion consultant to provide user to analyze and recommend the virtually try outfits, makeup and handbags in front of a mirror.

ABSTRAK

Sistem cermin pintar adalah antara ciri utama rumah Internet of Things (IoT). Pembantu peribadi berasaskan cermin pintar adalah kaca dua arah yang mempunyai dua fungsi. Bahagian depan kaca mempunyai ciri pantulan seperti kaca biasa, sementara sisi belakang disertakan dengan paparan elektronik yang memaparkan beberapa maklumat seperti jadual pertemuan, cuaca, waktu dan kemas kini berita. Isu semasa cermin biasa adalah hanya menunjukkan objek yang berada di hadapan cermin. Orang ramai membuang banyak masa berdiri di hadapan cermin untuk mencuci, berhias dan memakai pakaian. Oleh itu, cermin pintar yang memaparkan beberapa maklumat diperlukan untuk memanfaatkan masa sepenuhnya. Tujuan projek ini adalah untuk membangunkan pembantu peribadi berasaskan cermin pintar dengan menggunakan Raspberry Pi. Dalam projek ini, satu ciri khas arahan suara dilaksanakan untuk membolehkan pengguna berinteraksi dengan cermin pintar tanpa menyentuh skrin. Sistem ini terdiri daripada pengawal mikro (Raspberry Pi), sensor (Pi-kamera, mikrofon), pembesar suara dan skrin LCD. Kamera pi digunakan untuk mengenali pengguna yang berdaftar sebelum pengguna disahkan menggunakan sistem ini. Satu set kes ujian dijalankan untuk memastikan semua widget atau ciri tersedia telah memenuhi keperluan fungsional. Hasil kes ujian menunjukkan bahawa sistem dapat menampilkan semua ciri pada susun atur yang telah ditentukan pada skrin LCD. Ketepatan pengecaman suara dan wajah dianalisis melalui satu siri ujian sebenar. Word Error Rate adalah pengiraan yang digunakan untuk menganalisis ketepatan pengecaman suara. Hasilnya menunjukkan bahawa Word Error Rate adalah 5% di bilik yang bising sementara 1.67% di ruang sunyi kerana sistem menyalahtafsirkan ucapan input. Masa tindak balas purata Pembantu Google ialah 2.61 saat yang agak pantas untuk melakukan transkripsi masa nyata. Ketepatan pengecaman wajah untuk wajah yang dikenali dan tidak diketahui masing-masing adalah 90% dan 80% tetapi ketepatan pengecaman wajah dipengaruhi oleh masalah pencahayaan. Ini berdasarkan hasil yang menunjukkan bahawa 90% wajah dikenali oleh sistem dalam keadaan terang sedangkan hanya 30% wajah yang dikenali di ruangan gelap. Kesimpulannya, sistem yang dikembangkan dapat mengenali pengguna dengan tepat dan melakukan perintah suara seperti yang diperlukan. Projek ini berpotensi dipasang di lobi hotel, bilik mandi dan ruang tamu serta boleh disatukan dengan sistem maya atau augmented reality moden. Contohnya, aplikasi sistem realiti maya adalah perunding fesyen maya untuk menyediakan pengguna untuk menganalisis dan mengesyorkan pakaian, alat solek dan beg tangan yang boleh dicuba di hadapan cermin.

ACKNOWLEDGEMENTS

I would like to take this opportunity to express my deep sense of gratitude and appreciation for her timely guidance, advice, valuable and constructive suggestions during the planning and development of this project to my supervisor, Madam Zahariah Binti Manap. Moreover, I would like to acknowledge every lecturer who taught me, especially those who gave me all the information, skills and advice for my work. Such awareness, skills and suggestions are of great importance to me in completing this project. I would like to thank my friends Cheng Kar Yan and Ong Weng Sung for their support and help in order for me to complete this work. Last but not least, I would like to show my thankfulness to all those involved in this project for their support and cooperation, implicitly or explicitly. I would not be able to complete my work without their guidance.

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LIST OF SYMBOLS AND ABBREVIATIONS

IoT	-	Internet of Things
LED	-	Light Emitting Diode
Wi-Fi	-	Wireless Fidelity
MLP	-	Multi-Layer Perceptron
NB	-	Naive Bayes
AI	-	Artificial Intelligence
VNC	-	Virtual Network Computing
VR	-	Virtual Reality
ML	-	Machine Learning
AR	-	Augmented Reality
2D	-	2-dimension
3D	-	3-dimension
VF	-	Visual Features
ISS	-	Image-scale space
AWS	-	Aesthetic Words Space
CT	-	Computed Tomography
VKH	-	Korean Human dataset
ACC	-	Accuracy
FAR	-	False Acceptance Ratio
FRR	-	False Rejection Ratio
API	-	Application Programming Interface
IR	-	Infrared Red
GMM	-	Gaussian Mixture Model
MFCC	-	Mel Frequency Cepstral Coefficients
ZCR	-	Zero Crossing Rate
VA	-	Viterbi Algorithm
HMM	-	Hidden Markov Model
EER	-	Equal Error Rate
Rpi4B	-	Raspberry Pi Model B

CSI	-	Camera Serial Interface
USB	-	Universal Serial Bus
HDMI	-	High Definition Media Interface
LCD	-	Liquid Crystal Display
MP	-	Megapixels
TTS	-	Text-to-Speech
WER	-	Word Error Rate
RSS	-	Really Simple Syndication
ID	-	Identification

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

The overview of the project is discussed briefly in this chapter. This chapter describes the problem statement, objectives of the project, scope of works and the report structure.

1.1 Background

Demand for the recent technology is increasing and the way society lives is changing here now. The effect of technology on our lives is so intense that we are encircled by equipment filled with technology. Everything is turning to smart, from smart home to smart cities. Life-friendliness and comfort level also improve as technology progresses. People have begun to accept smart devices more now in their homes compared to previous years. One of the struggles people are experiencing these days is to keep up with daily news despite their busy schedules of work. Therefore, the purpose of this project is to develop a smart mirror-based personal assistant by using Raspberry Pi. A smart mirror is a two-way mirror with an electronic display behind the mirror where it displays several kinds of information in the form of weather, time, meeting schedule and news updates. The smart mirror has the applications and features necessary for a device focused on time management. People around the world are using these smart devices to re-evaluate their living experience, helping them to solve everyday problems by delivering effective solutions. Instead of constantly pulling out a device, one could get informed while finishing daily grooming tasks. Therefore, there has been increasing in smart mirror which are commercially available.

The aim of this project is to develop a smart mirror-based personal assistant by using Raspberry Pi. Raspberry Pi are used because of it low implementation cost, high energy efficient and easy to configure. This microcontroller acts as the central computation device where all processes are handled. Microphone and speaker are used to interact with smart mirror to perform tasks. The Pi-camera is used to capture user's image for security system in order to prevent unauthorized user view of the information displayed.

The development project will undergo several testing to ensure that system meets the functional requirements. Voice and face recognition will be tested by giving various inputs to the system and observed whether the system can identify the command or not.

1.2 Problem Statement

Keeping up with the news, some of the interruptions which disrupt our daily activity are adapting the varied weather conditions. These activities take a great amount of time and can be very stressful and could impact our daily activities. In the meantime, people still want to appreciate or take care of their appearance and spend excessive time in front of a mirror. According to a survey (S. Yong et al., 2018), people spend about 20 minutes in front of the mirror. However, time spent with a mobile phone, managing daily tasks while getting ready for the day will be a difficult task. This situation leads to poor time management which can lessening people's productivity. Due to limitation of traditional mirror, a smart mirror is introduced. Therefore, in this project we will develop a device that can assist people to keep up with current updates while getting themselves ready will improve their time management. Therefore, a smart mirror-based personal assistant is required for a person to complete all their task needed for the day.

1.3 Statement of the Purpose

The aim of this project is to develop a smart mirror-based personal assistant by using Raspberry Pi. There are three objectives as listed below;

1. To develop a smart mirror that can display compliments, weather, time and news updates.
2. To implement voice command algorithm to the developed system.
3. To analyse the performance of the developed system in terms of accuracy.

1.4 Project Scope

The scope of this project are as follows:

- Smart mirror acts as a regular mirror in the offline mode while in online mode the smart mirror based personal assistant displays information.
- Certain voice command input by user is used to perform certain task such as play YouTube, check traffic and event reminder.
- The system only recognises United Kingdom English while other languages are not identified by the system.
- Face recognition is applied for security system where only one users are recognized by the system. Thus, unregistered users are allowed to view the certain displayed information.
- 10 candidates will be used to test the accuracy of the face recognition.