UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Development of Hand Gesture Glove as Computer Pointing Device

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor's Degree in Electrical Engineering Technology (Industrial Automation & Robotics) with Honours

by

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor's Degree in Electrical Engineering Technology (Industrial Automation & Robotics) with Honours. The member of the supervisory is as follow:

……

(Project Supervisor)

ABSTRAK

Kajian ini adalah tentang tetikus sarung tangan yang boleh dipakai sebagai peranti komputer penunding yang berhubung dengan komputer secara wayarles. Matlamat projek ini adalah untuk menunjukkan accelerometer yang boleh digunakan sebagai sensor untuk mengesan dan membaca pergerakkan tangan dan jari kepada isyarat untuk mengawal kursor komputer. Peranti 'Glove Mouse' ini mengabungkan accelerometer untuk mengawal kursor komputer. Accelerometer yang digunakan membolehkan pengguna mengawal kursor melalui orientasi tangan dan pergerakan jari yang berbeza. 'Glove Mouse' ini boleh mengendalikan komputer dengan tangan mereka di udara tanpa perlu bergantung kepada permukaan meja atau wayar. Dalam kajian ini, accelerometer yang mempunyai tiga paksi dipilih untuk mengesan pergerakan tangan. Pada asasnya, accelerometer yang mempunyai dua paksi mengesan orientasi tangan dengan paksi X dan paksi Y. Selain itu, maklumat yang dibaca oleh accelerometer dikumpul dan dihantar secara wayarles melalui Bluetooth ke komputer pengguna. Software dalam komputer membenarkan 'Glove Mouse' untuk beroperasi seperti tetikus yang digunakan hari ini. Software yang digunakan pada komputer akan membaca segala pergerakan tangan pengguna kepada gerakan tetikus kursor. Accelerometer akan mengesan pergerakan tangan pengguna dan memprosesnya, kemudian menghantar data pergerakan melalui Bluetooth kepada komputer pengguna. Komputer akan menterjemah data ini untuk pergerakan tetikus kursor yang sebenar.

ABSTRACT

This research is about glove mouse as wearable computer pointing device which connect to computer wirelessly. The main purpose of this project is to demonstrate the accelerometer that worked as sensor to detect and translate hand and finger motions into computer interpreted signals. This computer pointing device is used with accelerometer based hand movement. The implementation of accelerometer to mouse is to allow the user to control cursor through different hand orientations and finger presses. This mouse can operate the computer by moving their hands in the midair without any wire and did not need to hassle the desks surfaces. In this research, 3-axis accelerometer is chosen to be used to sense hand gestures. Basically, 3-axis accelerometer makes hand orientation in X-axis, Y-axis and Z-axis. Z-axis purpose is to control roller. In addition, information of hand and finger movement is transmitted wirelessly via the Bluetooth device to the computer. The software in computer is allowing the glove to be used as a mouse pointing device. The software running on the computer will translate all these kind of movements into mouse cursor movement. The accelerometer will sense a user's hand movement and process it, then transmit the movement data through Bluetooth communication to the user computer. The computer then translates these data to actual mouse cursor movement.

DEDICATION

To my beloved parents

ACKNOWLEDGEMENT

I would like to thank to my supervision, Mr. Mohd Hanif bin Che Hasan for giving me many useful advise until I complete my Bachelor Degree Project. He always try to explain and answer my question in the best way.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

PC	-	Personal Computer
HCI	-	Human Computer Interface
LCD	-	Liquid Crystal Display
GUI	-	Graphical User Interface
USB	-	Universal Serial Bus
FSR	-	Force Sensitive Resistor
MEMS	-	Micro-Electro-Mechanical System
PS/2	-	Personal System/2 port
RF	-	Radio Frequency
MHz	-	Megahertz
RS-232	-	Recommended Standard 232
PIC	-	Programmable Integrated Circuit
A/DC	-	Analog to Digital Converter
PCB	-	Printed Circuit Board
DC	-	Direct Current
CPU	-	Central Processing Unit PCL/TPS
UART	-	Universal Asynchronous Receiver Transmitter
PWM	-	Pulse-width modulation
IC	-	An integrated circuit
Bluetooth SPP	-	Serial Port Protocol
LED	-	Light-emitting diode
I/O port	-	Input / output port
Vref	-	Voltage reference
Vdd	-	Drain supply
kbps	-	kilobytes per second

CHAPTER 1
INTRODUCTION

1.0 Introduction

In this chapter, background of this project is explain briefly. This chapter also discusses about the problem statement, the objectives and the scope of this project. Then, the contrast of study and project outline also be explained in this chapter.

1.1 Background

A pointing device is a type of input devices that allows a user to interact with a computer by moving a cursor on a monitor to select icons and trigger desired actions. A similar pointing device designed for desktop computers is a trackball an upside-down mouse that allows a user to control the cursor by rotating the ball in the direction of desired cursor motion. Another type of pointing device is an optical mouse which uses a light-emitting diode and photodiodes to detect movement relative to a surface. Although mouse has in general sufficed for the necessary interaction, one wonders how other styles of interaction would perform in doing tasks.

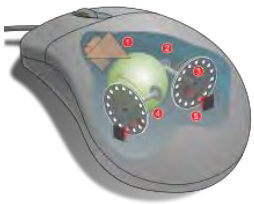
With this in mind the research presented in this paper is in the direction of a wireless mouse using accelerometer, called Glove Mouse. This Glove Mouse detect

the users hand motion to control computer cursor. Different orientation and finger press provide different mouse function. Based on the advantages of gravity, the accelerometer used induced acceleration offsets and it able to identify hand movement. The main advantages of this Glove Mouse is it can operate the computer with their hands in mid-air without wires or hassle the desks surfaces.

3-axis accelerometer is used instead of 2-axis accelerometer in this research. By using 3-axis accelerometer, Glove Mouse can control computer cursor in terms of x-axis, y-axis and roll function independent of a smooth or flat surface. Glove Mouse can be functioned in the mid air. All of this movement or orientation is detected using an embedded accelerometer sensor.

1.2 Problem Statement

An optical mouse as Figure 1.1, with a ball is the oldest design to control computer cursor. Then, the design is upgraded to laser mouse. Laser mouse (Figure 1.2) use of one or more light-emitting diodes (LEDs) and an imaging array of photodiodes to detect movement relative to the underlying surface, rather than internal moving parts as does a mechanical mouse. A laser mouse is an optical mouse that uses coherent (laser) light.



(a) Optical Ball Mouse

(b) Optical Laser Mouse

Figure 1.1

Although the technologic had evolved a lot, there are still not enough for every users. There are always a weakness appear in front of users. For example, the traditional mouse with a ball for roller always occur failure. The ball which is

infected by dust always cannot work smoothly, we need to take out the ball and clean it, then install it again.

For the laser mouse, same as the traditional mouse., they always need a flat surface to operate. The sensitivity also too high cause the cursor move easily as long as there is a surface near to it. So, a new device is developed to get rid of flat surface. Besides, the wired devices also make users feel uncomfortable. The wire usually too short or too long when users try to buy a cheaper mouse.

Therefore, a glove mouse is introduced to replaced the optical mouse. Glove Mouse is easier to handle. It does not require a flat surface to operate. This Glove Mouse is more accurate and can perform with more efficiency.

1.3 Objective of the Project

The objective to be achieved in this project are as follow:

(i) To study accelerometer sensor and wireless communication
(ii) To build and design wireless computer pointing device (Glove Mouse)
(iii) To evaluate performance of Glove Mouse

The main objective of this research is mainly focus to design and built a wireless computer pointing device (glove mouse). However, the acceleration of accelerometer sensor is needed to be studied to control the computer's cursor. Thus, the computer will understand all data and hand motion, it can translate all hand motions into actual mouse cursor. Besides understanding of accelerometer, the microcontroller and the wireless communication (Bluetooth) also need to be study so to use them without any obstacle. The performance of glove mouse then finally is evaluated following some specifications needs.

1.4 Scope of the Project

(i) Understanding of accelerometer sensor and wireless communication
(ii) Design of wireless computer pointing device based on accelerometer
(iii) Evaluation of wireless computer pointing device's performance in term of sensitivity

This projects is to build and design wireless computer pointing device by using accelerometer sensor for sensing our hand motion in the mid-air. A 3-axis accelerometer sensor is used to evaluate its relations with acceleration. Bluetooth module is used as a device for wireless communication to transmit the data from accelerometer sensor to computer.

1.5 Significant of the Project

There are a lot of benefits existed when this project is completed. As mentioned before, the first objective of this project is to build and design a wireless computer pointing device (glove mouse). So, as this application is existed, it can provide a lot of benefits. Apart to achieve this objective, it also can be used for computer games application. Besides, this device also help users to use software Autocad more comfortable. This application also help teacher to teach their student in class without making a lot of move whereby just pointing mouse cursor from a distance.

1.6 Project Outlines

The work presented in this study is organized in five main chapters.

First chapter consists of introduction of the project whereby simply introduce about this project with presented along with the background study. This chapter

explains briefly on the problem statement, objective, scope of project and the significance of project.

Next, the second chapter encloses the literature review. This part explains the previous study that have related to this project. It will briefly explain on how the existing project works and operates with the theories. Besides that, every facts and information that is found journals or other references will be mentioned in this chapter. Finally, a better related devices to this project can be selected.

Subsequently, methodology was covered in chapter three. This part will show the project methodology used in this project. It discuss the methodology and approach that used to develop this project. It also focuses on the hardware and the software implementation of this project.

At the last chapter, the result and discussion is taking through chapter four. All the results are presented in this chapter. Then, it discuss conclusion and future work. In this section, the conclusion of the project is represented and the future work for this project is explained.

CHAPTER 2
LITERATURE REVIEW

2.0 Introduction

This chapter is the most essential chapter in this study. A lot of useful information were found from sources such as paper, journal, internet resources and reference books. There are some research and project that is similar or related to this project. This chapter will briefly explain about the previous research. This chapter also explain the method used by previous researcher. However, there are some weakness which can be improve and develop into this project. Through this research, there were many methods used by previous researcher for controlling the computer cursor. Moreover, there were also different controller, and sensors used by earlier researchers. As a whole, all methods used before will be discussed in this chapter.

2.1 Previous Method of Controlling Mouse Cursor

From a few research papers, there are several methods that were found to control computer pointing device. Most of them use part of body to control their mouse cursor like a hand, head and eye were used. Future more, some of the researchers also use a method of capture image using camera to control the computer cursor.

2.1.1 Control by using Hand

Hands is one of the important part belong to human body. Everybody need hands to do their daily life work. For instance, people can done many jobs using their hands. Students use hand purpose for study especially writing. Workers use their hand to done their jobs in every working area. An athlete use his/her hands to play games. An employer use their hand to has a signature on documents or contract. Anyway, people also use hand to control a mouse and computer cursor. Now, researchers develop a way to dispose of holding a mouse since a mouse need flat surface to operate.

They came out with an idea of wearing a set of hardware (glove with arm hand) to transmit signal using wireless transceivers. A different hand orientations and finger presses to control the cursors on their computers was created (Adam Shih & Hyodong Lee 2012; Aggarwal et al. 2014). By create a new computer pointing device, people can prevent from touching hassle of desks surfaces or wires or holding a heavy mouse for controlling cursors. Basically, it contains a base station connected to the CPU. This base station receives signal from glove unit, wrap then in a proper HID format and forward mouse commands to the user's computer. In this project, they use Atmega 1284 microcontroller to do analog-to-digital conversion(ADC). Besides, 3-axis accelerometer also being used in their project to read the tilt of each axis and make a readable output as analog voltage. In their project, the speed and accuracy of pointer is considered fairy good.

Besides, a similar hand glove mouse system also being designed using accelerometer, flex sensors and microcontroller(Berlia & Santosh 2014). It consists of an accelerometer and two flex sensor. This innovation is an innovative solution to Carpal Tunnel Syndrome (CTS). The whole setup is encased in a glove that can be worn by the user. This glove can be connected to a personal computer or laptop via an RS232 cable, a PS/2 cable or Bluetooth. Accelerometer measure acceleration force either in static, moving or vibrating. Flex sensor change its resistance when bent. When finger is flexed to indicate a click, the resistance of corresponding sensor changes. When both sensors are flexed simultaneously scrolling is performed. Flex

sensor may change with metallic contacts. Microcontroller is programmed to move the mouse pointer, scrolling, left and right click. An Arduino Uno board is used as Microcontroller.

The integration of haptic devices into educational environments has become an increasingly popular area of research(Spurgeon 2015). Noel Spurgeon propose this project to create a generalized, wearable haptic educational device using two vibrotactile actuators on the mounted on the top and the bottom index finger to provide feedback based on the position of the user's hand in 2-dimensional space. In this project, an Arduino Uno microcontroller is used to program the programming for accelerometer. Besides, MPU-6050-IMU which contains accelerometer and gyroscopes also used. Overall, the device is worked slower and larger movement.

2.1.2 Control by using Head

A study which describes the motivation and the design considerations of an economical head-operated computer mouse was done (Chen et al. 2000; Chen & Member 2001). Two tilt sensors placed in the headset to determine head position. One of the tilt sensor detects the lateral head motion to drive the left/right displacement of the mouse or cursor. Another one of the tilt sensor detects the head's vertical motion to move up and down with respect to the displacement of the mouse. A touch switch device was designed to contact gently with operator's cheek. Operator may puff his cheek to trigger the device to perform single click, double click, and drag commands. This design is benefits to disabled people.

A headset-type computer mouse by using gyro sensors was developed (Kim 2002; Kim & Cho 2002). A ceramic gyro is a miniature angular rate sensor, a simple construction, made up of single piezoelectric ceramic column printed with electrodes. The output of the gyro sensor is proportional to the angular velocity of one axis. Gyro sensor also amplified and were inputted to A/D converter. Mouse click is performed by conscious eye blinking. This eye blinking is sense by using infrared rays. Reflections change with muscle movement because muscles alter the

shape of the skin. Speed of pointer can be achieve by rotating their head more swiftly. Small size, light weight, aesthetic appcal, and good performance of this device would enable disabled people to operate their computers more comfortably.

To provide a better option for users with spinal cord injuries or severe disabilities, a wireless head tilt mouse has been designed (Blackmon & Weeks 2009). This head tilt mouse uses Bluetooth to communicate with the host computer. Software running on the host translates accelerometer readings into cursor movements. Button presses designed to perform mouse clicks. User just to wearing a cap with microcontroller stick to the cap to operate this head tilt mouse. By moving the head, to left or right, up or down, we can control the mouse cursor on the computer screen. Head motion is sensed and transmitted over the Bluetooth wireless protocol to the user's computer. Then, the signals are mapped to mouse cursor movement.

Another way to control mouse cursor is to design a head-operated joystick. Design of head-operated joystick uses infrared light emitting diodes (LED's) and photo detectors to determine the head position, which is subsequently converted into signals that emulate a Microsoft mouse (Evans et al. 2000). The user just need to wear a Head Mounted Unit (HMU) that communicates with a Mouse Emulation Unit (MEU) in order to operate this device, so to control the mouse cursor.

An inertia sensors also being used to create in order to control mouse cursor by sense the head movement. sensor unit can be easily attached to a human head using a Velcro strap. Our head tracking sensor uses the MPU9150 9-axis Inertial Measurements Unit (IMU) (InvenSense, Sunnyvale, CA), in order to perform real-time data fusion from accelerometers, gyroscopes and magnetometers and capture the head kinematic signals. Besides controlling the mouse cursor, this invention also allow users to use on-screen keyboard.

2.1.3 Control by Holding a Controller

A computer mouse or pointing device using gyroscope and accelerometer and modified Kalman Filter was implemented (Barbosa Tarazona et al. 2012). They says that according to medical research, mouse provokes diverse ergonomic problems, intensive mouse use has been associated with increased risk of upper extremity musculoskeletal disorders, including carpal tunnel syndrome. Their design enable users to control the PC cursor by manoeuvring the device in the air. Inertia Measurement Unit (IMU) which include the gyroscope, accelerometer, and magnetometers were developed and it able to measure variables such as acceleration, angular velocity and the orientation of a body in the space. They measure angular position in the y-axis by the way of sensor fusion and modified Kalmar filter. Integration algorithm for the x-axis position of the device is done by obtain a GY-axis gyroscope.USB is use to read the signal from the device used and polling rate, dots per degree (DPD), and scroll design also in counted to finish this project. A USB HID stack in the microcontroller is used to perform the communication with the host computer.

Besides, Wii remote controllers which was only used on video games also introduce as another idea to control mouse cursors (Kim 2009). Wii remote controller has the biggest improvement for man-machine interactive interface which it is not limited by desk or a flat surface. Therefore, the researcher establish an interface suitable for PCs such as Wii remote controllers and use the accelerometer in a smart phone to implement this idea. This controller contains two subsystems, one is smart phone with an accelerometer and Wi-Fi tool inside. Another subsystem is computer software which allows digital signal processing to perform suitably on the computer after receiving data from users action.

Furthermore, a new mouse interface which does not need operation restrictions of the existing mouse was developed (Murata & Fujimoto 2012). This mouse system was developed using Augmented Reality Technology. This system attaches a mouse function to the marker attached to the object, makes a computer

recognize it, and operates. All the things that attached the marker with a mouse function by this system can be used as a mouse interface.

2.1.4 Control by Capture Head Movement

Recent new applications in Human-Computer Interaction (HCI) and Computer Vision (CV) bring a great opportunity to the improvement of human life. The future desired Perceptual User Interfaces (PUI) and human interface devices require more reliable and fast system performance in dealing with versatile use cases.

Camera capture head movement is innovated to do a head tracking driven virtual computer mouse (Fu & Huang 2007). This innovation is developed for manipulating hand-free perceptual user interfaces. This system consists of a robust real-time head tracker, a head pose/motion estimator, and a virtual mouse control module. This system is implemented in C++ using a typical web camera as video input and VisGenie as video based information visualization platform. User can move or rotate face up/down and left/right to navigate cursor. User can also change head roll orientation to click left or right mouse button at desired cursor position.

Besides, a almost similar concept as (Fu & Huang 2007) is designed. It also use a camera to recognize users head movement. There was a greater improvement which this innovation can also read user facial expression such as open or close a mouth and eye movement besides reading users head movement (Tu et al. 2007). An infrared light camera is used for tracking eye movement. The number of frame is used to trace the users face. This innovation also shows the difference of controlling a mouse cursor using between direct mode, joystick mode, and differential mode.

Furthermore, a set of wearable head-tracking device was developed. This head-tracking device was combined by using inertia sensors (Sim et al. 2013). The sensor used was MPU9150 9- axis Inertial Measurements Unit (IMU) (InvenSense, Sunnyvale, CA), in order to perform real-time data fusion from accelerometers, gyroscopes and magnetometers and capture the head kinematic signals. Our sensor