WIRELESS ROBOTIC ARM CONTROL USING MYO – ARMBAND

CHEN CHUN WOON

This Report Is Submitted In Partial Fulfilment of Requirements for the Bachelor Degree of Electronic Engineering (Computer Engineering)

Fakulti Kejuruteraan Elektronik dan Kejuruteraan Komputer

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ABSTRAK

Penghantaran tanpa wayar telah dilaksanakan di pelbagai peranti dan sistem elektronik kerana ia menyediakan penghantaran data untuk jarak jauh, pemasangan yang mudah, dan fleksibel. Selain itu, kebanyakan simulasi pada masa kini dilakukan menggunakan teknologi simulasi tiga dimensi. Laporan ini membincangkan pendekatan reka bentuk sistem tanpa wayar untuk kawalan lengan robot melalui modul nRF24L01 dan simulasi lengan robot tiga dimensi menggunakan Myo-Armband. Projek ini bertujuan untuk mereka bentuk sistem wayarles untuk lengan robot dengan menggunakan modul nRF24L01 dan juga simulasi lengan robot tiga dimensi untuk Myo-armband. Kajian dalam Euler sudut dan radio frekuensi adalah penting dalam mereka bentuk sistem tanpa wayar dan simulasi juga tiga dimensi untuk lengan robot. Nilai quaternion dan EMG yang diperolehi daripada Myo-armband telah dianalisis untuk mengenal pasti pergerakan tangan yang sedang dilakukan supaya ia boleh dihantar ke lengan robot untuk melakukan pergerakan dikesan. Data yang diperolehi juga telah digunakan dalam simulasi lengan robot tiga dimensi untuk menggambarkan simulasi lengan robot dari pergerakan tangan dikesan. Projek ini boleh diguna untuk mengurangkan kos bagi pemasangan wayar dan seterusnya boleh juga ubah suai untuk tujuan penerokaan.

ABSTRACT

Wireless transmission has been implemented in various electronic devices and systems because it provides long distance data transmission, simple installations and flexible. Besides that, most of the simulation nowadays are done using Three-Dimensional simulation technology. This report discusses the design approach of a wireless system for robotic arm control through the nRF24L01 module and Three-Dimensional robotic arm simulation using Myo-Armband. This project aims to design wireless system for robotic arm by using the nRF24L01 module and also a Three-Dimensional robotic arm simulation for Myo-Armband. Study on Euler angle and radio frequency is important in designing the wireless system and also Three-Dimensional simulations for the robotic arm. The quaternion and EMG value obtained from the Myo-Armband were analysed to identify the hand movement perform so that it can be sent to the robotic arm to perform detected movements. The data obtained were also applied in the three-dimensional robotic arm simulation to visualize the possible output from hand movement detected. This project can be used to reduce the cost for wire implementation and further modify for exploration purpose.

Keywords: Wireless transmission, Myo-Armband, 3D robotic arm simulation, hand gesture

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FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

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PROJEK SARJANA MUDA II

Tajuk Projek : WIRELESS ROBOTIC ARM CONTROL USING MYO-ARMBAND

Sesi Pengajian : 1 5 / 1 6

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Dr. Nurulfajar Bin Abd. Manap
Pensyarah Kanan
Fakulti Kejuruteraan Elektronik Dan Kejuruteraan Komputer
Universiti Teknikal Malaysia Melaka (UTeM)
Hang Tuah Jaya
76100 Durian Tunggal, Melaka

Tarikh: 17/6/16

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Specially dedicated to my beloved parent, siblings and my friends who give me great encouragement and support to help me achieved the work of this thesis. My supervisor, Dr. Nurulfajar Bin Abd Manap also gave me a lot of guidance and support throughout the project implementation. Thank you very much.

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LIST OF ABBREVIATIONS

2D	-	Two Dimension
3D	-	Three Dimension
CMOS	-	Complementary Metal-Oxide Semiconductor
DC	-	Direct Current
DOF	-	Degree of Freedom
EEG	-	Electroencephalogram
EMG	-	Electromyography
GND	-	Ground
GPM	-	Gradient Projection Method
GUI	-	Graphic User Interface
I/O	-	Input / Output
IMU	-	Inertial Measurement Unit
IR	-	Infrared
LED	-	Light-Emitting-Diode
NUI	-	Natural User Interface
PCB	-	Printed Circuit Board
PUMA	-	Programmable Universal Manipulator Arm
PWM	-	Pulse Width Modulation
USB	-	Universal Serial Bus
VSM	-	Virtual System Modelling

CHAPTER 1

INTRODUCTION

1.1 Background

Robotic had come into human life since the year 1960, although it is just industrial robots that carry out simple manufacturing task without the need for human assistance. The development of robotic arm is improving fast through the years, from the three degrees of freedom robot to now seven degrees of freedom; from carrying out a simple task until now carrying out a complex task. Robotic technology also had been applied to almost all kind of field such as industrial, medical, educational, and agricultural. Human keep on making robots perform like a human, improving their movement joint and way of thinking. Inputs for the robotic control has improved from simple joysticks and keyboards control until now, hand gesture, muscle EMG, sensors, and even mind EEG control. Among all the controller, hand gesture control is one of the new technology that is easy to use and to get popular among the technology nowadays.

This report uses Myo-Armband developed by ThalmicLabs as the controller for the robotic arm to carry out the robotic movement accurately. The EMG sensor in the Myo-Armband detects the muscle movements while the nine-axis IMU sense the hand movements so that the Myo-Armband can analyse the movement that is performing and thus transfer it into the robotic arm system.

Besides that, this report also discusses the simulation for the robotic arm control by using Processing to design the interface and also process the data obtained from the Myo-Armband. The reason Myo-Armband was chosen for this project is that this easy to use, portable, and small. The sensors built in Myo-Armband provide high accuracy of information, and all these information can be transfer to be used for any application with most of the platform available. For this project, Node.js platform was used to communicate with the Myo-Armband and process the data received.

There is significant attempt in this project, which is providing real-time operation and performing all the movement precisely according to the input are discussed and recorded. Besides that, this project also provides simple user's device and a small robotic arm to show that the implementation of this project is user-friendly. This project requires little power to process the data input that can help in saving the energy usage. Lastly, this concept can be applied in a lot of field in different method with the usage of the robotic system.

1.2 Objectives

The primary purpose of this project is to improve the robotic arm movement and user-friendly. Therefore, the objectives of this project are

- To design a wireless connection between the Arduino Mega and the Myo-Armband
- To create a 3D simulation for the Myo-Armband controller.
- To improve the performance of robotic arm via hand gesture and simulation.

1.3 Problem Statement

The industrial robot arm is hard to control, and the precision is not entirely accurate for the current manual controller. Although most of the industrial robotic arm are using pre-programed instructions and sensors, there is still some field that requires manual control such as chemical industry. The chemical industry is hazard environment where human have to handle dangerous chemicals. Thus, the robotic arm is needed to manage the chemical without harming the user. Besides that, the pre-programed controller was less flexible compared with manual control, providing a limited function for the robotic arm. This method can help to reduce the risk of hazard in the work environment, but with the current manual controller, the user requires time to be familiar with the controller for them to master it.

Furthermore, the medical industry also can apply this project on their surgical robot where doctors can perform surgery with lower error rate and in an easier way. Doctors can control the surgical robot directly from their hand movement, and this would reduce the training time used by doctors to master the surgical robot.

1.4 Scope of Project

This project is aiming for industrial robotic arms. Thus, this project will focus on the precision of the robotic arm movement and simulation on the robotic movement to check for any errors. This project also requires knowledge of Euler's angle so that the algorithms for input detection. Every signal of hand movements and gestures measured from the contraction of muscle such as yaw, pitch, and roll were taken into account to produce accurate robotic arm movement. Component used are Arduino Mega, Arduino Uno R3, Myo-Armband, servo motors, and nRF24L01 module.

The device will get the input from the Myo-Armband and execute it through node.js and firmata. The 3D simulation performs in Processing where it will obtain the data from Myo-Armband and create the 3D simulation by using data obtained. Therefore, real-time communication of software and hardware are also one of the element.

There is some limitation for this project, where the robotic arm is unable to carry heavy objects since the size and material of the robotic arm are small and not suitable to carry heavy objects. Besides that, Myo-Armband only supports the muscle reading from arm due to the difference of EMG value for other parts, or the body and Myo-Armband were pre-set to detect the EMG value from the arm.

1.5 Structure of Report

This report consists of five chapters which include the introduction, literature review, methodology, result, and analysis plus conclusion and recommendation for the project.

Introduction contain the background, objective, and scope of the project to let the reader understand about this project. Besides that, problem statement also mentioned in this chapter to explain the reason for doing this project. Relevant work of other people done on the robotic arm control system was discussed in literature review, which is used to compare and improve the project. Through this chapter, explanation on the terms used in this project also will be stated.

In methodology, all the method implemented in this project will be discussed, together with the flow chart and the material list of the project. Block diagrams were also stated to show the stages of implementation done in this project. In the part of result and analysis, the result obtained from the project will be discussed and show that the objective of the project had achieved. Besides that, the result of the simulation will be used to compare with the real result to compare the accuracy of the simulator and the precision of the robotic arm.

In the last chapter, which is conclusion and recommendation, the overall of the project will be concluded and reviewed to make sure that this project fulfils the requirement and scope mentioned. Furthermore, the recommendation will discuss the future research that can be implemented for this project to improve it.