ROBOTIC SYSTEM DESIGN CONTROL BY USING ARMBAND SENSOR

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ABSTRACT

Human gesture interaction with robotic system has become an important in control system because it provides more precise, efficient and sustainability control. This report discusses about the design approach of a robotic system controlled by using muscle sensor. The muscle sensor that has been used for this project is a Myo armband sensor which identified the Electromyography (EMG) signals based on the contraction and relaxation of muscle activity when human performed any gesture. This project aims to design the structure of robotic arm by using the servo motor with five degrees of freedom that can be controlled by the Myo armband sensor. The study of Euler's angle of robotics is important in order to develop the algorithms of gesture and motion performed by humans. The signal of Myo armband was analysed to identify the data for every specific gesture so that the data can be sent to microcontroller to control over the robotic arm. The outcome of this project is the robotic hand performed the gesture motion according to the intuitive interaction of human. Besides, the communication constructed between the signal of Myo armband and the robotic system. Finally, this human interaction implementation can be modified and applied to any types of robotic system.

ABSTRAK

Interaksi gerak isyarat manusia dengan sistem robotik telah menjadi teknologi penting dalam sistem kawalan kerana ia memberikan tindakan yang lebih tepat, cekap dan mampan. Laporan ini membincangkan pendekatan reka bentuk sistem robotik yang dikawal dengan menggunakan sensor otot. Sensor otot yang digunakan untuk projek ini adalah lilitan lengan sensor Myo yang mengenal pasti isyarat Elektromiografi (EMG) berdasarkan aktiviti pengecutan dan pengenduran otot apabila manusia melakukan apa-apa gerakan isyarat tangan. Projek ini bertujuan untuk mereka bentuk struktur robot tangan dengan menggunakan motor servo yang yang boleh dikawal oleh lilitan lengan sensor Myo. Kajian mengenai sudut Euler daripada robot adalah penting dalam usaha untuk mengkaji algoritma daripada isyarat dan gerakan yang dilakukan oleh manusia. Isyarat lilitan lengan Myo dianalisis untuk mengenal pasti data setiap isyarat tertentu supaya data boleh dihantar ke mikropengawal untuk mengawal robot tangan yang dibina. Hasil daripada projek ini adalah robot tangan dilakukan gerakan isyarat mengikut interaksi intuitif manusia. Selain itu, komunikasi yang dibina antara isyarat lilitan lengan Myo dan sistem robotik. Akhirnya, pelaksanaan interaksi manusia ini boleh diubah suai dan digunakan untuk apa-apa jenis sistem robotik.

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CHAPTER 1

INTRODUCTION

1.1 Background

Nowadays the technologies of the humanoid robot control system has been evolved tremendously [2] whereby the robotic system can be controlled by using many methods instead of using the remote control unit. One of the important methods is through the hand gesture performed by humans as a control base to manipulate the robotic system. There are so many industries, the medical field and others start to implement the application control by using the hand gesture control. It is believed that hand gesture can provide an intuitive based control whereby the robotic system can listen to the feeling of human and mimicking the hand gesture of humanity [6]. Gesture interface can be built with different sensing techniques such as sensor and mechanical sensor [7]. Recently, there must be always a need of commands to carry out some specific task thus gesture control is a new innovative technology to improve the our life.

This report uses Myo armband muscle sensor developed by ThalmicLabs to control the robotic system. The muscle hardware sensor builds in the Myo armband bracelet which consists of Electromyography (EMG) sensor, nine-axis of IMU containing gyroscope, accelerometer, and magnetometer. Based on a study of Electromyography (EMG), it

normally applies in medical science as a diagnostic procedure to measure the muscle and nerve activity signal during the contraction and relaxation of muscle to detect any of the muscle disease that related to damage muscle tissues, damage of the nervous system that supplying muscle and others. Due to advanced development of technologies, EMG signal can be used in a variety of applications such as an embedded control system whereby the signal is recorded from the Myo armband and send it to the microcontroller to let it control over the robotic system [2].

Besides this paper also extend its work to focus on the structural design of a robotic system by doing the fabrication after the design process to improve the sustainability as well as the appearance of the hardware. The Myo armband is chosen to implement in this project because this product is a touch free control device [8], easy to bring along as well as provide more precise signal than the sensor circuit. It detects the information on gesture performed and there is a platform to analyse data received from the device so that it can be used to communicate with any kind of application control.

This project marked some of the importance attempt to provide a real-time operation whereby the robotic system can perform the gesture accurately according to the intuitive control of humanity. Besides, the project also provides a simple user's hardware without requiring much of the configuration and the sensor device (Myo armband) is easy to wear and low cost. The whole robotic system also required less power to process the gesture because the robotic system only build with servo motor and the Myo armband is rechargeable unless the robotic might be involved in complicated work. Finally, the concept can be applied in modified ways to any robotic system; which can be developed to demonstrate the approach in a physical rehabilitation application scenario.

1.2 Objectives

The aim of this project is to develop a robotic arm system control by using a Myo gesture armband sensor. Therefore, the objectives for this project are:

- To design the structure of robotics systems controlled by Myo armband
- To develop the Myo algorithms based on desired gesture motion to control robotic system
- To construct the interaction and communication between the robotic hand and Myo armband

1.3 Problem Statements

The robotic system nowadays requires the external infrastructure or a controller, which has to hold onto and keep track of the gesture of the robotic system without the intuitive interaction of human. The use of controller raise some problems because sometimes it is difficult to locate the required remote controller [9] and cause troublesome when emergency happed that need to stop an operation of robot or any control system. With wearable hand gesture control device which attached to the forearm, human can always control the robotic system with intuitive of interaction in real time and control from far distance.

Besides, the robotic system is traditionally being programmed with preset function which is less flexibility without a wide range of functionality because there is always limited function that could be integrated with the robotic system. Unlike the hand gesture control device can provide the signal command analysis and user can calibrate the data based on the hand gesture because signal generated from the muscle armband is differ depending on the specific motion, rotation and movement of the hand. The robotic system is getting involved in more complex and less structured work which require the intuitive control application.

Other than that, human always work with the hazard environment to handle or carry the dangerous and heavy object, therefore a wearable interface is required to control the robotic system without direct touching of the object. Those who work in chemical industry also required hand gesture control robotic system to help them because sometimes they have to handle toxic substance or chemical. This technique can help to reduce the risk of hazard in the work environment.

Next, there are over three million [10] of disable people worldwide and normally most of them required additional support in home environment, especially for leg amputees because it is difficult for them to move from one place to another place to carry out their task. Thus a hand gesture control system is suitable for them to carry their task far from a distance without approach to the desired place.

1.4 Scope of Project

The scope of work of this project will be focused on the structural design of the robotic arm with gripper. Besides, this project also focuses on analysis of the muscle activity signal of the Myo armband bracelet when connecting to the laptop over Bluetooth connection. This project required knowledge based on a study of Euler's angle in order to develop the algorithms of indicated gesture motion. Every specific signal of movement and gesture based on the contraction of muscle such as yaw, pitch, and motion of the finger is taken into account and the algorithms based on the gesture and motion of activity of Myo armband is developed in order for the robotic hand to perform the motion accurately. This signal will be taken as an input command to send to thorough to the Arduino to let control over the robotic system.

This project also focuses on the real time communication of software and hardware over serial communication by using a cable. The limitation of this project is the robotic arm only designed for carry light weight object due to the size and material of the robotic system is smaller which is not suitable for carry heavy and large object. Besides, the Myo armband does not support muscle readings from leg, neck and others apart from the arm.

Other than that, some of the specific angle of yaw, pitch and motion gesture cannot be performed accurately.

1.5 Structure of Project

This thesis contain of five chapters which are the introduction, literature review, methodology, result and analysis as well as conclusions and recommendation of the project.

Chapter 1 is the overall introduction of background, objectives and scope of the project. Besides the problem statement also discussed in chapter 1 to explain the reason why important of this project. Next, chapter 2 is very important to review about the relevant work of other people that have been done so that can make comparison to improve the robotic hand control system. Besides, the explanation regarding the term that's going to be used throughout this project also stated.

Chapter 3 will discuss about the method use to implement this project, the overall flow of this project and the material is also stated in this chapter. In chapter 4, the result and the analysis of the hardware and software will be discussed to prove the result of the project tot achieve the objective of this project.

Finally, chapter 5 will conclude the whole project work and again review on the objectives to make sure this project fulfil the requirement and scope. Next, chapter 5 will also discuss about the future research which can be conducted related to the work of this project.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter includes the study review on basic knowledge regarding the history of robot, human robot interface and the basic theory of forward kinematic and inverse kinematic analysis of a robotic arm. Next, this chapter will go through the introduction of the product specification of Myo armband bracelet develop by ThalmicLabs. Besides, this product is built in with Electomyography (EMG) sensor, thus the basic knowledge regarding the Electromyography (EMG) is studying to get more understanding how the sensor work to measure the muscle activity. Last but not least, review of others project that related to this project is very important to make comparisons regarding the project methodology, material use, robot design and the difference between the project.

2.1.1 Brief History of Robotic

The name "robot" was first created by Karel Capek in 1920 and this word was disseminate by Isaac Asimov with his laws stated that robots do not harm human life instead it help to improve quality life of human. The first robot named as PUMA (Programmable Universal Manipulator Arm) was the first industrial

robotic constructed by company of Joseph Engleberger and George Devoe. Due to advanced of technology and high demand in automation system, there are many type of robtic system start to develop and the first industrial robotic arm that comprise of memory system was first developed in 1962 [11].

2.1.2 General Structure of Robotic System

The general of robotic system can be divided into part which are robot model, controller, actuators, sensing subsystem and information processing unit. These systems are communication between each other through the system interface that allow the information data to be transformed from the receiving end medium to transmitting end medium to control the robotic system.The general robotic system basically has programmable system which allow the prescribed task to change anytime either on the spot or off-line [12].

The robotic system would replace the human being in decision making with programmable task and artificial intelligence software system. Next, the actuator is the hardware of robotic system that received the information from input and drive the system to operate according to the instruction data. The output of the robotic system is considered as actual task which is control by the sensing subsystem. The sensing subsystem comparing the output instruction as feedback signal with prescribed task. If there is any error of instruction the system will send the error signal to the controller system to remove the unwanted signal [12]. The corrective instruction is then fed back into the actuator and the instruction drive the robotic system to carry out the task.

2.1.3 Type of Robotic System

The evolution of technology has developed many types of advanced robotic system to replace human beings in decision making and carry out the task. One of the important type of robotic system is serial manipulator. The manipulator