GESTURE-BASED CONTROL OF TELE-OPEARATED ROBOT FOR REMOTE OPERATION IN UNSTRUCTURED ENVIRONMENT

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2021

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A report submitted
in partial fulfillment of the requirements for the degree of
Mechatronics Engineering with Honours

Faculty of Electrical Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2021

DECLARATION

I declare that this thesis entitled "GESTURE-BASED CONTROL OF TELE-OPEARATED ROBOT FOR REMOTE OPERATION IN UNSTRUCTURED ENVIRONMENT is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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APPROVAL

I hereby declare that I have checked this report entitled "GESTURE-BASED CONTROL OF TELE-OPERATED ROBOT FOR REMOTE OPERATION IN UNSTRUCTURED ENVIRONMENT" and in my opinion, this thesis it complies the partial fulfillment for awarding the award of the degree of Bachelor of Mechatronics Engineering with Honours

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DEDICATIONS

To my beloved mother and father

ACKNOWLEDGEMENTS

The making of this report has a several effort and pleasure to remind all the person that involved to succeed in this final report and project. That I want to pleasure all the person that always in remind of my heart.

Firstly, this pleasured is given to the one and only my apple of the eyes in my life that is my both parents. My parents that always support me from the beginning of my journey as a student and pay all the financing for me. Then, my parents that give the encouragement for me to do this report and project also very convincing me and help me to build my moral support and confidence.

Next, full of my appreciation and thanks to my beloved supervisor PM. Ir. Dr. Ahmad Zaki Bin Haji Shukor that guide me from the beginning of this final year project. I am grateful to the Almighty God that give me such a kind and polite supervisor that help me from the starting point of this project. His advice in repairing my report is very useful and help me to finish this report within the allocated time. The guidance to make the experiment and his knowledge to setup the apparatus also I am thankful very much.

Besides, I also give my appreciation to the both of my respectful final year project panel Dr. Nik Sharim Bin Nik Anwar and PM. Ts. Dr. Muhammad Fahmi Bin Miskon that evaluate me from the seminar presentation and the marking of this paper. Both of them helped me improve my slide presentation and my final year report writing. The message from both panel will be kept in mind for future progress.

Lastly, I want to be apologized for the all wrong doing and mistakes from the beginning of this writing until the finish of my paper and I hope all the reader will pray for my success in the future.

ABSTRACT

Nowdays, the gesture control use in small number in the world where it can control by the wireless control and easy to control the receiver in far distance from the transmitter. The gesture control is more friendly and natural when using it with the flexible control interfaces. The less gesture control is the main reason the report is written. This research also has studied the previous literature to help in understanding the development of gesture-based control. This report has three objectives which is first, design the system of the gesture-based control of tele-operated robot by using human hand gesture. Second, develop the system that fast response to the signal to control the robot in real-time gesture. Third, evaluate the performance of the accuracy and precision of the response time of the signal gesture-based control of the robot by using the hand gesture. For the hand gesture data glove prototype has been used Arduino Nano, accelerometer sensor, Bluetooth module, and tilt sensors while for the mobile robot unit use the Arduino Nano, ultrasonic sensor, motor driver (L293D), DC motor and Bluetooth module. The data glove prototype monitors the movement of hand and fingers and transmits the signal to the mobile robot unit. The hand data glove unit hardware is for control the action of mobile robot. The unit will get power supply from battery source. The experiment was running from different distance of mobile robot from the data glove. The accuracy and the precision are calculated based on the distance and the response time of mobile robot when get signal from data glove. The highest accuracy of 92.55% for 2 meters while the lowest accuracy of 72.30% for 10 meters of distance of mobile robot to the data glove. The hand data glove recognition will improve with other algorithms in analysing the sensor output data.

ABSTRAK

Pada masa kini, kawalan isyarat digunakan dalam jumlah kecil di dunia di mana ia dapat dikawal dengan kawalan tanpa wayar dan mudah untuk mengawal penerima dalam jarak yang jauh dari pemancar. Kawalan isyarat lebih mesra dan semula jadi ketika menggunakannya dengan antara muka kawalan yang fleksibel. Kurang kawalan isyarat adalah sebab utama laporan ditulis. Penyelidikan ini juga telah mengkaji literatur sebelumnya untuk membantu memahami perkembangan kawalan berdasarkan isyarat. Laporan ini mempunyai tiga objektif iaitu pertama, merancang sistem kawalan berasaskan isyarat robot tele-dioperasikan dengan menggunakan isyarat tangan manusia. Kedua, kembangkan sistem yang memberi tindak balas pantas terhadap isyarat untuk mengawal robot dalam gerakan masa nyata. Ketiga, menilai prestasi ketepatan dan ketepatan masa tindak balas kawalan isyarat berdasarkan isyarat robot dengan menggunakan isyarat tangan. Untuk prototaip sarung tangan data isyarat tangan telah digunakan Arduino Nano, sensor akselerometer, modul Bluetooth, dan sensor kecondongan sementara untuk unit robot bergerak menggunakan Arduino Nano, sensor ultrasonik, pemandu motor (L293D), motor DC dan modul Bluetooth. Prototaip sarung tangan data memantau pergerakan tangan dan jari dan menghantar isyarat ke unit robot bergerak. Perkakasan unit sarung tangan data adalah untuk mengawal tindakan robot mudah alih. Unit ini akan mendapat bekalan kuasa dari sumber bateri. Eksperimen dijalankan dari jarak yang berbeza dari robot bergerak dari sarung tangan data. Ketepatan dan ketepatan dikira berdasarkan jarak dan masa tindak balas robot bergerak apabila mendapat isyarat dari sarung tangan data. Ketepatan tertinggi 92.55% untuk 2 meter manakala ketepatan terendah 72.30% untuk jarak 10 meter robot mudah alih ke sarung data. Pengenalan sarung tangan data akan bertambah baik dengan algoritma lain dalam menganalisis data keluaran sensor.

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LIST OF SYMBOLS AND ABBREVIATIONS

PIC	-	Programmable Interface Control
ADC	-	Analogue Digital Control
HCI	-	Human Computer Interaction
EMG	-	Electromyography
IMU	-	Inertial Measurement Unit
DOF	-	Degree of Freedom
IED	-	Improvised Explosive Devices
EOD	-	Explosive Ordnance Disposal
RGB	-	Red, Green, Blue
HMM	-	Hidden Markov Model
DTW	-	Dynamic Time Wrapping
RF module	-	Radio-frequency module
VGA	-	Video Graphics Array
FCU	-	Flight Control Unit
ROS	-	Robot Operating System
SVM	-	Support Vector Machine
SSD	-	Single Shot Multi-Box Detector
CNN	-	Convolutional Neural Network

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CHAPTER 1

INTRODUCTION

1.1 Background

Gesture recognition is a form of user interface for machine perceptions to capture and interpret manual gestures as commands. A computer is able to recognise the gesture and execute the command on the basis of such gestures. This general concept is gesture recognition.

To understand how gesture recognition works, the meaning of the term "gesture" should be understood. In the most general sense, a nonverbal communication meant to communicate a particular meaning can be referred to as a gesture. A gesture is a physical motion that can be perceived with a motion sensor in the field of gesture recognition. It can involve anything from a finger to a circular kick or a head nod to a squeeze or wave of the hand. Gestures may be broad and sweeping or small. In a few instances, voice or verbal commands may also be known as the "gesture."

Gesture Recognition is an effective user interface for supplying the computer with real-time data. The motion sense sensor considers and interprets gestures as the main source of data input instead of texting with keys or tapping into a touchscreen. Kinect, for example, explores a variety of human attributes to better recognise the command based on normal human inputs. In addition to gesture recognition, voice recognition and in some cases the depth and colour of the background scene it offers both skeletal and facial monitoring. All of this data is reworked by Kinect into 3D printable prototypes.

1.2 Motivation

Nowadays, the gesture control use in small number where people think that not relevant in the world. The people now just know about the wireless control where it easy to control the object with the far distance from the input. The wireless control is more usable in this era because the object will travel in the large range of distance compared to wiring control where only travel with limit range distance.

In the pandemic Covid-19 situation, the gesture control with the wireless control is more important because the people were advised to not hold and touch the objects that not know about the cleanliness of the places.

In the using of control gesture, it shows that more natural and friendly when using the gesture of hand without holding the other hardware control with the purpose of intuitive, natural, and flexible control interfaces, so the user can feel free of their hands. It became more easy compare when using joystick or something that can control the tele-operated robot.

The bomb squad official has risked their life while working, the high risk will be harm for they so this gesture-based control in tele-operated robot can use for the dangerous situation to uninstall the bomb and check the activate bomb if the enemy planted it anywhere.

1.3 Problem Statement

The first problem statement of this study is the less gesture control of objects or things in wireless control such as car, robot and other. The wireless control mostly controls by manual by using the joystick or something else with the Bluetooth connection. By using this, it become more natural of hand where no need to grab and hold something.

The second problem is the real time gesture control of robot is the evaluation of the accuracy of the reaction of mobile robot when the signal given. To overcome this, the data that collected from the multi-sensors remote and microcontroller will be calculated to confirm the decision based on each single sensor data and evaluate the information on the movement of the robot.

1.4 Objectives

1. Design the system of the gesture-based control of tele-operated robot by using human hand gesture.
2. Develop the system that fast response to the signal to control the robot in real-time gesture.

3. Evaluate the performance of the accuracy and precision of response time of the signal gesture-based control of the robot by using the hand gesture.

1.5 Scope

- Arduino used as microcontroller to setup the configuration of hardware.
- Accelerometers, gyroscopes, and tilt used as sensor to detect the movement of hand gesture.
- The response time of the signal of hand gesture to move the robot is measured.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

For this chapter, literature reviews are carried out by studying from validated resources such as articles, newspapers, and conferences, before to relativity with this project. Reviews on related research regarding on the use of hand gesture recognition for remote the autonomous mobile robot was analysed with distinction within each other. The evaluation of each component, method and technique of comparison is listed in this chapter. This section reviews some research or project that has some similarity that other researchers have conducted. This project is about the gesture-based control of tele-operated robot for remote operation in unstructured environment.

2.2 Hand Gesture Recognition System

Hand gesture recognition is an element of body language that can be conducted through the middle of the palm, the finger location, and the hand's shape, which focuses on the hand gesture [1]. The gesture recognition allows the interpretation of an image or series of images sequence such as recording via a consistent meaning [2]. The proposed gesture recognition system is designed to calculate roll, pitch and yaw values in real-time gestures using any sensor capable of detecting hand movements [3].

In [4], authors mentioned that in the human-robot interaction, the system plays a key role that provided hand gestures that are a natural and efficient communication mechanism that can be used for remote mobile robots. Two methods that are widely used to identify the gestures of human for the human-robot interaction, glove-based method, and vision-based approach.

The gestural interfaces allow fast and effective communication between users and computers via the body, face, or hand motion [5]. The system needs clearer body language, easy to understand and distinguish from each other, to obtain real-time operations. The system primarily detects the constant dynamic hand motion in real-time and perform the human-robot interaction [6].

Besides, the hand gesture has been found to give high major role in communication. From the identification across the world, the hand gesture is the universal component in communication. Considering that the movements of co-speak to the blinders are spontaneously generated through arms and hands where the particular action will provide information about how people act relating to their robot [7]. Some writers used 'gesture' to relate to the touch screen handwriting rather of the three-dimensional handwriting of the action of free hand. People could make a simple personal movement for daily contact in performance, simplicity, and minimal hardware specification for a single sensor of accelerometer [8]. The application [8] has the potential to allow customised gesture-based interaction with a wide variety of devices.

The author [9] mentioned that the hand postures and gestures of human is the powerful modality of interhuman communication. From the research of the authors, the interest in use of hand gestures as a way of manipulating or communicating to the artificial systems. The investigation of identification of multiple hand postures and the movement dependent on the myoelectric signals [9].

According to journal [10], the author has described the BioSleeve gesture recognition. It can either obtain the information or extract features from hardware of the sensor array to conduct the pattern recognition of hand [10,11]. The gesture library as Figure 2-1 has been selected and must be directed by a training time that must consist of keeping a fixed movement in range of 6-10 seconds within each gesture. There are 16 discreet hand and finger movements with 95% accuracy that accurately interpret by the program about an hour after training and detect the direction, pitch, and roll of the constant motion of the forearm [10,11].