

Accelerometer Implementation as Feedback on 5 Degree of Freedom Arm Robot

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Abstract— The research investigated the automatic control system implemented with the 5 DOF (Degree of Freedom) arm robot control system using the closed-loop control method with the MPU 6050 sensor, which integrated the rotation of the MG995 motor servo as a feedback function. The control of this robot used android-based application, in which the app sends data of the rotate angle for each servo motor rotated to a certain angle. The HC – 05 Bluetooth received the data and the Arduino UNO R3 microcontroller processed them. The microcontroller managed every rotation of each servo motor that integrated with an MPU6050 sensor with serial monitor communication to display the rotation of each servo motor. The test results obtained by the standard deviation value showed how large the sample diversity was. The result of this study showed a standard deviation correlation with the number of sample diversity. The higher the standard deviation value, the more sample data spread (data diverse or varies). Otherwise, the smaller the standard deviation value, the more homogenous the sample data. If the standard deviation equals zero, it indicates that the sample has identical data. The highest standard deviation value from servo motor 1 is 5.20, servo motor 2 and 3 are 1.00, servo motor 4 is 2.89, and servo motor 5 is 2.9.

Keywords— Close Loop, MPU 6050 Sensor, Servo motor, Arduino

I. INTRODUCTION

The use of technology in the digital era is based on computerization in both research and industry. The basic use of technology is that it must increase the productivity of human resources and the efficiency of products. The standardization of high-quality products in large quantities requires robotic technology to anticipate human error during the manufacturing process and logging.

Some researchers have conducted research using robotic arms. Kumar studied Object-Based computer vision grasping a 6DoF robot arm using camera [1]. The robot system was controlled with Arduino and Raspberry. the phase-wise development of remote-controlled robot arm was investigated by Sharma [2]. The robot system was controlled by using Arduino ATMEGA2560. The development of a robot arm for color-based goods sorter in the factory using tcs3200 sensor with web-based monitoring system was investigated by Panie and Mutiara [3]. The robot system used a color sensor and a Nodemcu microcontroller.

Tomaszuk investigated the combined drive system of robotic arms used in mobile robots [4]. The robot system was driven by using the STM32 microcontroller. Ababneh examined the gesture-controlled mobile robotic arm to help elderly and wheelchairs using Kinect sensors [5]. The robot system used a Kinect sensor and a microcontroller control. Chua studied the development of microcontroller-based wireless robot arm writing controlled by framework tracking [6]. The robot system used a Kinect sensor and was controlled by a microcontroller connected to the computer.

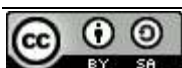
Kandalauft designed robot arms using sound and gesture recognition [7]. The robotic system used sound sensors and gestures. The robot was controlled using a microcontroller. Artal-Sevil designed a low-cost robot arm controlled by Surface EMG sensor [8]. The robot system consisted of an EMG sensor. The robot was controlled using Arduino UNO. Szczesny and Recko investigated control of robot arms for Mars rover analog [9]. The robot system was designed using 6 DoF and was controlled by an STM32F7 microcontroller.

The purpose of this control system is to create a closed-loop control system (Closed Loop) for the operation of the Arm Robot 5 DOF (Degree of Freedom) which is controlled by an Android smartphone using Bluetooth connection. The use of the Arduino UNO Microcontroller is the main controller for running the logic program that has been made. The MPU6050 is as feedback to the servo motor angle motion. In the operation, the Robot Arm enters the angle value of each input of each servo against the output angle, based on the MPU6050 sensor integrated with the Servo motor.

The purpose of this research is to control the Robot Arm with an android smartphone, obtain the angle value on each servo motor when the Robot Arm System is moved according to the specified angle, and obtain a closed-loop control system on the servo motor movement accurately.

II. METHOD

The research methodology of the Arm 5 DoF (Degree of Freedom) [10], [11] Control System with Android Smartphone [2], [7], [12]–[15] was carried out by designing a motion system based on a closed-loop method.



A. Movement system design

Robot Arm 5 DoF (Degree of Freedom) with Android smartphones required several devices used to run the motion system as illustrated in Figure 1.

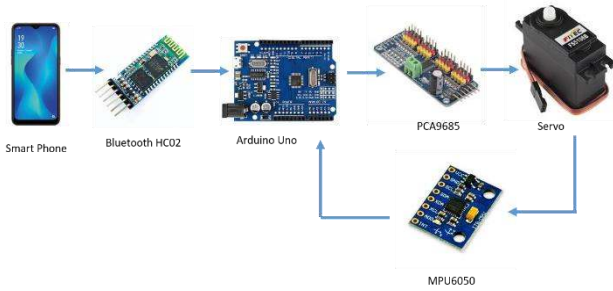


Fig. 1. System block diagram

The system block diagram shows the processing tools and materials from the initial to the final process. The Bluetooth is connected from the mobile phone to the HC05 Bluetooth module [2], [16]–[21] as a receiver from the Arduino application. The PCA9685 module is [22] used to control a servo motor with six servo motors.

B. System Schematic Design

The schematic design of electrical circuits functions to translate the design concepts of tools and materials into electrical circuits is shown in Figure 3. It consists of several components that make up the system namely input devices, control devices, and output components.

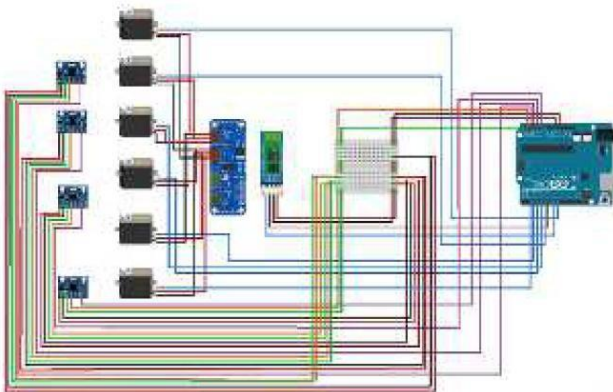


Fig. 2. System electrical schematic

In the system electrical schematic shown in Figure 2, the input is 5 Volt adapters for PCA9685 modules. The input device is from the angle value enters in each servo motor. The output components are six MG995 servo motors [23]–[27] and five MPU 6050 [28]–[31].

C. Firmware Design

There are several explanations on how the motion system works based on their respective functions on each device and material that has been run. The system workflow is shown in Figure 3.

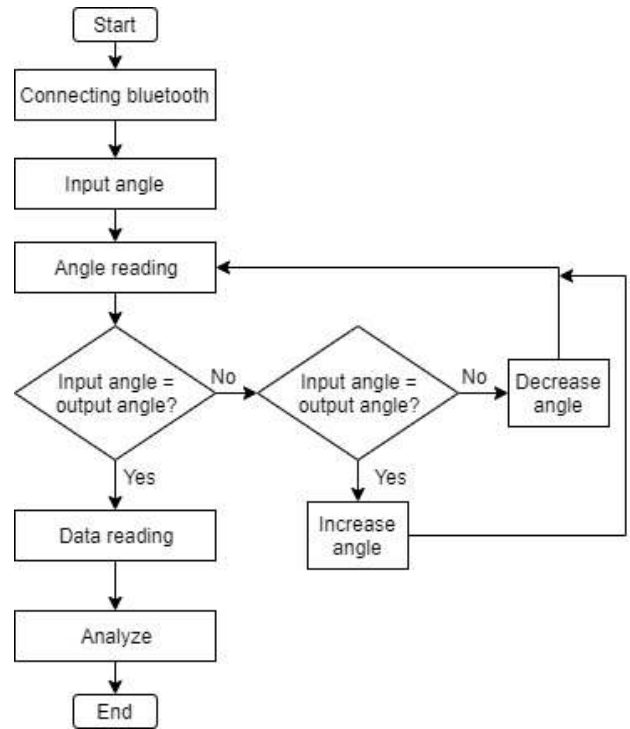


Fig. 3. System workflow

III. IMPLEMENTATION

The overall design and testing results of the servo motor movement were integrated with the MPU6050 sensor and time calculation.

A. Servo 1 Test

The data collection was carried out by giving a predetermined input angle value at three times experiments at each corner. The amount of time was recorded from the initial to the final angle. Figure 4 shows the results of data retrieval performed on servo motor 1 for 3 times with a predetermined angle of 0° and 135°.

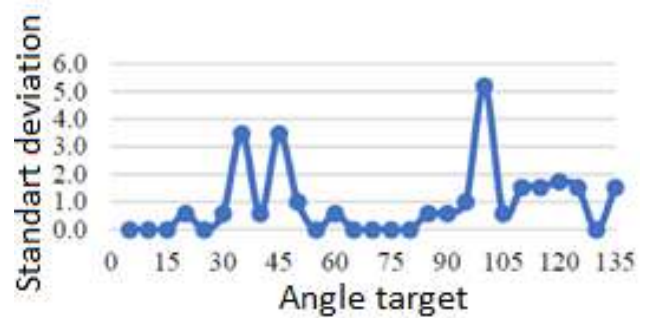


Fig. 4. Standard deviation against servo 1 angle target

Figure 4 shows that the standard deviation values at the targeted angles 5, 10, 15, 25, 55, 55, and 80 and the target angle of 130 has a standard deviation of 0.0 meaning that the values of all samples are the same (absolutely the same or identical). The samples which have a standard deviation value of 0.58 to 1.0 are more homogeneous or (almost the same), while the data of a standard deviation of 3.46 to 5.20 means that the sample data used is increasingly spread (varied or varied data). The largest standard deviation of servo motor 1 is at an angle of 100 with a value of 5.20, which means that

the sample data varies. The test of time shows that the data of the magnitude of the target angle with time fluctuate. The greater the angled target is determined, the longer the time is required. There is a significant decrease in the target angle of 50 with 3.59 time, and a target angle of 120 to 130 with 3.89 times.

B. Servo 2 and 3 Tests

Below are the results of the data collection which was conducted on servo motor numbers 2 and 3 for 3 times with a predetermined angle 0° and 125° .

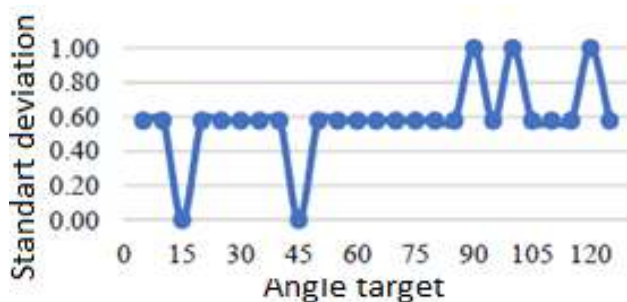


Fig. 5. Standard deviation of target servo angle 2 and 3

Figure 5 shows that the standard deviation at the 15th angle target is 0.0, meaning that the values of all samples are the same (absolutely the same or identical). The samples that have a standard deviation of 0.5 means that they are more homogeneous (or almost the same). Whereas the data with a standard deviation 1.0 means that the sample data used is increasingly diffused (varied). The largest standard deviation of servo motors 2 & 3 is at the target angle of 90, 100 and 120 with a value of 1.0 meaning that the sample data varies. The angular of time has a significant increase and decrease. The most significant decrease occurs at an angle of 90 to 95 f 3.59 time.

C. Servo 4 Test

Below are the results of data retrieval performed on servo motor 4 for 3 times with a predetermined angle 0° and 90° .

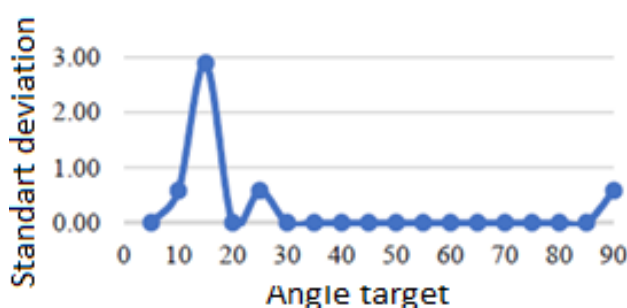


Fig. 6. Standard deviation against servo 4 angle target

Figure 6 displays that the standard deviation values of the target angle 5, 25, 30 to 85 are 0.00 meaning that the values of all samples are the same (absolutely the same or identical). The samples that have a standard deviation 0.58 means that the sample data are more homogeneous or (almost the same), while the standard deviation 2.89 means that the sample data are more diffuse (varied). The largest standard deviation on the servo motor 4 is the target angle 15 is 2.89, which means that the sample data varies.

The data of the target angle with time fluctuate. The greater the target angle determined, the longer the time taken. There is a significant decrease in the target angle from 85 to 90 in 5.06 times.

D. Servo 5 Test

Below are the results of data retrieval performed on servo motor 5 for 3 times with a predetermined angle 0° and 90° .

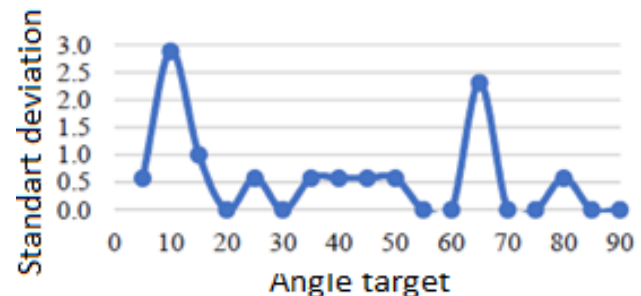


Fig. 7. Standard deviation against servo 5 angle target

Figure 7 shows that the standard deviation values at the target angle of 20, 30, 55, 60, 70, 75, 85, and 90 are 0.00, meaning that the values of all samples are equal (absolutely the same or identical). The samples that have a standard deviation 0.6 to 1.0 means that the sample data are more homogeneous or (almost the same). Whereas the standard deviation 2.3 to 2.9 means that the sample data used are more diffuse (varied or varied data). The largest standard deviation of servo motor 5 is at the target angle of 10 with standard deviation of 2.9, meaning that the sample data varies. The data of the angular target are fluctuating. The greater the angular target, the longer the time required.

IV. CONCLUSION

The research has succeeded to move the 5 DoF (Degree of Freedom) robot arm on an Android smartphone application with a Bluetooth connection. The output value on the movement of the servo motor is in accordance with the input value on the specified Android smartphone application. The test results of the research using close-loop method obtain standard deviation values indicating how large the diversity of the sample is. The greater the standard deviation, the more spread the sample data (varied), and reversely. The smaller the standard deviation, the more homogeneous the sample data (almost the same). If the standard deviation is 0, the sample has the same data (identical). The largest standard deviation value on servo motor 1 is 5.20, servo motor 2 and 3 is 1.00, servo motor 4 is 2.89 and servo motor 5 is 2.9.

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