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Robotic Arm using Arduino Uno

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Abstract: As technology and innovation continue to improve, the development of human-like systems and methods is becoming more involved in business to meet the needs of people at a rapid pace. Such revolutions are carried out with the desire to simplify the people. This paper focuses on the development of an electro-mechanical robotic arm that attempts to pick and place and is operated or controlled through a mobile phone application via an Android smartphone. An electro-mechanical robotic arm designed to simulate pre-determined commands can typically move in four directions; left, up, down and right control in the angle defined by six servo motors and loaded with practical mobile phone features. Control of the designed and implemented robot arm is carried out using a mobile phone application through a Bluetooth module programmed through an Arduino UNO controller.

Keywords: robot arm, Arduino, controller, servo motor

I. INTRODUCTION

Robotic Arm is an electromechanical model that uses electrical parts, electronic parts and mechanical components. The mechanical part of the arm is connected by zero-joints. The Robotic Arm is programmable and has the same interaction as a human arm. The Rotary servo motor is controlled by a smartphone using an Android app.

Now the automation industry is growing rapidly in India. Automation may not be new, but combining robotic technology with automation has made it productive, easy, and cost-effective. It also eliminates potential business or dangerous and life-threatening items making the manufacturing process safer.

A. Project Method

Basic information about the possible design and the first robotic arm is done. Using SolidWorks is a desktop software used for planning, visual conceptualization, and feasibility studies to complete the design. Using 6 servo motors, the robot arm can move in different directions and hold or release objects with its handle. Arduino UNO controller is used to control the correct arm. These microcontrollers are used because they are cheaper and more suitable for beginners especially for programming. The program code is written in Embedded C, one of the most popular and mainstream programming languages. We have also created a smartphone app that will connect to the Arduino UNO microcontroller via a Bluetooth module. Control of the robot arm can be achieved using a smartphone app.

B. Recommendations

The test results show that the servo cannot perform complex operations due to several limiting factors. A successful pre-installation test showed that there were no communication problems between the robot arm and the smartphone. However, it failed after the installation test due to the powerful servo motor. A torque not less than MG995 servo motor is recommended to improve performance. Reducing the density of the prototype can improve overall usability. PLA (Polylactic Acid) is a material with a very high strength-to-weight ratio and can be easily produced by 3-D printing. Storing operations larger than five directions can also be a problem for an Arduino board. Although the code only takes 60%, the procedure together proves very taxing on the processor. A continuous operation module like HC-05 also contributes to the loss of CPU performance. As such, the Arduino Mega is recommended because it offers a faster processor than the UART and UNO R3.

II. LITERATURE REVIEW

Industry 4.0 is a new field where the combination of Internet of Things, software, sensors, processors and communication technology, along with cyber-physical systems, plays a major role in creating "things" to have the ability to provide information. and ultimately add value to the production process. (Mohd. Ayman et al., 2016).

Today, technology is developing in the same direction based on rapidly increasing human needs. Efforts to meet these needs make life easier every day, and this research focuses on learning robotic arms. (Rajashekar K et al., 2020).

Designing robots together with the latest navigation computing platforms is no longer a problem. In robots, navigation guidance guides the robot through its environment and is a general requirement for almost any mobile robot. (G. N. Coelho, 2008).

"Today's smartphone is equipped with many sensors for navigation purposes such as accelerometer, gyroscope, camera, GPS and Wi-Fi transmitter, and most of them are equipped with fast processors. (W.-W. Kao and B. Q. Hui, 2013).

Designers have a variety of options to choose internal sensors to create their robot navigation platform. Like using a smartphone In this project, the robot can be controlled by a Bluetooth device using an android application, which can be interfaced to the control unit in the robot to feel the signal sent by the android application over a wide area. Before a few years ago, conventional practice operated using RF circuits with several limitations such as operating range, frequency range, and control range. By using a smartphone to control the robot, this limitation can be eliminated, it has more advantages such as reliable control, includes a large working distance, and the biggest advantage is long-term control. (Nick Firdaus, 2015).

From meaning to comparison; "Wi-Fi is a low-cost solution that covers short distances such as airports, hotels and conference venues." Of this, Wi-Fi has some limitations in providing a wide area solution, as infrared, WLAN, and Bluetooth technology can only provide a few devices within a short distance of Wi-Fi. (S. Tang, 2011).

III. CIRCUIT DESIGN AND HARDWARE SELECTION

A. *Arduino UNO R3*

Although the microcontroller is commonly used in programming and software, the open source controller is the ATmega328P based microcontroller. Arduino UNO refers to a board equipped with analog and digital inputs or output points that can be connected to various circuits and expansion boards. Processing is written for non-programming users. Figure 1 shows the Arduino Uno R3 used in this project.

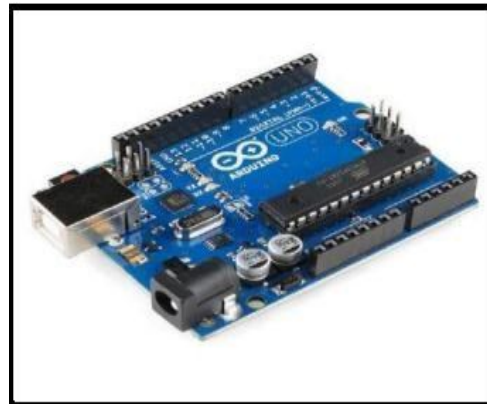


Figure 1 Arduino UNO R3

B. *Motor Servo*

A servo motor can rotate through a directed angle. A simple servo driven motor. A servo motor usually comes with a screw and gear assembly that provides high torque with light and a small servo motor. According to this feature, servo motors are used in Toys, Robotics, Printers, etc. It is used in various applications such as



Figure 2 Motor Servo

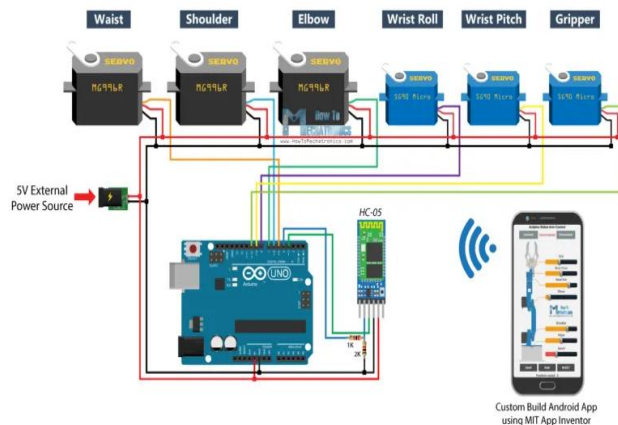
Table 1 Characteristics of Servo Motor

Specifications	MG995	SG90
Operating Voltage	4.8 – 7.2 Volts	+5V
Torque	4.8V: 130.54 oz-in (9.40 kg-cm)	2.5kg/cm
No Load Speed	4.8V: 0.20 sec/60°	5V:0.1s/60 degree
Rotational Range	Approximatel y 180°	Approximatel y 180°

C. HC-05 Bluetooth Module

This module is used to communicate between two microcontrollers such as Arduino or to communicate with any device via Bluetooth. This module communicates on the 9600 using USART. HC-05 shown in Figure 7 has two working modes, 1 is data mode, which can send and receive data from other Bluetooth devices, and the other is AT command mode, which can change the default device settings.

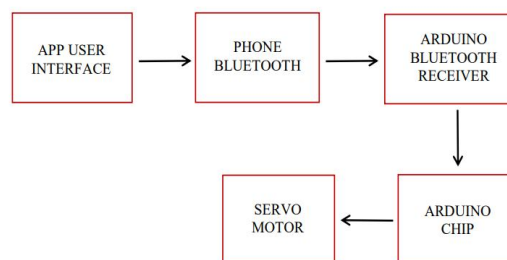
D. Chain diagram



The circuit consists of an Arduino board and a HC-05 Bluetooth module to communicate with a smartphone. The six servo motor control points are connected to the six digital pins of the Arduino board.

Servos need 5V to run, but that has to come from an external power source because the Arduino can't handle the amount of current they can draw. The power supply must be able to handle a current of at least 2A. So if everything is connected, we can start programming the Arduino and create an Android app.

E. Block Diagram



IV. CONSTRUCTION OF THE ROBOTIC ARM:

The design of the robotic arm is divided into two parts, the mechanical design and installation parts. In this project, hardware and software functions are combined to make the system productive and reliable.

A. Mechanical Design

The materials needed for the mechanical part of the robot arm were supplied and were drawn on SolidWorks in the form of an IPS unit. The robotic arm will have 5 outputs consisting of a base, handle, wrist, elbow, shoulder and waist. The robot has a combination of round and rectangular base capable of holding the Arduino UNO microcontroller and the body of the robot arm. 20 pt chipboard was used as the main material for the construction of the robot arm because it is easy to shape, cheap and can support the weight and movement of the motor. The robot's DOF mechanism is driven by two different types of servomotors. The robot gripper is also made of plastic fiber.

B. Mechanical Assembly

The robotic arm moves in 4 axes with 6 servo motors in a specified position according to the specifications of the mobile application.

The robot is designed to have a stationary base and a movable arm body with servomotors connected to move the arm. Each servomotor (6) is assigned as a joint of the robot arm, which then each corresponds to a mobile application, namely for; (s1) waist, (s2) shoulder, (s3) elbow, (s4) wrist, (s5) wrist span and (s6) grip. The assembly of the servomotors is shown in Figure 13.

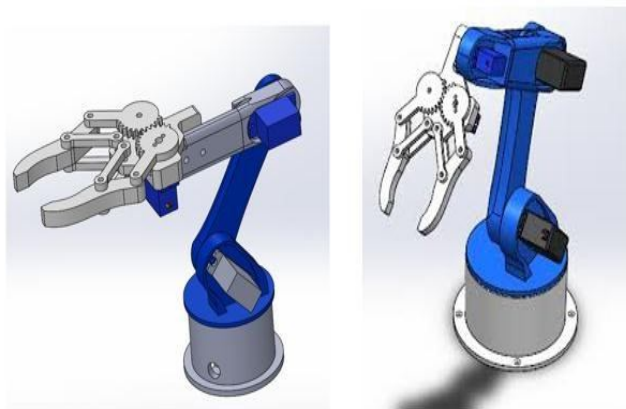


Figure-4: Installation of servo motors
(Some were sealed inside the body)

C. Programming for Android

The Android app used in the project was created using App Inverter. App Inverter is a free unified web application development environment developed by Google and later developed by MIT. The mobile application was developed and created by dropping and dragging components into the design view and using visual block language to make the program application behave. In this section, many variables such as wrist spacing, wrist tilt, elbow, shoulder, grip, waist and arm speed are the design criteria.

V. RESULTS AND DISCUSSION

A. Project Method

Using SolidWorks is software used for visual conceptualization, planning, and feasibility studies to complete the design. Using 6 servo motors, the robot arm can move in different directions and hold or release objects with its handle. A single Arduino UNO controller board is used for optimal control of the robot arm. These microcontrollers are better to use because they are cheap. The program code is written in Embedded C, one of the most popular and mainstream programming languages. We also created a mobile application that will connect to the Arduino UNO (master) controller via the HC-05 Bluetooth module (slave). Controlling or guiding your hand will be done using a smartphone app.

B. Detailed Design of the Robot Arm



Figure 5: finished robot arm

C. Operation of the Robotic Arm

Figure 6 shows a robotic arm workstation. The robot arm for this project has 5-DOF. Table 2 shows the angle of each servo that the robot arm can move.

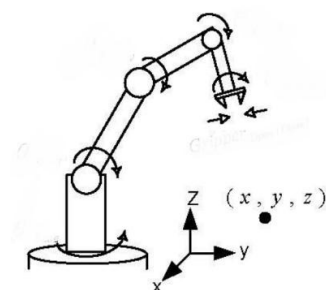


Figure 6: Work space with robots

Table-2: different maximum angle that each servo in the robot arm can move.

No.	Servo Part	Maximum Angle(°)
1	Waist	180
2	Shoulder	60
3	Elbow	85
4	Wrist Roll	180
5	Wrist Pitch	180
6	Grip	90

VI. CONCLUSION

The use of Arduino Uno to create a robotic arm shows the versatility and potential of this microcontroller in robotics manufacturing. It offers precise control, accessibility and customization options. This project demonstrates the interdisciplinary nature of robots and opens up possibilities for various applications. As technology advances, we can expect more advanced and innovative uses of Arduino-based robotic arms, promising a future where robots will continue to improve and simplify various tasks.

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