

The Development of Robot Arm with Smartphone Control Using Arduino

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Abstract: *In recent decades, the manufacturing sector has seen a rapid evolution. From mass production with an intensive labour force in production lines to the use of robotics to increase efficiency, the manufacturing industry is constantly evolving with more and more infusion of automation. Today, the next phase of evolution is referred to as the Fourth Industrial Revolution or Industry 4.0. This paper presents the development of a robot arm with smartphone control using Arduino Uno. A mobile robot that functional to do pick and place robot are one of the technologies in manufacturing industries that are designed to perform pick and place operations and be controlled by using a smartphone via Bluetooth connection. The development of this robot is based on the Arduino Uno platform that will be interfaced with the wireless controller to the mobile robotic arm. This system is designed to eliminate human error and human intervention to get more precise work. There are many fields in which human intervention is difficult but the process under consideration must be operated and controlled this leads to the area in which robots find their applications. Finally, this prototype of the robot is expected to overcome the problem such as placing or picking objects that far away from the user, pick and place a hazardous object in the fastest and easiest way.*

Keywords: robot, pick and place, smartphone control

1. Introduction

On October 31, 2018, International Trade and Industry Ministry (MITI) has launched the National Policy on Industry 4.0 aimed at boosting digital transformation in the Malaysian manufacturing sector and its related services by facilitating companies to embrace the related technologies systematically and comprehensively. The end goal is for Malaysian manufacturers to be stronger through smart technologies. For many years people try to replace human workers with machines. Many companies, research centers, and universities acknowledge that robotics and automation technology is the basis of industrial manufacturing and an important driver for Industry 4.0. Machines called robots are faster and more effective than people are. The term robotics is practically defined as the study, design, and use of robot systems for manufacturing.

Robots are generally used to perform unsafe, hazardous, highly repetitive, and unpleasant tasks. They have many different functions such as material handling, assembly, arc welding, resistance welding, and machine tool load and unload functions, painting, and spraying. Many elements of robots are built with inspiration from nature. The construction of the manipulator as the arm of the robot is based on the human arm. The robot can manipulate objects such as pick and place operations. It is also able to function by itself. The development of electronic

industry robot system technology has been expanded increasingly. As one such application, the service robot with machine vision capability has been developed recently.

In this highly developing society, time and workforce are critical constraints for the completion of tasks on large scale. Automation is playing an important role to save human efforts in most of the regular and frequently carried works. One of the major and most performed works is picking and placing jobs from source to destination. The pick and place mechanical arm is a human-controlled based system that detects the object picks that object from the source location and places it at the desired location. For the detection of objects, humans detect the presence of objects and move machines accordingly. With the rapid increase in the flow of information, people are now guided to search for different markets and people have entered the competition to manufacture quality products cheaply.

The robotic arm is made of an Android phone or tablet control; it can carry the desired material, mix it up, and perform the commands previously determined by a user. If this project is also a designated task; the robotic arm takes a piece of material and brings it to the desired position and then records its movements and lets it do the same action until we stop it. The servomotor is preferred to be able to perform these operations properly since the motor to be selected must operate precisely and must be at high torque. The robot arm shows in Figure 1 is composed of 5 servo motors and can move in 4 axis directions with these motors.

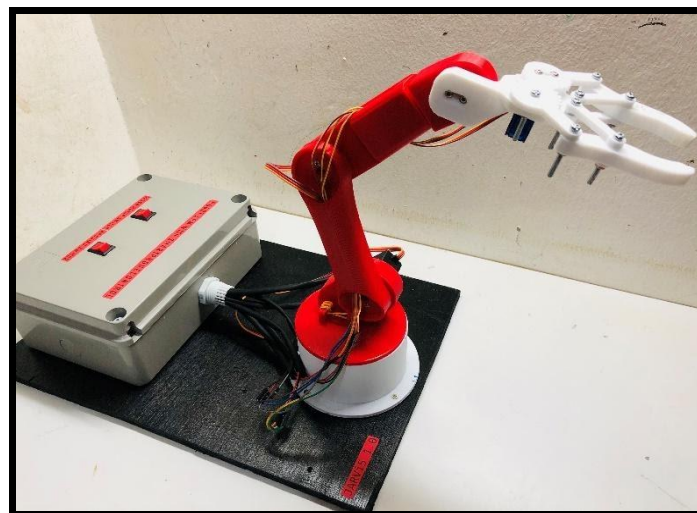


Figure 1: Robot Arm

2. Literature Review

Industry 4.0 is a new area where the Internet of things alongside cyber-physical systems interconnect in a way where the combination of software, sensor, processor, and communication technology plays a huge role in making “things” to have the potential to feed information into it and eventually adds value to manufacturing processes. (Mohd Aiman et al., 2016). Today technology is developing in the same direction in line with rapidly increasing human needs. The work done to meet these needs makes life easier every day, and these studies are concentrated on robotic arm studies. (Rajashekar K et al., 2020).

Recently, designing a robot along with a navigation-computing platform is not a problem anymore. In robotics, navigation refers to the way a robot finds its way into the environment and is a common requirement for almost any mobile robot. (G. N. Coelho, 2008). “Today's

smartphone is already equipped with multiple built-in sensors for navigation purposes like accelerometer, gyroscope, camera, GPS, and Wi-Fi transceiver plus most of them embedded with fast processors. (W.-W. Kao and B. Q. Huy, 2013). The designers have wide options to choose any built-in sensors to create the navigation platform of their robots. It is like using the smartphone as a “brain” for the robots. (R. V Aroca et al., 2012).

In this project, by using an android application, the robots could be controlled with a Bluetooth device, interfaced to the control unit on the robot for sensing the signals transmitted by the android application in the wide range area. Normal practice for the past few years ago, robots are controlled by using RF circuits, which have several limitations like working range, frequency range, and control range. These limitations could be vanished by using smartphones for robotic control, it has more advantages like robust control, large working range coverage and the biggest advantage is long-lasting controlled. (Nik Firdaus, 2015). For comparison, from the definition; “Wi-Fi is a cheap solution aimed to cover short distances such as airport, hotels, and conference areas”. From this, Wi-Fi has some limitations in providing a wide coverage solution, while the Infrared, WLAN, and Bluetooth technology only able to remote some equipment in the coverage less than Wi-Fi. (S. Tang, 2011).

The pick and place robot being implemented to ease the process of sorting, the process of moving heavy materials, etc. Usually, the transfer process of the heavy materials is being carried out, using manpower and if the transfer process is repeated for a while, it can cause injuries to the operator. By using the robot, the operator will no longer have to bend and lift heavy loads thus preventing injuries and increasing the efficiency of the work. An operator will make mistakes whether small or big in a while. In the industrial world, the industry cannot afford to take any kind of mistake. As every mistake is costly whether interns of time, money, and material. (Harish K et al., 2017)

3. Methodology

This project has been planned in three major different stages to understand each stage carefully and to complete the project in time. Figure 2 below shows the stages design of project development.

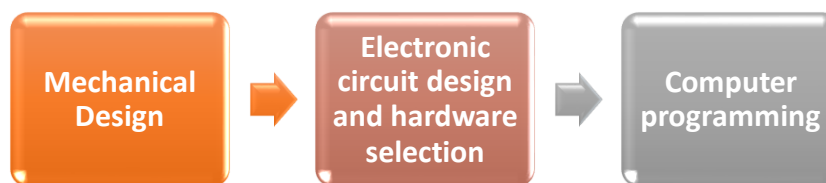


Figure 2: Stages design of project development

3.1 Mechanical Design

The first task in mechanical design is to create a computer-aided product. An initial design was built with the help of Solid works 3D modelling software and the arm has 5 degrees of freedom that gives the shape of a robotic arm in a virtual environment. For the first 3 axis, the waist, the shoulder, and the elbow are used the MG996R servos, and for the other 2 axis, the wrist roll and wrist pitch, as well as the gripper used the smaller SG90 micro servos. Figure 3 and Figure 4 show the side view and front view of this project.



Figure 3: Side view

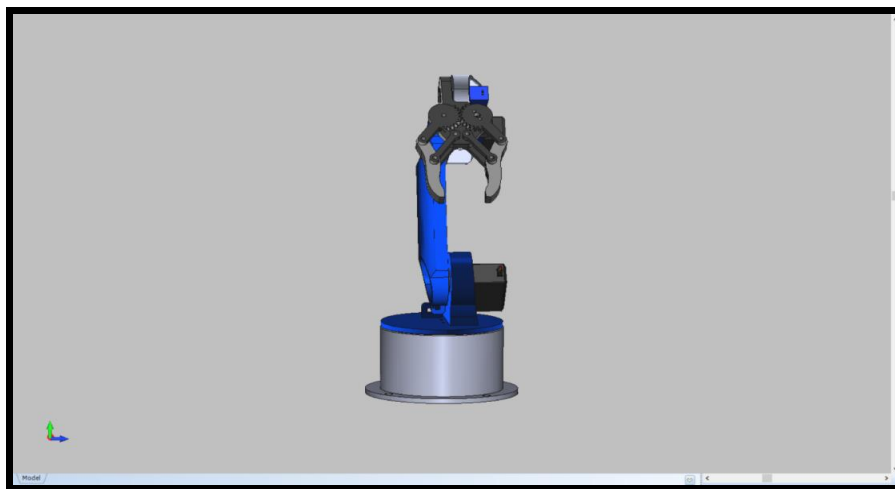


Figure 4: Front view

3.2 Electronic Circuit Design and Hardware Selection

3.2.1 Arduino UNO

Although microcontroller type PIC is usually used in programming and software fields, Arduino Uno is an open-source microcontroller board based on the microchip ATmega328P microcontroller and developed by Arduino. cc. The board is equipped with sets of digital and analog input/output pins that may be interfaced to various expansion boards and other circuits. Processing is written for non-programming users. Arduino wiring is produced based on the programming language. Figure 5 shows the Arduino Uno R3 is used in this project.

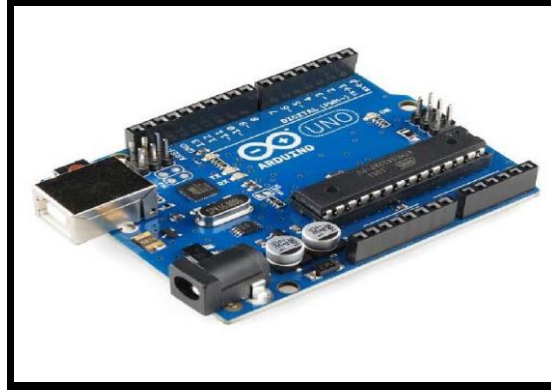


Figure 5: Arduino Uno R3

3.2.2 Servo Motors

The next hardware that is a drive system of a robotic arm is a servomotor. They are small but pack a big punch and are very energy efficient. Servo motors operate from 4.8V to 6.5V, the higher the voltage higher the torque we can achieve, but most commonly they are operated at +5V. Figure 6 below shows the SG90 micro servo and MG996R servo motor that had been used for this project.



Figure 6: SG90 micro servo and MG996R servo motor

3.2.3 HC-05 Bluetooth

This module is used to communicate between two microcontrollers like Arduino or communicate with any device via Bluetooth. This module communicates with the help of USART at 9600 baud rates. The HC-05 that show in Figure 7 has two operating modes, 1 is the data mode in which it can send and receive data from other Bluetooth devices and the other is AT command mode where the default device setting can be changed.

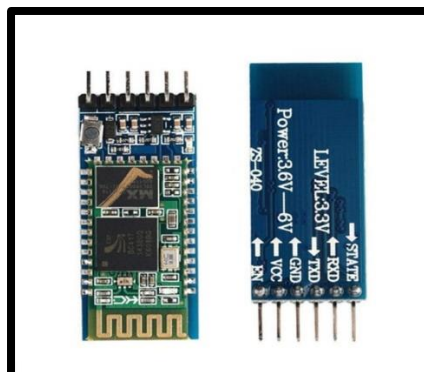


Figure 7: HC-05 Bluetooth

3.3 Computer Programming

3.3.1 Arduino Software

Arduino Software is free software that can be downloaded on <http://arduino.cc/>. The requirement for the installation is low, so any computer can install it and use it. The Arduino has its development environment which contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions, and a series of menus. It connects to the Arduino hardware to upload programs and communicate with them.

3.3.2 Smartphone Controller Software

The original Robot Arm control app was using sliders for controlling the positions of the servos. The app is using the MIT App Inventor online application. At the top, we have two buttons for connecting the smartphone to the HC-05 Bluetooth module. Then on the left side, we have an image of the robot arm, and on the right side, we have the six sliders for controlling the servos and one slider for the speed control. Each slider has a different initial, minimum and maximum value that suits the robot arm joints. At the bottom of the app, we have three buttons, SAVE, RUN, and RESET through which we can program the robot arm to run automatically. There is also a label below which shows the number of steps we have saved. Figure 8 below shows the smartphone software layout.

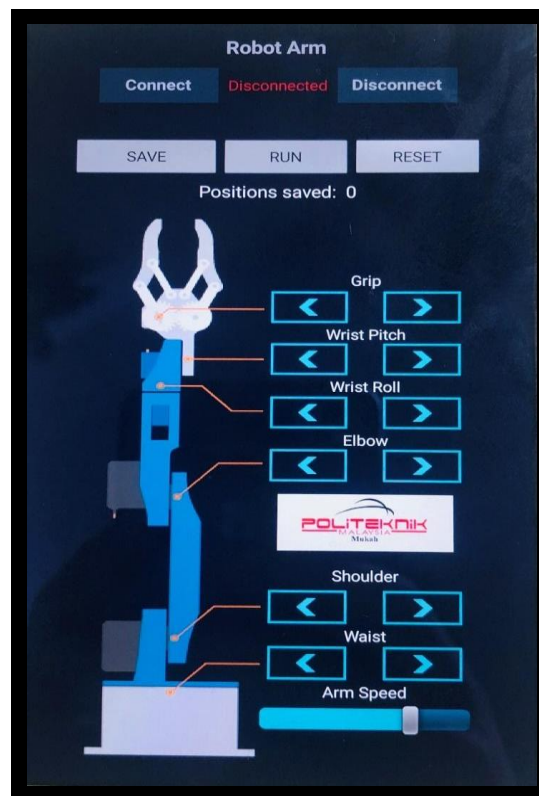


Figure 8: Smartphone Software Layout

4. Discussion and Result

4.1 Circuit Connection

Arduino board and an HC-05 Bluetooth module for communication with the smartphone. The control pins of the six servo motors are connected to six digital pins of the Arduino board. Figure 9 shows the connection of the main circuit of the Robot Arm, by using Arduino UNO as the Microcontroller, the HC-05 Bluetooth Device act as the communication medium for the

Smartphone and the Robot. Six servo motor used includes three MG996R Servo Motor and three of the SG90 Micro Servo Motor to control the angles of the Robot Arm. For powering the servos, we need 5V, but this must come from an external power source because the Arduino is not able to handle the amount of current that all of them can draw. The power source must be able to handle at least 2A of current.

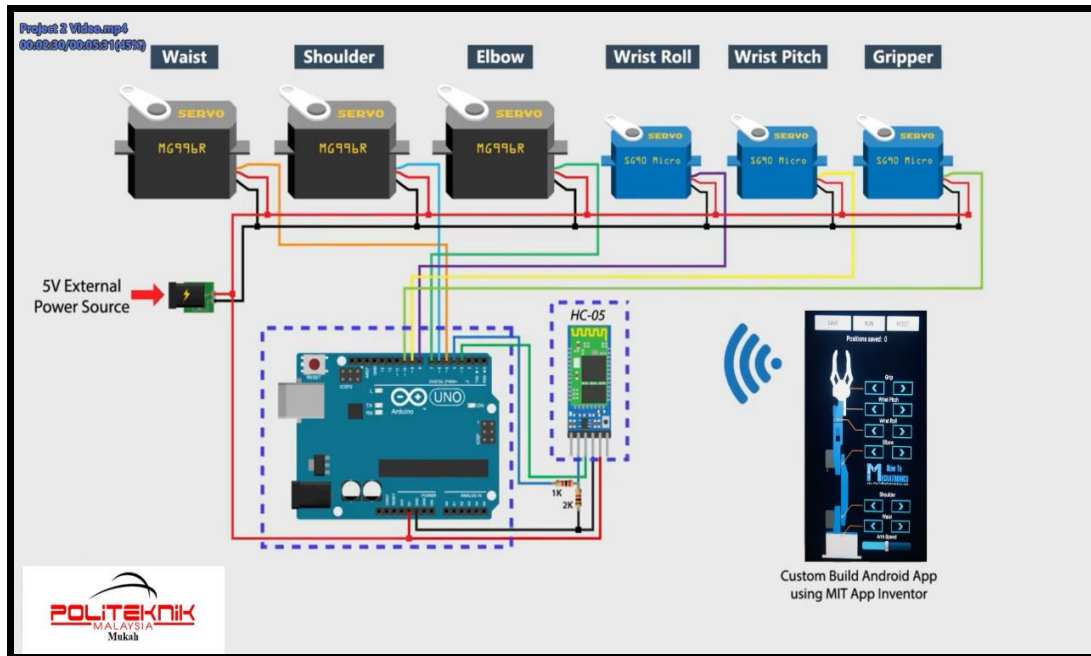


Figure 9: Circuit connection

5. Conclusion

Overall, the objectives of this project have been achieved which are developing the hardware and software for wireless mobile robotic arm, implementing the pick and place system operation and testing the robot that meets the criteria of purpose project. From the analysis that has been made, it is clearly shows that its movement is precise, accurate, and easy to control and user friendly. The mobile robot has been developed successfully as the movement of the robot including mobile and arm robot can be controlled wirelessly. This robot is expected to overcome the problem such as placing or picking object that away from the user, pick and place hazardous object in the fastest and easiest way. The development of this system has wide area of applications such as in industry, as Malaysia is chasing the Industry Revolution 4.0.

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