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Implementation of 5-axis Robot Arm for Automatic Processes

Enes Bugra BAYIR[1], **Lida KOUHALVANDI**[2], **Farzad MIR**[3]
[1]*Electrical and Electronics Engineering Dept., Dogus University, Istanbul 34775, Turkey*
[1]*e.bugrabayir@gmail.com*
[2]*Electrical and Electronics Engineering Dept., Dogus University, Istanbul 34775, Turkey*
[2]*lkouhalvandi@dogus.edu.tr*
[3]*Electrical and Computer Engineering Dept., University of Houston, Texas, USA*
[3]*fmir@cougarnet.uh.edu*

Abstract

This project devotes to implement the 5-axis movable robot arm leads to provide an automated process for capturing the utensils. The main target is to perform material separation manually and via android program using a 5-axis movable robot arm. In this generated environment, there is information about the electrical circuits, mechanical structures and software of a robot arm that can be used in automation systems. Practically, an experimental study is developed to move the robot arm by adjusting the angular values it receives by remote connection and positioning the motors. 3D printer filaments, which are light in weight, and gear sets of the servo motor are used in order not to burden the servo motors in the mechanical parts of the robot.

Key words: Automation robot arm, 5 axis, robot

1 Introduction

A robot is an electro-mechanical device that can perform autonomous or pre-programmed tasks [1, 2, 3]. Robots can work directly under the control of an operator or independently under the control of a computer program [4]. Robotics is the joint study area of Mechanical Engineering, Industrial Engineering, Electrical and Electronics Engineering and Computer Engineering disciplines. It benefits from robotics, mathematics, and physical sciences in which, a subject close to Robotics is Mechatron-ics.

Robot technology includes the integration and application of many scientific and technological phenomena developed in the development process of our age on technological products that we call robots. In addition to the robots that make our life easier, there are also industrial robots that al-

ways make our work life easier [5, 6, 7]. The use of industrial robots lies in many areas, from tightening a screw to stacking boxes, saves time, labor and money. Moreover, robots are mainly used in a new area of research such as communication system which contain different type of antennas [8, 9, 10, 11, 12]. These features help without human interaction positions of antennas for better communications improve. Also, robots are becoming more and more popular for measuring methods due to their high rate of accuracy [13].

This study devotes to present the practical implementation of the robot arm that can be used in industrial for picking and handling the objects. Using the advantage of easy programming of the project Arduino, making it functional within 6 servo motors is a 3D printer-printed robot arm programming event. In situations and events that require sensitive or superior workforce, machines that should be able to do a job as delicate as a human are needed. Robot arms promise to meet this. The purpose of this project is to send remote commands to the robot arm and to get the desired work done with the desired delicacy and precision. By using the Android operating system, we have the opportunity to send the necessary commands from a phone or tablet as we want within the interface. Functions such as forward-backward, up-down and hold-release are the movements that the robot arm can do in this project. In order to do this most comfortably, software has been developed to assign the angle that the servo motors should make to the software as a command. The main purpose of this project was to perform the commands said in the most harmless and controlled way.

This work is organized as following: Sec. 2 provides the historical view of robot generation. Section 3 devotes to provide the important steps for generating the robot. Finally, Sec. 4 concludes this paper.

2 Historical Development Of The Concept Of Robot

The American Robotics Institute defines the concept of robot as: "The robot is a multifunctional, reprogrammable manipulator designed to move materials, parts, tools, or specific parts through variable programmed movements to perform a variety of tasks." Studies in robotic technology now rely heavily on advances in computer technology. Although computers were available when the robotics industry was born, they were not suitable for use in robot control until the late 1970s due to their size.

The most comprehensive definition of industrial robot and classification of robot types are determined in ISO 8373 standard. According to this standard, a robot is defined as: "An auto-controlled, reprogrammable multi-purpose manipulator with three or more programmable axes, which can be stationary or mobile, used in industrial applications." An industrial robot is a general-purpose programmable machine with human-like characteristics. The most important human-like feature of a robot is its arm. The robot arm is used for holding and placing operations. The robot arm is combined with another machine, loading the material and changing the tool. It performs manufacturing operations such as cutting, shaping, surface coating, cylindrical and plane surface grinding. It is used in assembly and control applications.

All robots on the market today use computer control. However, it is certain that the field of robotics includes machine and computer sciences. The robot revolution will create a temporary wave of hardship for workers, just as machines did at the beginning of the Industrial Revolution. Robots, on the other hand, can be quite slow to take over some jobs because it still hasn't been possible to develop robots with human dexterity. When robotic automation processes are started to be used actively all over the world, the workforce will be provided by robots instead of humans. With this robotic revolution, dark factories will be created in every region of the world, where no light enters and only robots work in production.

3 Generation and construction of 5-axis robot arm

This section devotes to describe the methodology employed for implementing the 5-axis arm of robot.

There is more than one way to get the right result when designing the robot arm project. However, choosing the most logical and practical one is an important issue for the development of the project. For this reason, a detailed research is done before the construction phase. In which area the robot arm will be used, the material quality and durability are selected accordingly. Figure 1 visuals are created with drawings made on the computer and this section devotes to describe the methodology employed for implementing the 5-axis arm of robot.

3.1 Basic elements used for generating robot arm

The robot arm consists of six important sections and sequences where the detail of each one is presented as following:

• Mechanical Part: It forms the skeletal Part of the Robot.

• Handle (End effector): This element is the part that does the real work, it is the most extreme point

Figure 1: 3D Design of practical robot arm.

of the robot and takes an active part in the application.

• Motors: This part is used to move the joints and the handle, the most commonly used are servo and hydraulic motors.

• Controls: In order to process the input and perform the robot's task, controls must be added.

• Sensors: The important necessity of each is the sensors. They provide the robot with feedback and input data for the robot to do the targeted performance.

• Power Source: As the final stage, the suitable source for motor, driver, microcontroller must be selected.

After introducing the required parts of robot, electronic connections are completed and the software part is started for implementation. For illustration, Fig 2 presents the simple connection diagram.

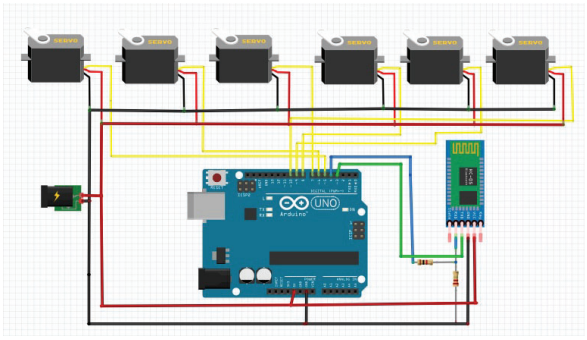

Figure 2: Robot arm wiring diagram.

3.2 Practical implementation of robot

This section provides the practical implementation of the robot. Providing a user-friendly interface and avoiding complexity are the basis of application selection. There are multiple platforms developed for designing applications. For this project, it is decided that the MIT App Inventor application is more useful. The main reason why this application is suitable for working is that it can work in harmony with the Arduino IDE. Figure 3 presents the working diagram.

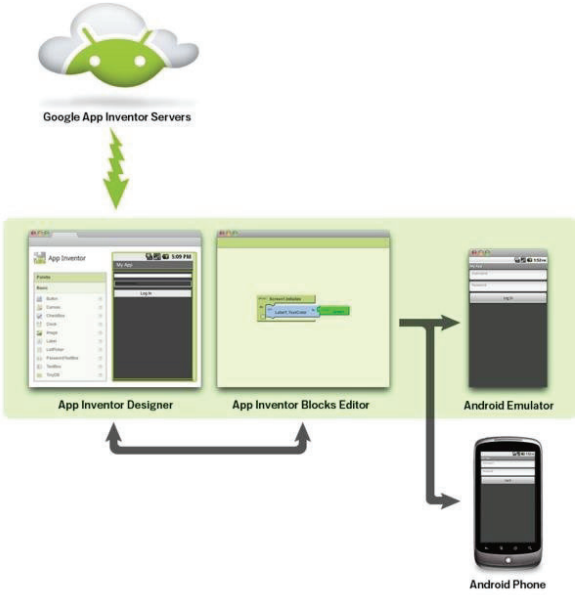

Figure 3: MIT App Inventor working diagram.

MIT App Inventor is a program that works in harmony with Arduino programs and provides simple analysis with the schema feature on it. After the electronic and software studies, a bluetooth-based application is designed in the App Inventor interface. Figure 4 shows the movable joints of the robot arm. It then runs or moves the positions saved through the application. The application interface is describing in detail as following:

The Android phone is paired with the HC-05 module on the robot arm. Afterwards, the robot takes its initial set position. In order to move the robot arm connected to the application, commands must be given through the application, then the "Run" command must be given through the application to run the recorded commands.

With the slide button added to the application, joint motion angles are being determined, and the degree determined in this range are assigned to the variable in the IDE. If it is not desired to wait for the recording time, the arm can be moved at that moment with the "RUN" button and the robot arm movement immediately. The robot arm will hold the objects with the gripper at the end and then move the part to another place autonomously or with directions.

When a command is sent via the application, the LED lights up and warns the user. At each new command, the green led lights up, confirming that the command is transmitted to the IDE. The robot

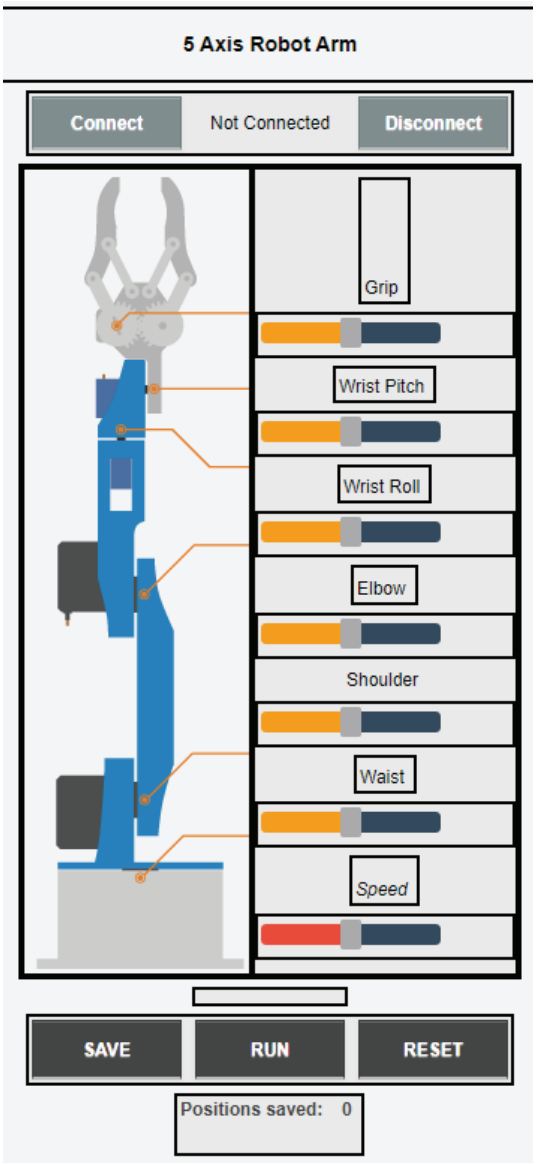

Figure 4: Application Interface.

moves the joints with the commands it receives, and the moving joints perform packaging tasks in part handling and mass production lines and the foundations of unmanned production are laid.

3.3 The Overall Design of Robot Arm

In summary, the robot arm is an intermediate element that helps speed up the processes in mass production lines, and is a useful element when it works with the right system and the right speeds. The prototype project wis created with 3D printing. The design is printed on a 3D printer with a 2 mm layer height and fifty percent fill rate setting. Figure 5 is designed to prevent cable tangles and to allow comfortable movement of the arm.

Figure 6 presents the initial and first construction of robot arm. In our generation, eventhough

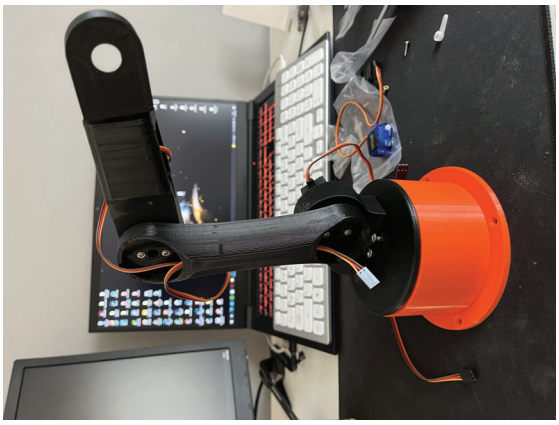

Figure 5: 3D Printing Assembly and Cable Ducts.

the torque values are sufficient but plastic geared servo motors are used since the servo motors carrying the center and lower arms, where the system weight is intense, have experienced heating and vibration problems. The servo motors at these points are replaced with metal gear servo motors aiming to tackle to the problem.

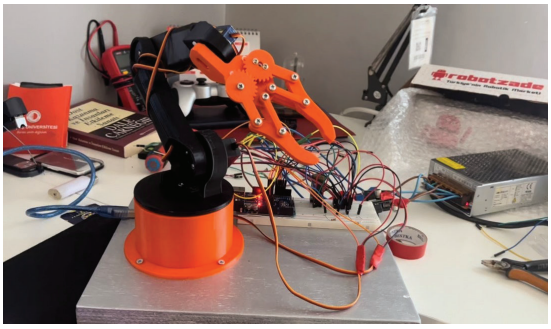

Figure 6: Adjusting Engine Angles and Joints.

Consequentially, Fig. 7 and Fig. 8 describe the motor mechanical assemblies and afterwards the base assembly is configured. Cable lengths are adjusted according to the ground height and transferred to the code part.

Figure 7: 3D Printing and Assembly.

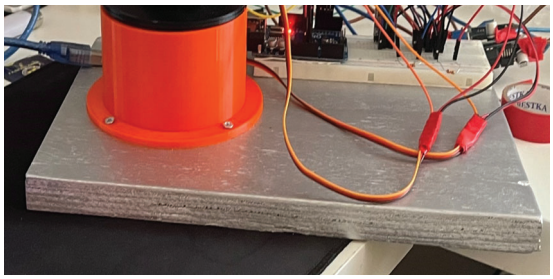

Figure 8: Base and links.

As the feeding source, the servo motors draws 500mA current. In principle, six servo motors are used in the system and a minimum of 3(A) current is required. Hence, this is the main reason of selecting this power supply.

Finally, the complete configuration of robot is generated as Fig. 9 presents. The constructed structure is operating in a sufficient way leading to capturing the utensils appropriately that can be used for future industrial.

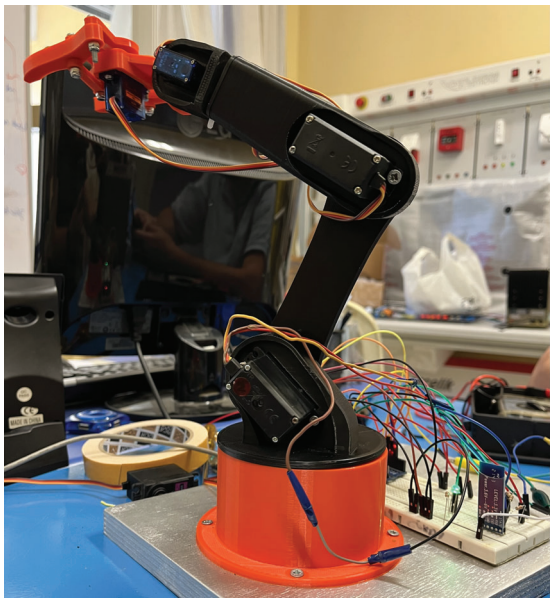

Figure 9: Android Controlled 5 Axis Robot Arm

4 Conclusion

This paper devotes to describe the methodology for generating the 5-axis robot arm aiming to picking the utensils automatically. The automation process is performed through the android program and the angular values are adjusted suitably for turning and capturing equipment. For constructing this robot arm, suitable servo motors, sensors, and power sources are provided.

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