

INTERDISCIPLINARY PROJECT REPORT
at
Sathyabama Institute of Science and Technology
(Deemed to be University)

Submitted in partial fulfilment of the requirements for the award of
Bachelor of Engineering Degree in Computer Science and Engineering

BY

SRINITHI SARASWATHI D (REG. NO. 40731102)



DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
SCHOOL OF COMPUTING
SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY
JEPPIAAR NAGAR, RAJIV GANDHI SALAI,
CHENNAI – 600119, TAMILNADU

APRIL 2023



SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)

Accredited with Grade "A" by NAAC

(Established under Section 3 of UGC Act, 1956)

JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI- 600119

www.sathyabama.ac.in



DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **SRINITHI SARASWATHI D (Reg. No. 40731102)** who carried out the project entitled "**ROBOTIC ARM**" under my supervision from January 2023 to April 2023.

Internal Guide

Dr.A.Annie Micheal, M.E, PhD

Head of the Department

Dr S.Vigneshwari, M.E.,Ph.D

17-04-2024

Submitted for Viva-voce Examination held on _____

Internal Examiner

External Examiner

DECLARATION

I, **SRINITHI SARASWATHI D** hereby declare that the Project Report entitled “**Robotic Arm**” done by me under the guidance of **Dr A.Annie Micheal, M.E, PhD** is submitted in partial fulfilment of the requirements for the award of Bachelor of Engineering degree in Computer Science and Engineering.

DATE: 17-04-2023



PLACE: Chennai

SIGNATURE OF THE CANDIDATE

ACKNOWLEDGEMENT

I am pleased to acknowledge my sincere thanks to the **Board of Management of SATHYABAMA** for their kind encouragement in doing this project and for completing it successfully. I am grateful to them.

I convey my thanks to **Dr. T. Sasikala M.E., Ph.D., Dean**, School of Computing, **Dr.S.Vigneshwari, M.E., Ph.D.**, Head of the Department of Computer Science and Engineering for providing me necessary support and details at the right time during the progressive reviews.

I would like to express my sincere and deep sense of gratitude to my Project Guide **Dr. A. Annie Micheal, M.E, PhD** for her valuable guidance, suggestions and constant encouragement that paved the way for the successful completion of my project work.

I wish to express my thanks to all Teaching and Non-teaching staff members of the **Department of Computer Science and Engineering** who were helpful in many ways for the completion of the project.

TRAINING CERTIFICATE



CERTIFICATE OF COMPLETION

PROUDLY PRESENTED TO

Srinithi Saraswathi D

HAS SUCCESSFULLY COMPLETED THE TWO MONTH "ROBOTIC COURSE" FROM
OCTOBER 13 - DECEMBER 13, 2022 THROUGH ONLINE CONDUCTED BY
HEURISTERS TECHNOLOGY SOLUTIONS LLP



HARISH B
(Designated Partner)

ABSTRACT

Today, technology is developing in the same direction in line with the rapidly increasing of human needs. The work done to meet these needs makes life easier every day, and these studies are concentrated in robotics studies. Actually in research scientists use the word "Robot" to mean any man-made machine that can perform work or other actions normally performed by humans, either automatically or by remote control because of this robot pervasive machine because of it is the accuracy of work and doing thing that people can't do in addition robot can work in dangerous regions that human can't work in it because of all these reason robot became one of the most popular thing that scientists still persevere to make it better by finding new controllers and designs that make robot more efficient and more reliable and in our project we have built a robot arm with 5 DOF (degree of freedom). In fact there are several methods were implemented to make a 5-DOF manipulator capable of performing pick-and-place operations. but the problem is that all the controller is relentless that mean if we need to change the program of the arm we have to reboot and write or designs another one and upload it to arm robot this way apparently is not efficient, on balance we choose a different and unconventional method to control the robot arm by using image processor device that called (Kinect).

TABLE OF CONTENTS

CHAPTER NO.	TITLE	PAGE NO
	ABSTRACT LIST OF FIGURES LIST OF ABBREVIATIONS	6 9 10
1	INTRODUCTION 1.1 Robotic Arms 1.2 Design	11 12 13
2	AIM AND SCOPE OF THE PRESENT INVESTIGATION 2.1 Objectives 2.2 Advantages 2.3 Application	14 15 16 17
3	EXPERIMENTAL OR MATERIALS AND METHODS; ALGORITHMS USED 3.1 Arduino UNO 3.2 Servo Motor 3.3 Dual-Axis Joystick Module	18 18 19 20
4	RESULTS AND DISCUSSION, PERFORMANCE ANALYSIS 4.1 Project Implementation 4.2 Future Works 4.3 Result 4.4 Circuit Diagram	21 21 21 22
5	SUMMARY AND CONCLUSIONS	23
	REFERENCES APPENDIX A. WORK FLOW SCREENSHOT B. SOURCE CODE	24 26 26 27

LIST OF FIGURES

FIGURE NO	FIGURE NAME	PAGE NO
Figure 1.1	Robotic Arm	13
Figure 2.1	Aim and scope of Robotic Arm	14
Figure 3.1	Arduino UNO	18
Figure 3.2	Servo Motor	19
Figure 3.3	Dual Axis Joystick	20
Figure 4.1	Circuit Diagram of the robot arm	22

LIST OF ABBREVIATIONS

ABBREVIATION	EXPANSION
AMR's	Autonomous Mobile Robot
Arduino IDE	Arduino Integrated Development Environment
MG996R	Metal Gear Digital Servo Motor

CHAPTER-1

INTRODUCTION

A robot is a machine designed to execute one or more tasks automatically with speed and precision. We need robots because robots are often cheaper to use over humans, in addition it is easier to do some jobs using robots and sometimes the only possible way to accomplish some tasks! Robots can explore inside gas tanks, inside volcanoes, travel the surface of Mars or other places too dangerous for humans to go where extreme temperatures or contaminated environments exist. Robotics is an interdisciplinary branch of engineering and science that includes mechanical engineering, electrical engineering, computer science, and others. Robotics deals with the design, construction, operation, and use of robots, as well as computer systems for their control, sensory feedback, and information processing. Robotic system has been widely used in manufacturing, military and surgery since the robot can perform many advantages and used as the counter measure for some job that cannot be conduct by the human excellently.

Robots are used in different fields such as industrial, military, space exploration, and medical applications. These robots could be classified as manipulator robots and cooperate with other parts of automated or semi-automated equipment to achieve tasks such as loading, unloading, spray painting, welding, and assembling. Generally robots are designed, built and controlled via a computer or a controlling device which uses a specific program or algorithm. Programs and robots are designed in a way that when the program changes, the behavior of the robot changes accordingly resulting in a very flexible task achieving robot. Robots are categorized by their generation, intelligence, structural, capabilities, application and operational capabilities.

1.1 ROBOTIC ARM

Robotic arms, also known as articulated robotic arms, are fast, reliable, and accurate and can be programmed to do an infinite number of tasks in a variety of environments. They are used in factories to automate execution of repetitive tasks, such as applying paint to equipment or parts; in warehouses to pick, select, or sort goods from distribution conveyors to fulfill consumer orders; or in a farm field to pick and place ripe fruits onto storage trays. And as robotic technologies develop and industrial environments become more connected, the capabilities of robotic arms expand to enable new use cases and business operation models.

In the past, a robotic arm required teaching to perform narrowly defined tasks, such as picking a single type of object from a precise location with a specific orientation. Robots were not able to identify a particular type of object among many, determine an object location with some tolerance (area rather than exact position), or adjust the grasp based on object orientation.

With these advancements in machine vision, AI and network technologies, robotic arms can now see, analyze, and respond to their environments while transmitting valuable data and insights back to facility and business management systems. One area that benefits from this transformation is equipment (robot included) maintenance. The robot can compute data at the edge or transmit it to a server or the cloud for remote monitoring. This process enables predictive maintenance, which in turn helps reduce maintenance costs while improving machine uptime.

1.2 Mechanical Design

The first step of designing a robot is to decide the dimension and workspace configuration according to the requirements. The next step is to decide the specification of each actuator. The arm is attached to a base which is the most bottom part of the robot. It is important to mention that the base ought to have considerably heavy weight in order to maintain the general balance of the robot in case of grabbing an object. Although the idea of using stepper and gear motors is brilliant, but physical movement of the robot is done by using servo motors. The advantage of the servos is that they can be programmed to return to their initial position. Since the servo motors operate using the signals received from the microcontroller, they could be programmed according to the requirements. The diagram of our robot arm and its coordinates before we construct it is shown in Figure 3.1.

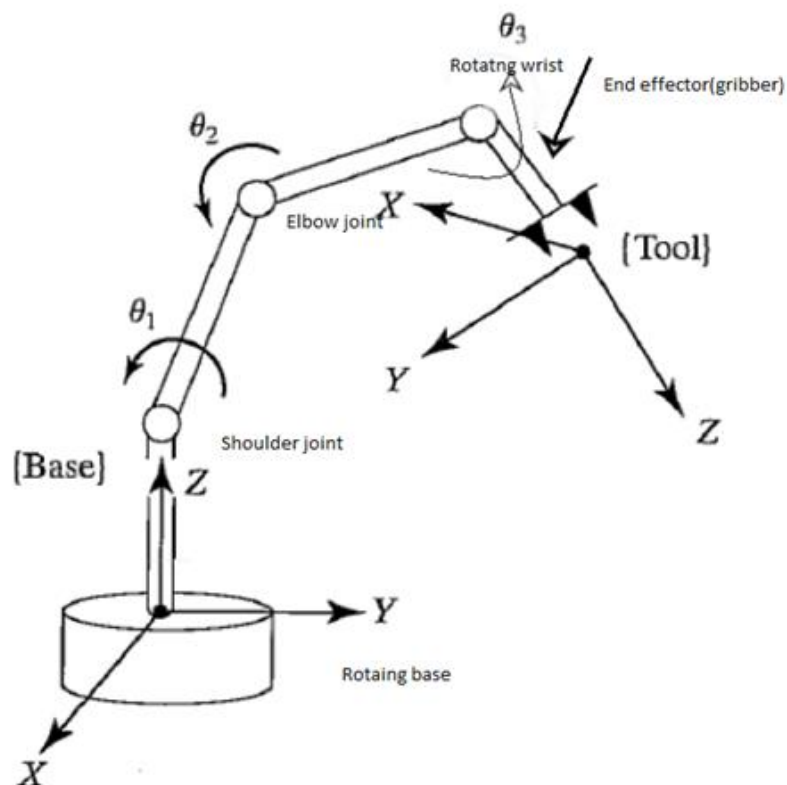


Figure (1.1): robot arm diagram

CHAPTER-2

AIM AND SCOPE OF THE PRESENT INVESTIGATION

Figure (1.7) shows the scope and aim of this project, starting from the revision of different load-shedding techniques to validate the proposed scheme experimentally.

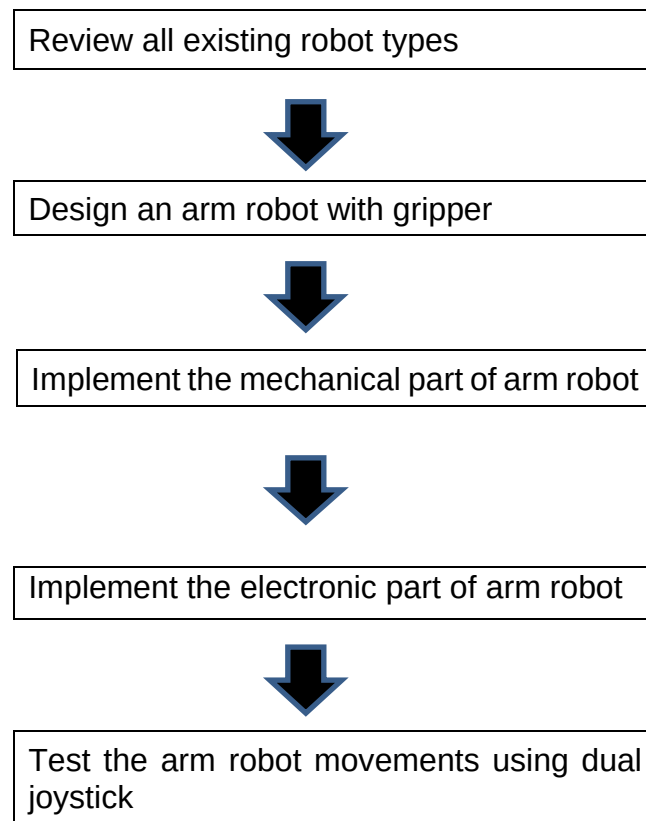


Figure (2.1): Aim and scope of arm robot

In robotics, it is a tool used to manipulate things at the end of a robotic arm. The end effector, often referred to as end-of-arm tooling, is located at the end of the robot arm and only moves when a user activates it using the corresponding software. A robotic arm is required to automate and improve a process, but the end effector allows the robot to work. Different end effectors are suitable for various purposes, and the choice of end effectors depends on the task at hand.

2.1 Objectives

Robotic arms can be used to automate the process of placing goods or products onto pallets. The use of robotic arms also frees human workers from performing tasks that present a risk of bodily injury. Robotic arms can be used in Army Defense, Chemical Handler, Lifting of very heat/cold objects and Self Defense

Industrial robotic arms are helping companies reach new levels of productivity through enhanced speed, efficiency, and precision across a variety of applications. Machine vision and network technologies allow robotic arms to see, analyze, and understand their environments. This intelligence enables them to perform tasks with flexibility, precision, and speed while increasing quality and factory/warehouse safety. Robotic arms equipped with remote monitoring and analytics technologies at the edge can provide businesses with actionable insights on robot equipment health status and performance in real time and enable predictive maintenance, which can increase uptime while reducing maintenance costs. Robotic arms enhanced with Intel® technologies enable multiple use cases and applications across industries, including real-time welding and painting with inline inspection, material handling, and object manipulation.

The main objectives of Robotic Arm is listed:

- 1- Design and fabricate a five DOF robot arm with gripper (end effector) that can be used for demonstrative and educational purposes in addition it will be able to hold thing or repairing thing since it will have a wide work envelope.
- 2- Use Kinect device to control the robot arm that successfully achieved the task of lifting an object from one location to another as per programed sequence.
- 3- The ability of using this arm in dangerous or poisonous environments to do some work depending on human arm orders.

2.2 Advantages

Businesses can realize several benefits from industrial robotic arms:

- **Improved safety.** Robotic arms help keep workers safe by operating in environments that are hazardous and executing tasks that present high risk of injury to humans.
- **Improved efficiency and productivity.** Robotic arms can operate 24 hours a day, seven days a week without fatiguing, allowing businesses to keep production, inspections, or other tasks going continuously to increase output.
- **Enhanced precision.** By their very nature, robotic arms perform more consistently and accurately than humans for tasks that require extreme precision or consistency.
- **Greater flexibility.** As business priorities change, robotic arms can easily be repurposed for new activities or mounted onto different platforms, such as autonomous mobile robots (AMRs), a stationary assembly line platform, or wall or shelf, as needed.

2.3 Application

One of the key advantages of industrial robotic arms is their versatility for supporting multiple applications—from the simplest to the most complex jobs in the safest or harshest environments. Automating these types of tasks not only removes human workers from possibly hazardous situations, but it enables those workers to take on high-value tasks such as interfacing with customers.

Here are some of the most common ways manufacturers are using robotic arms today:

Material Handling

Material-handling robotic arms can help create a safe and efficient warehouse by ensuring goods and materials are properly stored, easy to find, or transported correctly. Automating these processes can help accelerate the delivery of goods to customers, prevent workplace accidents, and improve the efficiency of a facility.

Welding

Welding is a task that can be performed by robots in advanced industrial settings such as automotive manufacturing. Given its critical impact on product quality, welding is an excellent candidate for advanced robotics with vision and AI augmentation for inline quality inspection.

Pick and Place

Pick-and-place robots are typically used in modern manufacturing and logistics. They are equipped with advanced machine vision systems to identify an object, grasp it, and move it from one location to another —quickly and efficiently— to increase speed of production and distribution of goods.

CHAPTER-3

EXPERIMENTAL OR MATERIALS AND METHODS;ALGORITHMS USED

The following sensors are used in building the robotic arm:

- Arduino UNO
- Servo Motor
- Dual Axis Joystick
- Jumper Wires

3.1 Arduino UNO

Arduino has become very popular in the world in recent times. In this project the arduino mega is used to communicate with processing and control the arm robot servo motor. The Arduino UNO Code is loaded using Arduino IDE software. The causes of the spread of Arduino at such a rapid rate are: 1) it can be used on all platforms due to the simplicity of the development environment with driver usage. 2) With the help of the advanced library, even complex operations can be easily solved. 3) There is a lot of hardware support that is compatible with Arduino and can work together. 4) Communication with the environment is easy because it is open source. The Arduino mega is shown in figure 2.2.



Figure (3.1): Arduino UNOboard

3.2 Servo Motor

Servo motors are the kinds of motors that can fulfill the commands we want. They can operate steadily even at very small or very large speeds. In these motors, the large moment can be obtained from the small size. Primarily, servomotors are geared dc motors with a positional feedback control that allows the rotor (shaft) to be positioned accurately. The position control signal is a single variable width pulse. The pulse can be varied from 1 to 2 ms. The width of the pulse controls the position of the servo motor shaft. A 1-ms pulse rotates the shaft to the extreme counterclockwise (CCW) position (-45°). A 1.5-ms pulse places the shaft in a neutral midpoint position (0°). A 2-ms pulse rotates the shaft to the extreme clockwise (CW) position (+45°). The pulse width signal is sent to the servomotor approximately 50 times per second (50Hz). This servo motor is shown in figure 2.4.



Figure(3.2): Servo Motor (MG996R)

3.3 Dual Axis Joystick Module

The Joystick module is an analog output device, which is used to sense movements in 2 directions (axes). These modules are mainly used in a gaming controller, Remote controller, etc. Also, we can use it in Electronic and DIY projects for controlling purposes. It allows you to control X and Y dimensions. The Joystick module consists of two potentiometers and a push-button switch. These potentiometers provide analog output value and the push button provides digital output value. It has a self-centering spring-loaded mechanism, it means when we release the joystick knob/cap it will centre itself. The dual-axis joystick is shown in figure 2.5



Figure(3.3): Dual Axis Joystick

CHAPTER-4

RESULTS AND DISCUSSION, PERFORMANCE ANALYSIS

4.1 PROJECT IMPLEMENTATION

In reality, there are many different types of end effectors with most of them resembling something less of a hand that you would imagine. The world of robots manipulating objects is changing each day but there are some end effectors that regularly make appearances on the business end of a robot arm. It might be more beneficial to look less at how the effector appears and more at how it operates.

4.2 Future Works

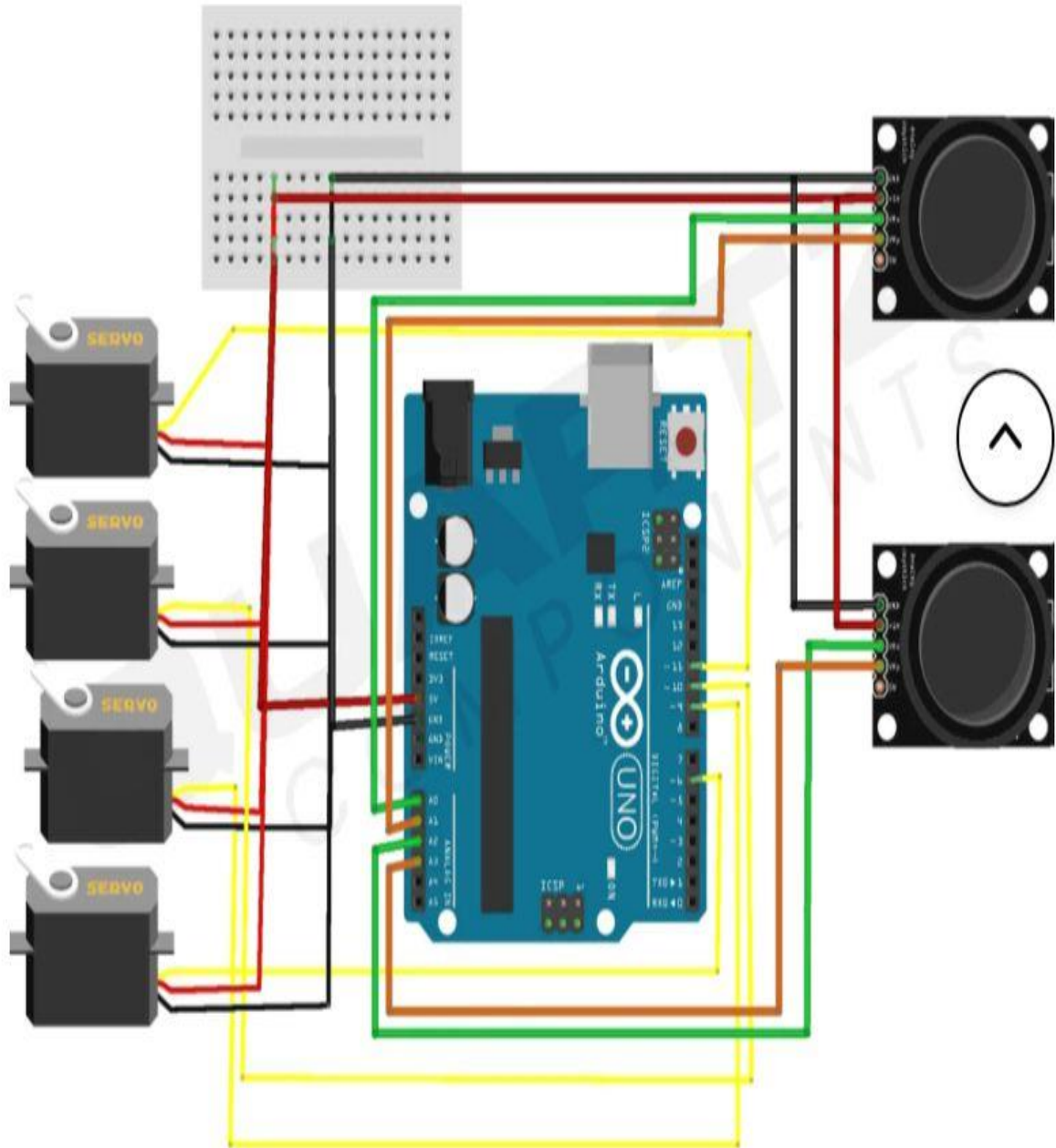
The robotic arm will next be attached to the robot and worked for advanced technologies. The fully assembled robot will now be able to act 50% of the human's activity. The robotic arm will be designed for hospital operation purpose which is so much useful for the doctors to operate.

4.3 Result

After completing all the design process and reviewing, the final test is on its place. The robotic arm is assembled and programmed in different sequence to check the result of the system.

The pick and place function is working fine when the dual joystick is commanded.

4.4 CIRCUIT DIAGRAM



Figure(4.1): Circuit Diagram of Robotic Arm

CHAPTER-5

SUMMARY AND CONCLUSIONS

Summary:

Most robots are designed for heavy, dangerous, and repetitive tasks to achieve perfection and cut down on costs. A robotic arm is a machine programmed and designed to perform specific tasks efficiently and precisely. The work of a robotic arm is mostly driven by a motor and is used in different industrial sectors. A robotic arm may be one of the main parts of an [industrial robot](#) and is a programmable mechanical arm that can perform a variety of tasks. It contains several attachments through joints known as axes. Every attachment has a stepper or a servo motor that moves in a specific motion. The greater the number of joints or axes, the greater the range of motion. These motorised axes help the robot operate with precise movements for better accuracy.

CONCLUSION:

A robot that can understand, “Something is in my way, I must move it to complete this task,” then actually perform that action is the idea that robot hand developers are aiming for. Development will obviously continue in mechanical construction but even the most realistic hand is only as effective as the intelligence driving it. This project is a prototype of an immense number of projects that we can use it in a lot of purposes like military, medical, social, educational, and industrial and we can use it for people with special needs.

REFERENCES:

- [1] Introduction and Objective Robotic Arm by (Abdul Zahier Ismail)
<https://www.scribd.com/document/362905868/Introduction-and-Objective-Robotic-Arm>
- [2] Patil, C., Sachan, S., Singh, R. K., Ranjan, K., & Kumar, V. (2009). Self and Mutual learning in Robotic Arm, based on Cognitive Systems. West Bengal: Indian Institute of Technology Kharagpur.
- [3] Craig, J. J. (2005). Introduction to Robotics-Mechanics and Control (3rd ed.). (M. J. Horton, Ed.) Upper Saddle River, USA: Pearson Prentice Hall.
- [4] Angelo, J. A. (2007). Robotics: A Reference Guide to the New Technology. Westport: Greenwood Press.
- [5] Carlson, M., Donley, E., Graf, K., & Jones, T. (2013). Helping Hand: Senior Design Final Documentation. Orlando: University of Central Florida.
- [6] ROBOT ARM CONTROL WITH ARDUINO by Aimn Mohamed Ahmed Ghiet
MECHANICAL AND AERONAUTICAL ENGINEERING:
https://www.researchgate.net/publication/317277584_ROBOT_ARM_CONTROL_WITH_ARDUINO
- [7] Motion Control of Robot by using Kinect Sensor by: Mohammed A. Hussein,
Ahmed S. Ali, Department of Electronics Technology, Faculty of Industrial
Education, Beni-Suef University, Egypt
[https://www.researchgate.net/publication/290594972_Motion_Control_of_Robot_b](https://www.researchgate.net/publication/290594972_Motion_Control_of_Robot_by_using_Kinect_Sensor)
[y using Kinect Sensor](https://www.researchgate.net/publication/290594972_Motion_Control_of_Robot_by_using_Kinect_Sensor)

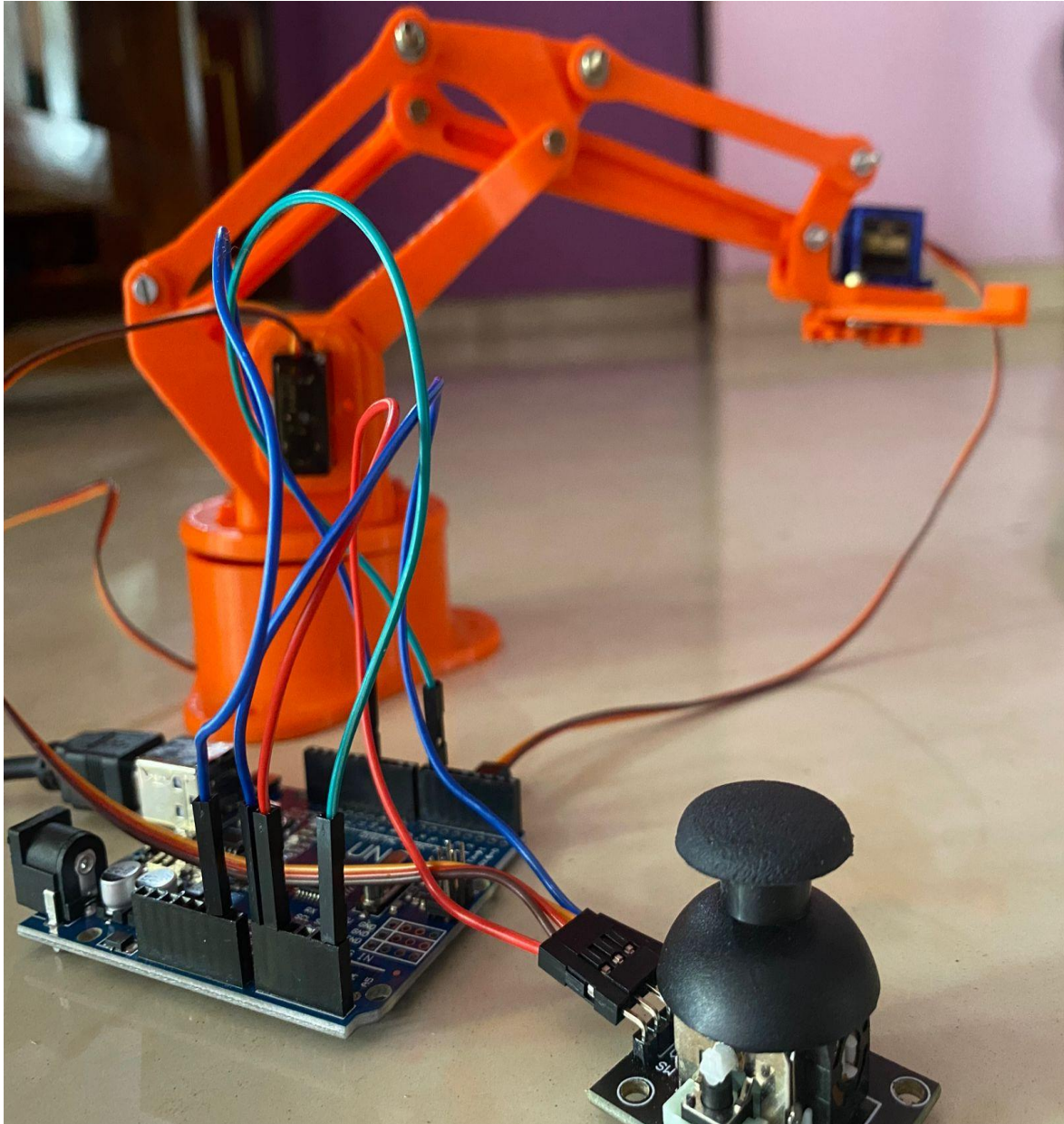
PREVIOUS PAPER PUBLICATION:

Introduction and Objective Robotic Arm by (Abdul Zahier Ismail)
<https://www.scribd.com/document/362905868/Introduction-and-Objective-Robotic-Arm>

In this experiment, the student was explained by the technician on robotic system. The robot part introduced to the student with basic layout of the robotic where consist robot arm, robot arm link and robot arm joint. We practice the robot with basic movements that have been shown by the lab assistant and recorded all the data of the robot arm movement. The basic movement of the robot arm depend on the joint types where our robot has revolute joints for rotary joint and prismatic joint for the linear movement of the robot arm. Robotics is an interdisciplinary branch of engineering and science that includes mechanical engineering, electrical engineering, computer science, and others. Robotics deals with the design, construction, operation, and use of robots, as well as computer systems for their control, sensory feedback, and information processing. Robotic system has been widely used in manufacturing, military and surgery since the robot can perform many advantages and used as a countermeasure for some job that cannot be conducted by human excellently. These robotic arms have been used to perform a variety of tasks such as inspection of the Space Shuttle using a specially deployed boom with cameras and sensors attached at the end effector, and also satellite deployment and retrieval manoeuvres from the cargo bay of the Space Shuttle.

APPENDIX

WORK FLOW SCREENSHOT:



SOURCE CODE



```
ROBOTIC_ARM_CODE | Arduino 1.8.19 (Windows Store 1.8.57.0)
File Edit Sketch Tools Help

ROBOTIC_ARM_CODE$
#include <Servo.h>
#include <EEPROM.h>

//All the gripper positions will be saved and read from eeprom to resume same positon
int gripper_pos = EEPROM.read(0);
int updown_pos = EEPROM.read(1);
int frontback_pos = EEPROM.read(2);
int neck_pos = EEPROM.read(3);

// Create a servo object - one each for 4 servos
Servo Gripper_servo;
Servo UpDown_servo;
Servo FrontBack_servo;
Servo Neck_servo;

//Function the control the servo based on joystick position
void control_servo (Servo &current_servo, int current_pos, int EEPROM_addr)
{

    //positon should alwasly be between 0 to 180
    if (current_pos>=180)
        current_pos=175; //jitter at maximum limit

    if (current_pos<=0)
        current_pos=10; //jitter at minimum limit

    current_servo.write(current_pos); //update servo postion
}

-----

Done compiling.

Sketch uses 3830 bytes (11%) of program storage space. Maximum is 32256 bytes.
Global variables use 250 bytes (12%) of dynamic memory, leaving 1798 bytes for local variables.

17

30°C
Partly sunny
Search
```

```

current_servo.write(current_pos); //update servo position

EEPROM.write(EEPROM_addr, current_pos); //save position in EEPROM

Serial.print(EEPROM_addr); Serial.print(" = "); Serial.println(current_pos); //for debugging on serial monitor
}

void setup() {
  Serial.begin (9600);
  Gripper_servo.attach(6);
  Gripper_servo.write(gripper_pos);
  UpDown_servo.attach(9);
  UpDown_servo.write(gripper_pos);
  FrontBack_servo.attach(11);
  FrontBack_servo.write(gripper_pos);
  Neck_servo.attach(10);
  Neck_servo.write(gripper_pos);
}

void loop() {
  delay(50); //predefined delay to make the servo move slower

  //A0 to control Gripper Servo
  int Joy_value_X1 = analogRead (A0);
  if (Joy_value_X1 > 700){
    gripper_pos = gripper_pos + 1;
    control_servo (Gripper_servo, gripper_pos, 0);
  }
}

```

Done compiling.

Sketch uses 3830 bytes (11%) of program storage space. Maximum is 32256 bytes.

Global variables use 250 bytes (12%) of dynamic memory, leaving 1798 bytes for local variables. Maximum is 2048 bytes.

17



Search





ROBOTIC_ARM_CODE \$

```
void loop() {
    delay(50); //predefined delay to make the servo move slower

    //A0 to control Gripper Servo
    int Joy_value_X1 = analogRead (A0);
    if (Joy_value_X1 > 700){
        gripper_pos = gripper_pos + 1;
        control_servo (Gripper_servo, gripper_pos, 0);
    }

    if (Joy_value_X1 < 300){
        gripper_pos = gripper_pos - 1;
        control_servo (Gripper_servo, gripper_pos, 0);
    }

    //A1 to control UpDown Servo
    int Joy_value_Y1 = analogRead (A1);
    if (Joy_value_Y1 > 700){
        updown_pos = updown_pos + 1;
        control_servo (UpDown_servo, updown_pos, 1);
    }

    if (Joy_value_Y1 < 300){
        updown_pos = updown_pos - 1;
        control_servo (UpDown_servo, updown_pos, 1);
    }

    //A2 to control FrontBack Servo
```

Done compiling.

Sketch uses 3830 bytes (11%) of program storage space. Maximum is
Global variables use 250 bytes (12%) of dynamic memory, leaving 1

17



Search



```

ROBOTIC_ARM_CODE $
++ (Joy_value_X1 < 300){
    updown_pos = updown_pos - 1;
    control_servo (UpDown_servo, updown_pos, 1);
}

//A2 to control FrontBack Servo
    int Joy_value_X2 = analogRead (A2);
    if (Joy_value_X2 > 700){
        frontback_pos = frontback_pos + 1;
        control_servo (FrontBack_servo, frontback_pos, 2);
    }

    if (Joy_value_X2 < 300){
        frontback_pos = frontback_pos - 1;
        control_servo (FrontBack_servo, frontback_pos, 2);
    }

//A3 to control Neck Servo
    int Joy_value_Y2 = analogRead (A3);
    if (Joy_value_Y2 > 700){
        neck_pos = neck_pos + 1;
        control_servo (Neck_servo, neck_pos, 3);
    }

    if (Joy_value_Y2 < 300){
        neck_pos = neck_pos - 1;
        control_servo (Neck_servo, neck_pos, 3);
    }
}

```

Done compiling.

Sketch uses 3830 bytes (11%) of program storage space. Maximum is 32768 bytes.
 Global variables use 250 bytes (12%) of dynamic memory, leaving 1750 bytes for local variables. Maximum is 2048 bytes.

17



30°C
Partly sunny

