

SERVO ROBOTIC ARM FOR PICK AND PLACE APPLICATIONS IN MANUFACTURING INDUSTRIES

Submitted in partial fulfillment of the requirements for the award of
Bachelor of Engineering Degree in
Electronics and Communication Engineering

By

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**DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
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SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)

**Accredited with Grade "A" by NAAC | 12B Status by UGC | Approved by
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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **KISHORE KUMAR M (37130198)** who carried out the project entitled **"SERVO ROBOTIC ARM FOR PICK AND PLACE APPLICATIONS IN MANUFACTURING INDUSTRIES"** under my supervision from December 2020 to March 2021.

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DECLARATION

I **KISHORE KUMAR M (37130198)** here by declare that the Project Report entitled “**SERVO ROBOTIC ARM FOR PICK AND PLACE APPLICATIONS IN MANUFACTURING INDUSTRIES**” done by me under the guidance of **Dr. S. BARANI** at Sathyabama Institute of Science and Technology, **Chennai-600119** is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Electronics and Communication Engineering

DATE:

PLACE:

1.

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I would also like to express my sincere and deep sense of gratitude to our internal guide **Dr. S. Barani** for her valuable guidance and suggestions during the progressive reviews for our project.

ABSTRACT

Now a days machines and robots are playing an important role in the automation industry. This project is presenting the process through which robotic arm is made with the help of Arduino and Potentiometer for controlling and coordinating the industrial processes. Here, we realize that the robotic arm has the ability to move in four directions with the help of servo motors. The movement of servo motor, UNO is responsible which converts the analog signal into the digital signal which is further received by servo motor. This project discuss about the technical imputation, the issue related with the implications and application of robotic arm in the field of automation of industries. It can be used for manufacturing industry.

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CHAPTER 1 INTRODUCTION

Since many years people try to replace human work with machines. Machines called robots are faster and more effective than people. 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, spraying, etc. Many elements of robots are built with inspiration from the nature. Construction of the manipulator as the arm of the robot is based on human arm. The robot has the ability to 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 man power are critical constraints for completion of task in large scales. The automation is playing important role to save human efforts in most of the regular and frequently carried works. One of the major and most commonly performed works is picking and placing of jobs from source to destination. Present day industry is increasingly turning towards computer-based automation mainly due to the need for increased productivity and delivery of end products with uniform quality. The inflexibility and generally high cost of hard automation systems, which have been used for automated manufacturing tasks in the past, have led to a broad based interest in the use of mechanical arm capable of performing a variety of manufacturing functions in a flexible environment and at lower costs. The use of Industrial mechanical arm characterizes some of contemporary trends in automation of the manufacturing process. However, present day industrial mechanical arm also exhibit a monolithic mechanical structure and closed-system software architecture. They are concentrated on simple repetitive tasks, which tend not to require high precision. The pick and place mechanical arm is a human controlled based system that detects the object, picks that object from source location and places at the desired location. For detection of object, human detect presence of object and move machine accordingly.

1.1Introduction of servo robotic arm

A robot arm has a mechanical structure that alters its form using a group of electric motors that behave like servo motors, pneumatic, or hydraulic actuators. They attempt to reproduce movement similar to a human arm

CHAPTER 2

LITERATURE SURVEY

Navin Kumar Agrawal, Vinay Kumar Singh, Vinay Singh Parmar, vijay Kumar Sharma, Dipti Singh, Muskan Agrawal (2020) [1]: In the current scenario machines and robots are playing an important role in the automation industry. In this project is presenting the process through which robotic arm is made with the help of Arduino and Potentiometer for controlling and coordinating the industrial processes. Here, we realize that the robotic arm has the ability to move in four directions with the help of servo motors. The movement of servo motor, UNO is responsible which converts the analog signal into the digital signal which is further received by servo motor. This project discuss about the technical imputation, the issue related with the implications and application of robotic arm in the field of automation of industries. It can be used as a artificial arm for a human who have lost his hand in any accident.

S. C. Suhaimin, N. L. Azmi, M. M. Rahman and H. M. Yusof (2019)[2]Point-to-point robotic arm has been used in manufacturing industry to assist company in increasing its production rate. However, the biggest concern in robotic arm is the accuracy for the robot to complete the task of pickandplace of an object which is dependent on the designed controller. This study investigates the accuracy of the 5 degrees of freedom (DOF) robotic arm model with PID controller. The forward kinematic is analysed systematically in order to determine the required movements for each of the robotic arm joint for its desired operations. The objective of this project is to simulate the movements of the robotic arm with and without controller by utilizing MATLAB GUI, a microcontroller and servo motors in order to demonstrate the effectiveness of the system. Performance comparison of the robotic arm in completing the pick-and-place task with and without PID is presented in this project. The preliminary results showed that the difference errors between the desired

angular displacement of with and without controller are 0.65%, 3.61%, 10.74%, 82.18% and 44.44% for the five movements.

K. Rahul, Hifjur Raheman, Vikas Paradkar (2019)[3] This project presents a complete mechatronic approach in designing and developing a robotic arm for handling paper pot seedlings in a transplanter for the purpose of inclusion of automation and possible reduction of heavy mechanical components in pot seedling transplanters by utilizing microcontrollers and embedded systems. The robot arm developed was of two degrees of freedom (DOF), five revolute joints (5R) with parallel arm structure using 3D printed parts, commercially available embedded microcontrollers and sensors. The gripper which was connected to the parallel robot arm performed pick and place operations at a desired path. For achieving the preferred maximum and minimum reach of the gripper, a suitable method for synthesizing the link length has been discussed. A complete logical technique to program microcontrollers was developed which enabled smooth actuation of both the independent input links simultaneously. Parabolic blends were utilized at the beginning and at the end of the robot input joint trajectory for minimizing dynamic vibrations during continuous operation. The developed robot arm was flexible to change the number of pickup points in a row, pickup and drop coordinates within the workspace envelope. Finally, the robot arm was tested and evaluated for picking and placing 15 numbers (4 replications, 60 runs) of actual paper pots filled with vermicompost, soil and sand. Each pot weighed approximately 80 g with a moisture content of approximately 5%. The robot arm took 2.1 to 2.4 s to pick and drop a pot seedling from a distance of 116.6 mm with a maximum power consumption of 20.47 W. Experimental results showed that no pots were missed in picking and dropping, no visual cracks and damage appeared on the pots. The repeatability of the robot arm was 2.1 mm in X-axis and 3.4 mm in Y-axis.

Ikuo Mizuuchi, Masayuki Inaba, Hirochika Inoue (1999)[4] The aim of this research is to achieve adaptive carrying behaviors using the whole body of a humanoid robot; in other words to create humanoid robots' "pick-

andplace" behaviors. We developed a small-sized whole-body humanoid robot. The robot's body consists of 22 DOFs, lots of sensors, an onbody micro processor network, and a wireless modem. The robot's brain consists of primitive sensor-motor reflex modules running in parallel as a lower layer and an event-driven planner that starts/stops appropriate modules as a higher layer. Using this system the robot can hold, lift up, and put down various objects without knowing its size, hardness or weight. We believe this work will be one of footholds toward achieving various whole-body behaviors of humanoid robots, especially carrying behaviors. © 1999 Elsevier Science B.A. All right reserved.

Ms. Puja Dhepekar, . Yashwant G. Adhav (2016) [5]In today's world, robotic surgery plays a very important role to enhance the surgical field. A robot which performs the various complex operations with minimal invasion, higher accuracy and flexibility are used in robot assisted surgeries. The robots used for such surgery have extreme higher cost because of their sophisticated software and hardware. Here, we proposed wireless controlled robotic system for surgical tool handling (pick and place). In this, we use three different fingers position of hand to control the robotic system with the help of flex sensor movement. According to different positions of the finger, resistance of the flex sensor changes, this change in the resistance is used to move the shaft of servo motor that moves the robotic arm as per position of a flex sensor in wireless environment using Zigbee device.

Shunli Xiao and Yangmin Li (2014) [6]This project presents a novel micro manipulation system based on visual servo feedback control, which is composed of a micro/nano positioning stage with large workspace, a micro gripper, and a microscopebased visual servo system. The positioning stage is featured with compliant flexurebased totally decoupled characteristics, which is driven by electromagnetic actuators. The gripper is designed with its arms moving completely parallel, which has a large displacement of gripping range. In this research, the gripper is mounted onto the micro positioning stage to form a micro-hand dedicated to micro assembly application. A microscope is adopted to

observe this tiny view field and capture the information about the position of the gripping fingers and the objects. Meanwhile, a small piece of silver wire with a diameter of about 30 microns is used as the micro part. The positioning information about tips of the gripping fingers and the object can be captured via the digital microscope and processed by a novel rapid identification method. A kind of visual servo feedback tracking and gripping control algorithm is developed. The algorithm is validated through experiments by realizing the task of picking up a small piece of silver wire then placing it to a new place precisely.

S. A. Khan, T. Z. Anika, N. Sultana, F. Hossain, M. N. Uddin (2019) [7] This project represents the design and implementation of color sorting robotic arm which can detect the exact position of an object and can pick up the object to place it in designated place. This robotic arm is like human arm which can rotate according to its predefined angles. On the other hand, detecting an object on color basis is done by ultrasonic sensor & color sorting sensor. The heart of this project is microcontroller board ATMEGA328P which controls servo motors used in base, elbow, wrist and grip. The prototype of this project was made and used for picking red, green and blue color objects.

Shivam Sharma, Shashwat Sahai, Jaisal Joshi, Hema N (2018) [8] This project represents the stage-wise development of trainable remotely controlled robotic arm based on servo motors. The robot is expected to perform primary pick and place operations and repeat the recorded actions with error corrections. The arm has four degrees of freedom. The robotic arm is mounted on a base that allows it to traverse between different coordinates. Arduino Mega 2560 is used for controlling functionalities of the robot. The robot was developed in four stages. In the first stage, the robot was controlled with the help of potentiometer. In the second stage of development, remote functionality was added. This functionality was achieved using Bluetooth module. The third stage of development included usage of the real-time remote control over the internet. The robot was controlled using an android application for the stages mentioned

above. In the fourth stage, a Unity-3D model was integrated to realize the realtime visual simulation of the robot.

Pei-Chi Huang, Aloysius K. Mok (2018) [9]

Although modern robots in warehousing systems can perform adequately in a goods-to-person model using handdesigned algorithms that are specialized to a particular environment, developing a robotic system that is capable of handling new products at an inexpensive cost remains a challenge. A conspicuous example of this challenge is seen in Amazon's use of autonomous robots to fetch customers' orders in their massive warehouses. To encourage advance in this hardware and software for the general task of picking a designated set of products from inventory shelves and then placing them at a target location (called a pick-and-place task). Current technology for pick-and-place tasks is still insufficient to meet the demand for low-cost automation. Handling awkward or oddly shaped object must still depend on handprogramming or specialized robotic systems, making manufacturing automation less flexible and expensive. In this project, we shall present the design and implementation of a software system that is a step in advancing the technology toward full automation at reasonable costs. Our system integrates a set of state-of-the-art techniques in computer vision, deep-learning, trajectory optimization, visual servoing to create a library of skills that can be composed to perform a variety of robotic tasks. We demonstrate the capability of our system for performing autonomous pickandplace tasks with an implementation using Hoppy, an industrial robotic arm in an environment similar to the Amazon Picking Challenge.

Reduanur Rahman, Md sajid Rahman,jillor Rahman Bhuiyan (2019) [10]

]The popularity of using robots in industries and factories instead of human workers has seen a high rise. Through this work we have attempted to make an alternative system of human for reducing the human labor by using simple and available components. This robotic system is controlled by a user through joystick. By the use of the joystick the user can operate both the robotic vehicle and the robotic arm. It will move from one place to another according to the command of the user and pick the desired object and place it for the user. This

design of the robot is easy, cheap and versatile, making it a great commercial candidate. With the increasing use of this kinds of robot the production rate will increase and the number of mishaps will decrease.

CHAPTER 3

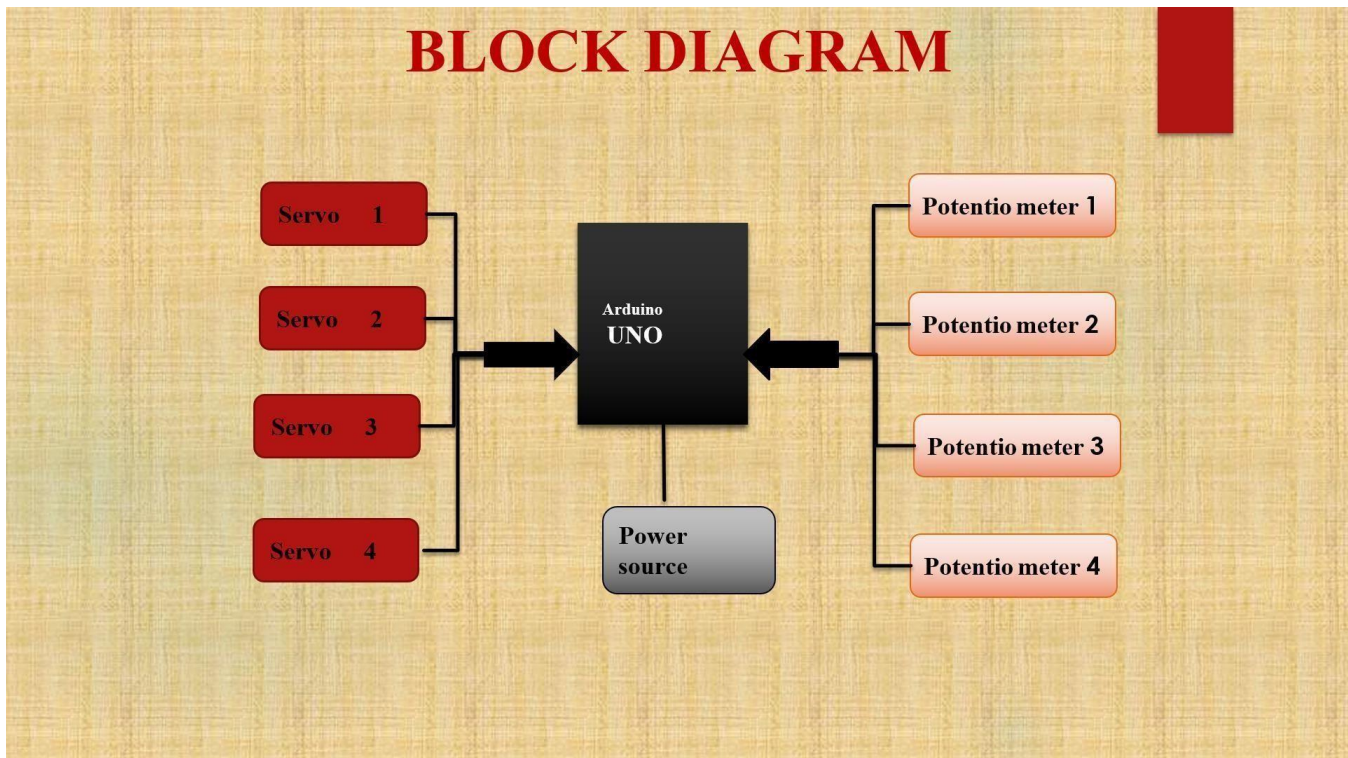
OBJECTIVE

Pick and Place Robots speeds up the process of picking parts up and placing them in new locations, while also increasing production rates. To execute the pick and place applications in manufacturing industries with the help of a robotic arm. It will transfer object one to another place. It will work in 360 degree

CHAPTER 4

METHODS AND MATERIALS

The theoretical background of the project is examined below as main headings and subheadings.



4.1. Arduino UNO

The Arduino microcontroller is an easy to use yet powerful single board computer that has gained considerable traction in the hobby and professional market. The Arduino is open-source, which means hardware is reasonably priced and development software is free. This guide is for students in ME 2011, or students anywhere who are confronting the Arduino for the first time. For advanced Arduino users, prowl the web; there are lots of resources. The Arduino project

was started in Italy to develop low cost hardware for interaction design. The Duemilanove board features an Atmel ATmega328 microcontroller operating at 5 V with 2 Kb of RAM, 32 Kb of flash memory for storing programs and 1 Kb of EEPROM for storing parameters. The clock speed is 16 MHz, which translates to about executing about 300,000 lines of C source code per second. The board has 14 digital I/O pins and 6 analog input pins. There is a USB connector for talking to the host computer and a DC power jack for connecting an external 6-20 V power source, for example a 9 V battery, when running a program while not connected to the host computer. Headers are provided for interfacing to the I/O pins using 22 g solid wire or header connectors.

Arduino programming language is a simplified version of C/C++. If you know C, programming the Arduino will be familiar. If you do not know C, no need to worry as only a few commands are needed to perform useful functions.

An important feature of the Arduino is that you can create a control program on the host PC, download it to the Arduino and it will run automatically. Remove the USB cable connection to the PC, and the program will still run from the top each time you push the reset button. Remove the battery and put the Arduino board in a closet for six months. When you reconnect the battery, the last program you stored will run. This means that you connect the board to the host PC to develop and debug your program, but once that is done, you no longer need the PC to run the program

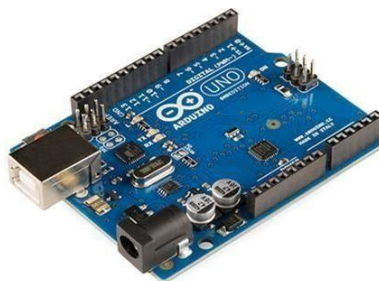


Figure 4.1arduino UNO microcontroller

4.2.Servo Motors

Servo; Detects the operation error of a mechanism, provides feedback and corrects faults. The servo motor can have alternating current (AC), direct current (DC) or stepper motors. In addition to these, there are drive and control circuits. 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.

Servo motors are used in control systems such as fast operation, excessive axis movement, condition control and so on. Servo motors are the last control element of a mechanism. They are highly sensitive and servo motors are used in conjunction with electronic or programmable circuits. These engines are divided into AC and DC. When the AC servo motors are brushless type motors, the servo motors brush. Servo motors are mostly three cables. These are a red cable for power, black for grounding and yellow cables for control (data, data). One of the servomotors used in the production phase of the project is shown in Fig.1



Figure 4.2DC servo motor

The Servo Motors come with three wires or leads. Two of these wires are to provide ground and positive supply to the servo DC motor. The third wire is for

the control signal. These wires of a servo motor are color coded. The red wire is the DC supply lead and must be connected to a DC voltage supply in the range of 4.8 V to 6V. The black wire is to provide ground. The color for the third wire (to provide control signal) varies for different manufacturers. It can be yellow (in case of Hitec), white (in case of Futaba), brown etc.

Futaba provides a J-type plug with an extra flange for proper connection of the servo. Hitec has an S-type connector. A Futaba connector can be used with a Hitec servo by clipping of the extra flange. Also a Hitec connector can be used with a Futaba servo just by filing off the extra width so that it fits in well.

4.3. RF Transmitter and receiver Module

In general, the wireless systems designer has two overriding constraints: it must operate over a certain distance and transfer a certain amount of information within a data rate. The RF modules are very small in dimension and have a wide operating voltage range i.e. 3V to 12V.

Basically the RF modules are 433 MHz RF transmitter and receiver modules. The transmitter draws no power when transmitting logic zero while fully suppressing the carrier frequency thus consume significantly low power in battery operation. When logic one is sent carrier is fully on to about 4.5mA with a 3volts power supply. The data is sent serially from the transmitter which is received by the tuned receiver. Transmitter and the receiver are duly interfaced to two microcontrollers for data transfer.

RF modules to transmitting and receive the data because it has a high volume of applications than IR. RF signals travel in the transmitter and receiver even when there is an obstruction. It operates at a specific frequency of 433MHz.

RF transmitter receives serial data and transmits to the receiver through an antenna which is connected to the 4th pin of the transmitter. When logic 0 applied to transmitter then there is no power supply in the transmitter. When

logic 1 is applied to transmitter then the transmitter is ON and there is a high power supply in the range of 4.5mA with 12V voltage supply.

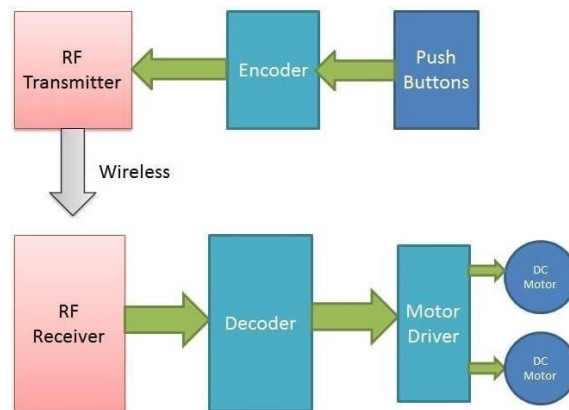


Fig 4.3.1. RF Transmitter and receiver Block Diagram

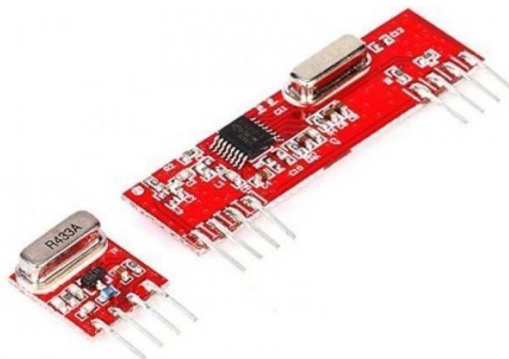


Fig 4.3.2. RF Transmitter and receiver Module

4.4 H12 E encoder IC with base&H12 D decode IC with base

It is an encoder IC of 2¹² series of encoders. Mainly used in interfacing RF and Infrared circuits. Encoders and decoders should have same no of address and data format. Converts the parallel input's into serial output.

HT12D is a decoder integrated circuit that belongs to 2¹² series of decoders. This series of decoders are mainly used for remote control system applications, like burglar alarm, car door controller, security system etc. HT12D converts the serial input into parallel outputs.

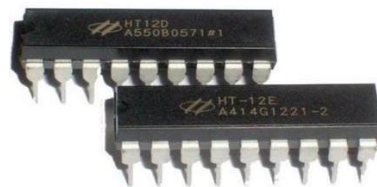


Figure 4.4 H12 E encoder IC with base&H12 D decode IC with base

4.5 Principles of Rover

The robot is a moving vehicle remotely controlled by one transmitting unit and a receiving unit for its moment. In this, we used an HT12E encoder which converts 4bit data to serial output. As explained above this is then fed to the RF module for transmitting the same to be received by the receiver. The RF module the output is fed to HT12D the serial decoder IC, the output of which is fed to microcontroller pin 1 to 4. The transmitting end microcontroller is connected to a set of pushbutton switches to its port 3 of 20 pin microcontroller AT89C2051. Thus while a particular button is pressed the program is executed to deliver corresponding 4-bit data which are then transmitted serially at port 1 as explained above. The data so received at the receiver end of port 1 of the Microcontroller.

Laser light is driven by transistor Q1 from the output of microcontroller pin 15, while the robotic vehicle is maneuvered to the location by operating the left, right, forward and backward button, etc. after it reaches the site the laser mounted on it takes position to throw the beam by operating specific action button.

4.6 Circuit Diagram servo robotic arm (Above Board)

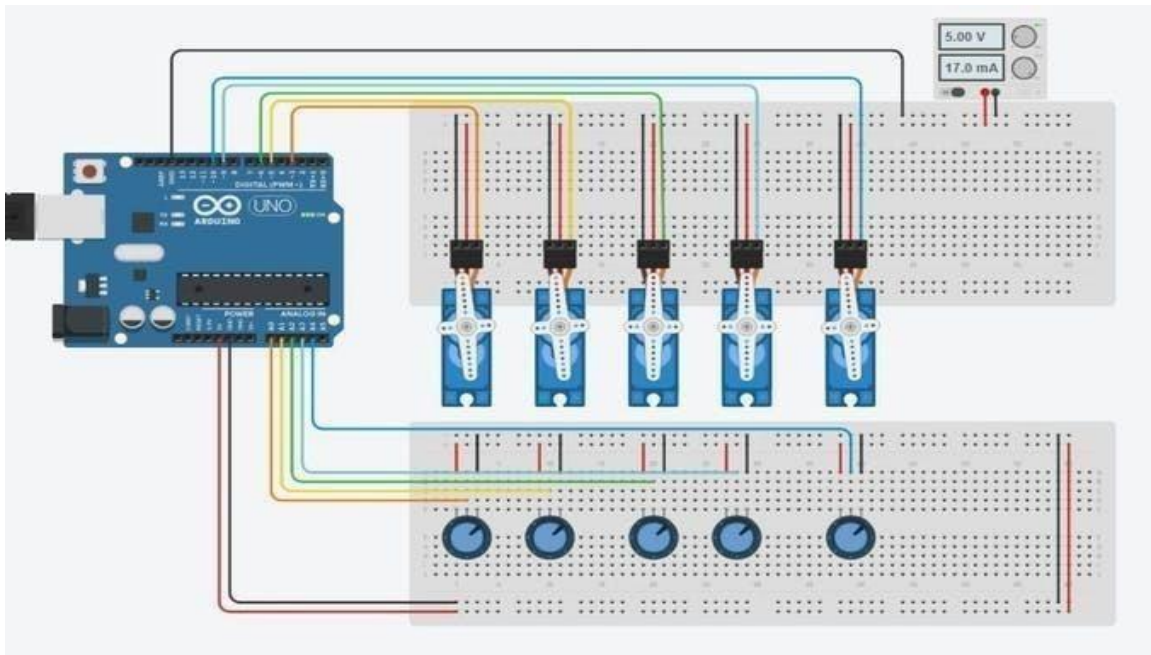


Figure 4.6.1.CIRCUIT DIAGRAM FOR SERVO ROBOTIC ARM

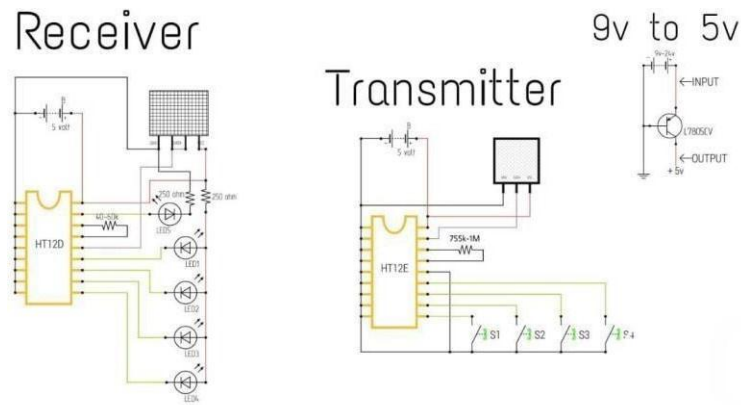


Figure 4.6.2. CIRCUIT DIAGRAM FOR ROVER

4.7 Power

The power supply selected for feeding the control circuit of the servomotors is capable of delivering the same current even if all the synchronous servomotors are operating. When all servo motors are operated at the same time, they draw 0.5A current. In addition, 5 V was needed for the Arduino used for robot movement in the project. This requirement is provided by a 5V power supply. In spite of lead acid battery we are using lithium iron battery to reduce battery weight. For constant output we are using battery magnificient.

CHAPTER 5 ROBOT ARM MECHANIC

5.1. General Characteristics of Robot Arm Mechanics

Kinematics in robotics is the science of motion investigation. Robot arm links can be rotated or offset according to the reference coordinate frame.

A systematic and general approach developed by Denavit and Hartenberg establishes the relationship between the robot endpoint and the total displacement of robot arm links (1). Angular and linear displacements between limbs are called joint coordinates and are defined by limb variables. In order to determine the amount of rotation and displacement according to the reference coordinate system of the endpoint, the matrices A which represent the amounts of each limb rotation and displacement are multiplied in turn. If the coordinates of the end point are given, limb variables can be obtained by going backward. These operations are called forward and inverse kinematics. The next section will explain how to determine forward and reverse kinematics. The general transformation matrix can be quite complex even for simple robots. It can be found in standard textbooks such as the Jacobian matrix for standard robots (2) and (3).

Coordinate Frames and Transformation Matrices for a General Robot Arm

An n -dimensional position vector is denoted by an $n + 1$ dimensional vector and is called a homogeneous coordinate representation. In the following, a matrix of 4×4 is shown which shows a position vector in the homogeneous coordinates between the coordinate frames (4).

$${}^R T_H = \left[\begin{array}{c|c} & \\ \hline (3 \times 3) & (3 \times 1) \\ \hline 0 & 1 \\ \hline (1 \times 3) & (1 \times 1) \end{array} \right] = \begin{bmatrix} x_x & y_x & z_x & p_x \\ x_y & y_y & z_y & p_y \\ x_z & y_z & z_z & p_z \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

new frame.	$p = p_i + p_j + p_k$	The vector of the origin of the new frame,
	z	
	$x = x_i + x_j + x_k$	The contour vector of the x-axis of the new frame,
	$y = y_i + y_j + y_k$	The contour vector of the y-axis of the new frame,
	$z = z_i + z_j + z_k$	Represents the contouring vector of the z-axis of the

Column 4 of the transformation matrix has 3 elements corresponding to displacement in the x, y, and z directions.

$$\mathbf{Trans}(p_x, p_y, p_z) = \begin{bmatrix} 1 & 0 & 0 & p_x \\ 0 & 1 & 0 & p_y \\ 0 & 0 & 1 & p_z \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

If any of the 3 coordinate axes is possible to rotate, there are 3 rotational transforms corresponding to the rotations in the x, y, and z-axes up to the q angle. The following matrix can be written for x-axis;

$$\mathbf{Rot}(x, \theta) = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos(\theta) & -\sin(\theta) & 0 \\ 0 & \sin(\theta) & \cos(\theta) & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

The matrices representing only the revolutions around the y and z-axes can be written in a similar manner.

$$\mathbf{Rot}(y, \theta) = \begin{bmatrix} \cos(\theta) & 0 & \sin(\theta) & 0 \\ 0 & 1 & 0 & 0 \\ -\sin(\theta) & 0 & \cos(\theta) & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$\mathbf{Rot}(z, \theta) = \begin{bmatrix} \cos(\theta) & -\sin(\theta) & 0 & 0 \\ \sin(\theta) & \cos(\theta) & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

The elements of the transformation matrix can be found by the arithmetic multiplication of pure rotation and displacement matrices. This can be obtained by a sequence of rotations about the axes of the stationary reference frame if the orientation is desired according to the reference frame of the Cartesian space endpoint. Although there are many ways to do this, one of the best known is the "roll-pitch-yaw" transformation. 3 turns. First turn around the x-axis, then y and then around the z-axis.

$$\mathbf{RPY}(\phi, \theta, \Psi) = \mathbf{Rot}(z, \phi) \mathbf{Rot}(y, \theta) \mathbf{Rot}(x, \Psi)$$

$$= \begin{bmatrix} C(\phi)C(\theta) & C(\phi)S(\theta)S(\Psi) - S(\phi)C(\Psi) & C(\phi)S(\theta)C(\Psi) + S(\phi)S(\Psi) & 0 \\ S(\phi)C(\theta) & S(\phi)S(\theta)S(\Psi) + C(\phi)C(\Psi) & S(\phi)S(\theta)C(\Psi) - C(\phi)S(\Psi) & 0 \\ -S(\theta) & C(\theta)S(\Psi) & C(\theta)C(\Psi) & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Kinematics in robotics is the science of motion investigation. The robot examines the positions of the limb limbs, the relationships between velocities and accelerations, ignoring forces and other factors that affect movement.

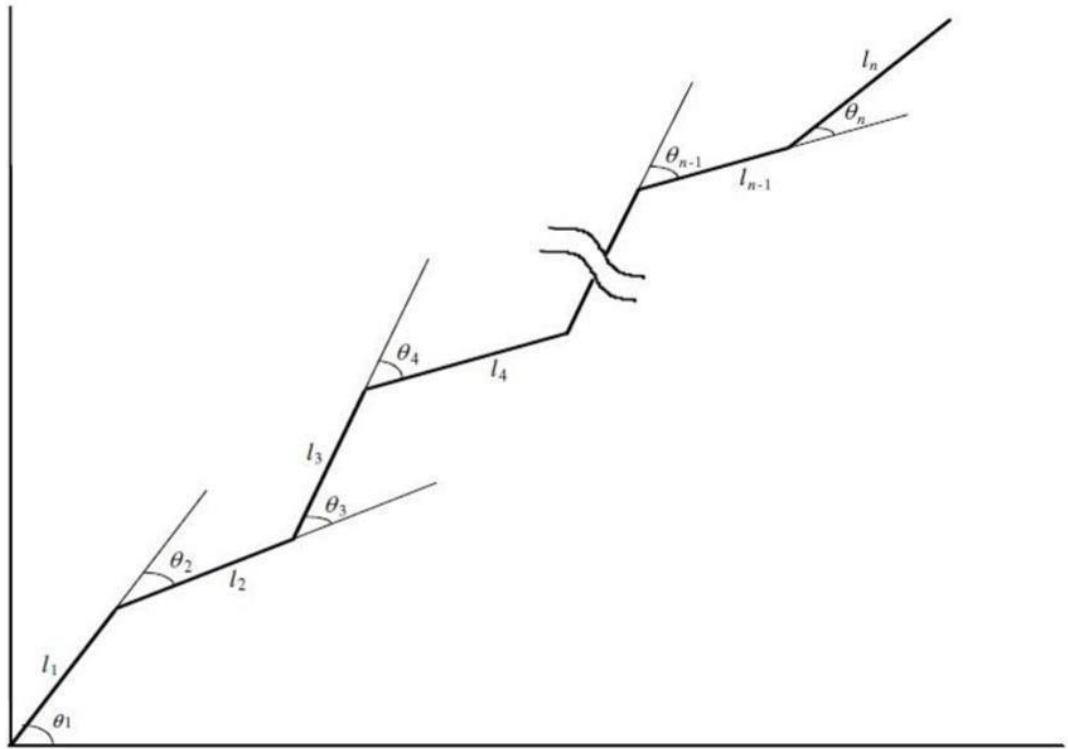


Figure i5 Serial irobot iarm iwth in ilines ishowing irelative iangles

The position and orientation of one of the limbs, or the orientation of the limbs between this limb and the end point, will change when the serial limb robot arm is shown in

Fig. When the positions and orientations of the limbs change, it is generally desirable to determine the position and orientation of the end point according to the basic reference frame.

When each mobile station is connected to a coordinate frame, the transformation between both limbs can be defined by a homogeneous transformation matrix, called the matrix A. For example, the first limb is connected to the base frame by 0A_1 , which is the matrix 1.A. The transformation matrix ${}^R T_H$ of the end point can be expressed according to the reference frame by the arithmetic product of matrices A from the matrices 1.A of the matrices A to the matrix A of the endpoints.

$${}^R T_H = {}^R T_1 \cdot {}^1 T_2 \cdot \dots \cdot {}^{n-2} T_{n-1} \cdot {}^{n-1} T_H = {}^0 A_1 \cdot {}^1 A_2 \cdot \dots \cdot {}^{n-2} A_{n-1} \cdot {}^{n-1} A_n$$

When this equation is in closed form, any term can be expressed by another and is very important in the kinematic analysis of the robot arm. Because the robot is used to analyze the forward and inverse kinematics of the arm.

CHAPTER 6 DESIGN

BRIEF



Figure 6.1 robotic arm assemble (step 1)

Connect now the two preassembled links to the forward drive arm (004). Punt in position horizontal arm (005) and triangular link (006) aligned with the upper connection of the forward drive arm (004). Fix all parts with the M3x30 screw, locked by the nut on the other side. Verify the freedom of movement and If everything is ok, proceed to the next step.



Figure 6.2 robotic arm assemble (step 2)

Align the servo and introduce the wiring in the central part of the basement.
Gently pull the wire to make it straight while continue to push in it housing the servo
The wire is then kept in position making it pass through a frontal hole

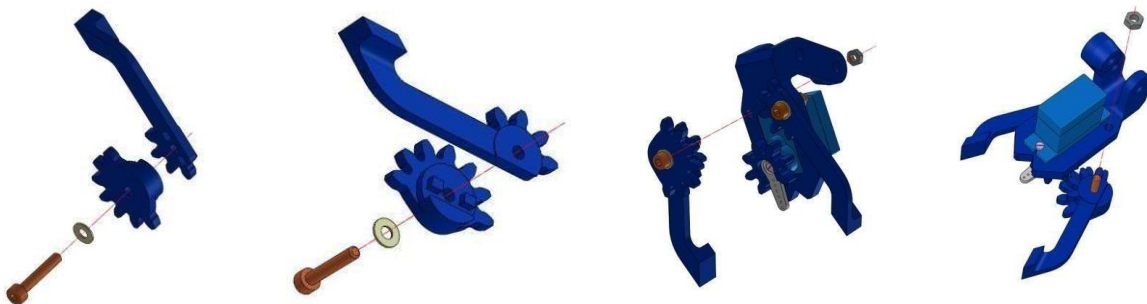


Figure 6.3 robotic arm assemble (step 3)

Insert the two pin of the driven gear into the dedicated holes on the left finger the driven gear has also a shoulder that has to be aligned with the lateral side of the finger. If you find difficulties coupling them, reduce interference using a file. Once coupled insert an M3 screw in the central hole and attach the finger to the claw support. Now the gripper is ready to be installed on the horizontal arm of the EEzybot. Verify freedom of movement of the gripper manually or using a servo tester.



Figure 6.4 robotic arm assemble

Now we have the three main sub assembly ready to be connected each other.

CHAPTER 7

RESULT AND DISCUSSION

Experimental studies are within themselves; the method followed in the project, robot arm control system, and programming. In the method and robot arm control system part of the project, the basic commands are explained after the basic information is given and the robot can perform the required tasks. In the program section, there is the software information required for the movement of the robot. The programming part of the program is given in Appendix to the project to make the project more regular.

7.1. Projected Method

First, a historical research on robot arms was carried out and the basic information needed to establish the system was obtained. The robot used in the project types with arm joint and can move in 4 axis directions (left and right, up and down) and also can hold and swing motion thanks to the holder on it. The microcontroller Arduino UNO is used to provide optimal control of the robot arm. The reason for preferring this microcontroller is that it is more accessible to be able to get a solution to a possible error because the open source code is easier to use than the other microcontrollers and the number of users is higher.

After these studies, detailed information has been obtained about the servo motors to be used. The servomotor is preferred because it can be carried out smoothly in the robot project, the motor can be operated precisely and it must be at high torque. The robot arm, 5 servo motors are formed. Servo motors are numbered from top to bottom in order to explain their tasks because of the excess

7.2. Robot Arm Control

The connection box is made to distribute the 5V voltage from the supply source to the servo motors. In doing so, servo motor inputs, Arduino pin inputs, and communication circuit elements are used. The mechanical part of the robot arm is designed by combining the pre-selected parts appropriately. In order to move the robot arm properly, software with the selected Arduino microcontroller has been implemented and then the experiment with the control with the potentiometer and servo motors has been done to learn about the system operation. The software has been implemented with the appropriate Arduino microcontroller selected so that the robot arm can be moved appropriately for the intended purpose. Control of the robot arm with potentiometer . For movement of the arm we are using 12v DC (*four)gear motors.

CHAPTER 8

CONCLUSION

Robotic arms, many areas are developable. Thanks to the robotic arms, many tasks are made easier and the resulting error level has been reduced to a minimum. For example; some pharmacy-based drug-giving robots and a projected robot arm have been developed. In addition to this, the ability to move the robot arm is further increased, and when the camera is placed in the finger area and the sensitivity is increased, it can be used in a wide range of applications from the medical sector to the automation systems. With the robotic arms developed in this way, the risk of infecting the patient in the medical sector is minimized, while the human errors are minimized during the surgical intervention. Despite the fact that the robotic arm made by this project is of prototype quality, it has a quality that can be improved for more robotic systems. Besides these, robotic arm sector, which is open to development, will keep its importance in the future.

The purpose of the project is to provide control of 4 axes moving robot arm design and this robot arm with a suitable microcontroller and Bluetooth module with android application. The necessary theoretical and practical information for this purpose has been obtained and the necessary infrastructure has been established for the project. During the process of making and developing the project, a lot of theoretical knowledge has been transferred to the practice and it has been ensured that it is suitable for the purpose of the project.

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**SERVO ROBOTIC ARM FOR PICK AND PLACE
APPLICATIONS IN MANUFACTURING INDUSTRIES**

Submitted in partial fulfillment of the requirements for the award of Bachelor
of Engineering Degree in Electronics and Communication Engineering

By

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of

KAVIN S (37130196) and KISHORE KUMAR M (37130198) who carried out the

project entitled "SERVO ROBOTIC ARM FOR PICK AND PLACE APPLICATIONS
IN MANUFACTURING INDUSTRIES" under our supervision from December 2020 to

March 2021.

Dr. S. BARANI M.E,PHD.,

Guide and Supervisor

Dr. T. RAVI, M.E., Ph.D.,

Head of the Department

Submitted for Viva voce  Examination held on _____

Name:

Signature:

Internal Examiner

External Examiner

 DECLARATION

We **KAVIN S (37130196)** and **KISHORE KUMAR M (37130198)** here by declare that the Project Reportentitled **“SERVO ROBOTIC ARM FOR PICK AND PLACE APPLICATIONS IN MANUFACTURING INDUSTRIES”** done by us under the guidance of **Dr. S. BARANI** at Sathyabama Institute of Science and Technology, **Chennai-600119** is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Electronics and Communication Engineering

DATE:

PLACE:

1.

2.

OF THE CANDIDATES

SIGNATURE

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We are pleased to acknowledge our sincere thanks to Board of Management of SATHYABAMA for their kind encouragement in doing this project and for completing it successfully. We are grateful to them.

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ABSTRACT

Now a days machines and robots are playing an important role in the automation industry. This project is presenting the process through which robotic arm is made with the help of Arduino and Potentiometer for controlling and coordinating the industrial processes. Here, we realize that the robotic arm has the ability to move in four directions with the help of servo motors. The movement of servo motor, UNO is responsible which converts the analog signal into the digital signal which is further received by servo motor. This project discuss about the technical imputation, the issue related with the implications and application of robotic arm in the field of automation of industries. It can be used for manufacturing industry.

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CHAPTER 1

INTRODUCTION

Since many years people try to replace human work with machines. Machines called robots are Master and more elective than people. 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, spraying, etc. Many elements of robots are built with inspiration from the nature. Construction of the manipulator as the arm of the robot is based on human arm. The robot has the ability to 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 man power are critical constraints for completion of task in large scales. The automation is playing important role to save human efforts in most of the regular and frequently carried works. One of the major and most commonly performed works is picking and placing of jobs from source to destination. Present day industry is increasingly turning towards computer-based automation mainly due to the need for increased productivity and delivery of end products with uniform quality. The inflexibility and generally high cost of hard-automation systems, which have been used for automated manufacturing tasks in the past, have led to a broad based interest in the use of mechanical arm capable of performing a variety of manufacturing functions in a flexible environment and at lower costs. The use of Industrial mechanical arm characterizes some of contemporary trends in automation of the manufacturing process. However, present day industrial mechanical arm also exhibit a monolithic mechanical structure and closed system software architecture. They are concentrated on simple repetitive tasks, which tend not to require high precision. The pick and place mechanical arm is a human controlled based system that detects the object, picks that object from source location and places at the desired

location. For detection a] object, human detect presence of object and move machine accordingly.

Introduction of servo robotic arm

A robot arm has a mechanical structure that alters its form using a group oT electric motors that behave like servo motors, pneumatic, or hydraulic actuators. They attempt to reproduce movement similar to a human arm

CHAPTER 2

2.LITERATURE SURVEY

Navin Kumar Agrawal, Vinay Kumar Singh, Vinay Singh Parmar, vijay Kumar Sharma, Dipti Singh, Muskan Agrawal (2020) [1]: In the current scenario machines and robots are playing an important role in the automation industry. In this project is presenting the process through which robotic arm is made with the help oT Arduino and Potentiometer for controlling and coordinating the industrial processes. Here, we realize that the robotic arm has the ability to move in Tour directions with the help oT servo motors. The movement oT servo motor, UNO is responsible which converts the analog signal into the digital signal which is further received by servo motor. This project discuss about the technical imputation, the issue related with the implications and application of robotic arm in the field oT automation oT industries. It can be used as a artificial arm for a human who have lost his hand in any accident.

s. c. suhaimin, N. L. Azmi, M. M. Rahman and H. M. Yusof (2019)[2]Point-to-point robotic arm has been used in manufacturing industry to assist company in increasing its production rate. However, the biggest concern in robotic arm is the accuracy for the robot to complete the task of pick-andplace of an object which is dependent on the designed controller. This study investigates the accuracy a] the 5 degrees a] freedom (DOF) robotic arm model with PID controller. The forward kinematic is analysed systematically in order to determine the required movements for each o] the robotic arm joint 1or its desired operations. The objective o] this project is to simulate the movements o] the robotic arm with and without controller by utilizing MATLAB GUI, a microcontroller and servo motors in order to demonstrate the effectiveness o1 the system. Performance comparison o] the robotic arm in completing the pick-and-place task with and without PID is presented in this project. The preliminary results showed that the difference errors between the desired angular displacement of with and without controller are 0.65%, 3.61%, 10.74%, 82.18% and 44.44% 1or the five movements.

K. Rahul, Hifjur Raheman, Vikas Paradkar (2019)[3]This project presents a complete mechatronic approach in designing and developing a robotic arm for handling paper pot seedlings in a transplanter for the purpose oT inclusion oT automation and possible reduction oT heavy mechanical components in pot seedling transplanters by utilizing microcontrollers and embedded systems. The robot arm developed was a] two degrees o1 freedom (DOF), five revolute joints (5R) with parallel arm structure using 3D printed parts, commercially available embedded microcontrollers and sensors. The gripped which was connected to the parallel robot arm performed pick and place operations at a desired path. For achieving the

preferred maximum and minimum reach of the gripper, a suitable method for synthesizing the link length has been discussed. A complete logical technique to program microcontrollers was developed which enabled smooth actuation of both the independent input links simultaneously. Parabolic blends were utilized at the beginning and at the end of the robot input joint trajectory for minimizing dynamic vibrations during continuous operation. The developed robot arm was flexible to change the number of pickup points in a row, pickup and drop coordinates within the workspace envelope. Finally, the robot arm was tested and evaluated for picking and placing 15 numbers (4 replications, 60 runs) of actual paper pots filled with vermicompost, soil and sand. Each pot weighed approximately 80 g with a moisture content of approximately 5%. The robot arm took 2.1 to 2.4 s to pick and drop a pot seedling from a distance of 116.6 mm with a maximum power consumption of 20.47 W. Experimental results showed that no pots were missed in picking and dropping, no visual cracks and damage appeared on the pots. The repeatability of the robot arm was 2.1 mm in X-axis and 3.4 mm in Y-axis.

Ikuo Mizuuchi, Masayuki Inaba, Hirochika Inoue (1999) [4] The aim of this research is to achieve adaptive carrying behaviors using the whole body of a humanoid robot; in other words to create humanoid robots' "pick-and-place" behaviors. We developed a small-sized whole-body humanoid robot. The robot's body consists of 22 DOFs, lots of sensors, an onbody micro processor network, and a wireless modem. The robot's brain consists of primitive sensor-motor reflex modules running in parallel as a lower layer and an event-driven planner that starts/stops appropriate modules as a higher layer. Using this system the robot can hold, lift up, and put down various objects without knowing its size, hardness or weight. We believe this work will be one of footholds toward achieving various whole-body behaviors of humanoid robots, especially carrying behaviors. 1999 Elsevier Science B.A. All right reserved.

Ms. Puja Dhepekar, . Yashwant G. Adhav (2016) [5] In today's world, robotic surgery plays a very important role to enhance the surgical field. A robot which performs the various complex operations with minimal invasion, higher accuracy and flexibility are used in robot assisted surgeries. The robots used for such surgery have extreme higher cost because of their sophisticated software and hardware. Here, we proposed wireless controlled robotic system for surgical tool handling (pick and place). In this, we use three different fingers position of hand to control the robotic system with the help of flex sensor movement. According to different positions of the finger, resistance of the flex sensor changes, this change in the resistance is used to move the shaft of servo motor that moves the robotic arm as per position of a flex sensor in wireless environment using Zigbee device.

Shunli Xiao and Yangmin Li (2014) [6] This project presents a novel micro manipulation system based on visual servo feedback control, which is composed of a micro/nano positioning stage with large workspace, a micro gripper, and a microscope-based visual servo system. The positioning stage is featured with compliant flexure-based totally decoupled characteristics, which is driven by electromagnetic actuators. The gripper is designed with its arms moving completely parallel, which has a large displacement of gripping range. In this research, the gripper is mounted onto the micro positioning stage to form a micro-hand dedicated to micro assembly application. A microscope is adopted to observe this tiny view field and capture the information about the position of the gripping fingers and the objects. Meanwhile, a small piece of silver wire with a diameter of about 30 microns is used as the micro part. The positioning information about tips of the gripping

fingers and the object can be captured via the digital microscope and processed by a novel rapid identification method. A kind of visual servo feedback tracking and gripping control algorithm is developed. The algorithm is validated through experiments by realizing the task a) picking up a small piece of silver wire then placing it to a new place precisely.

S. A. Khan, T. Z. Anika, N. sultana, F. Hossain, M. N. Uddin (2019) [7] This project represents the design and implementation a) color sorting robotic arm (2019) can detect the exact position of an object and can pick up the object to place it in designated place. This robotic arm is like human arm which can rotate according to its predefined angles. On the other hand, detecting an object basis is done by ultrasonic sensor & color sorting sensor. The heart of this project is microcontroller board ATMEGA328P which controls servo motors used in base, elbow, wrist and grip. The prototype a) this project was made and used for picking red, green and blue color objects.

Shivam Sharma, Shashwat Sahai, Jaisal Joshi, Hem a N (2018) [8] This project represents the stage-wise development of trainable remotely controlled robotic arm based on servo motors. The robot is expected to perform primary pick and place operations and repeat the recorded actions with error corrections. The arm has 1our degrees of freedom. The robotic arm is mounted on a base that allows it to traverse between different coordinates. Arduino Mega 2560 is used 1or controlling functionalities oT the robot. The robot was developed in Tour stages. In the first stage, the robot was controlled with the help oT potentiometer. In the second stage oT development, remote functionaliy was added. This]unctionalig was achieved using Bluetooth module. The third stage a) development included usage o1 the real-time remote control over the internet. The robot was controlled using an android application for the stages mentioned above. In the fourth stage, a Unity-3D model was integrated to realize the real-time visual simulation a) the robot.

Pei-Chi Huang, Aloysius K. Mok (2018) [9]

Although modern robots in warehousing systems can perform adequately in a goods-to-person model using handdesigned algorithms that are specialized to a particular environment, developing a robotic system that is capable of handling new products at an inexpensive cost remains a challenge. A conspicuous example o1 this challenge is seen in Amazon's use oT autonomous robots to fetch customers' orders in their massive warehouses. To encourage advance in this hardware and software Tar the general task o1 picking a designated set oT products from inventory shelves and then placing them at a target location a pick-and-place task). Current technology Tar pick-and-place tasks is still insufficient to meet the demand for low-cost automation. Handling awkward or oddly shaped object must still depend on hand-programming or specialized robotic systems, making manufacturing automation less flexible and expensive. In this project, we shall present the design and implementation oT a software system that is a step in advancing the technology toward full automation at reasonable costs. Our system integrates a set oT state-of-the-art techniques in computer vision, deep learning, trajectory optimization, visual servoing to create a library oT skills that can be composed to perform a variety oT robotic tasM. We demonstrate the capabiliy o1 our system for performing autonomous pick-andplace tasM with an implementation using Happy, an industrial robotic arm in an environment similar to the Amazon Picking Challenge.

Reduanur Rahman, Md sajid Rahman, jillor Rahman Bhuiyan (2019) [10]

]The popularity oT using robots in industries and factories instead o1 human workers has seen a

high rise. Through this work we have attempted to make an alternative system oT human for reducing the human labor by using simple and available components. This robotic system is controlled by a user through joystick. By the use a] the joystick the user can operate both the robotic vehicle and the robotic arm. It will move from one place to another according to the command a] the user and pick the desired object and place it for the user. This design a] the robot is easy, cheap and versatile, making it a great commercial candidate. With the increasing use a] this kinds a] robot the production rate will increase and the number a] mishaps will decrease.

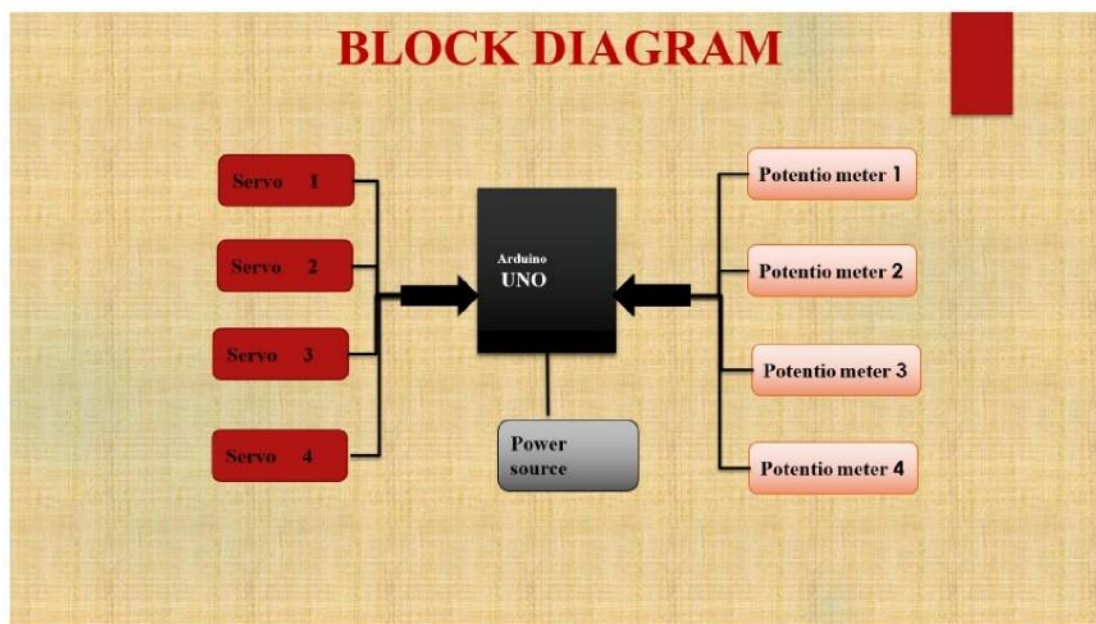
CHAPTER 3

OBJECTIVE

Pick and Place Robots speeds up the process of picking parts up and placing them in new locations, while also increasing production rates.To execute the pick and place applications in manufacturing industries with the help a] a robotic arm .It will transfer object one to another place.It will work in 360 degree

4. METHODS AND MATERIALS

The theoretical background a] the project is examined below as main headings and subheadings.



4.1. Arduino UNO

The Arduino microcontroller is an easy to use yet powerful single board computer that has gained

considerable traction in the hobby and professional market. The Arduino is open-source, which means hardware is reasonably priced and development software is free. This guide is for students in ME 2011, or students anywhere who are confronting the Arduino for the first time. For advanced Arduino users, prowl the web; there are lots of resources. The Arduino project was started in Italy to develop low cost hardware for interaction design. The Duemilanove board features an Atmel ATmega328 microcontroller operating at 5 V with 2 Kb of RAM, 32 Kb of flash memory for storing programs and 1 Kb of EEPROM for storing parameters. The clock speed is 16 MHz, which translates to about executing about 300,000 lines of C source code per second. The board has 14 digital I/O pins and 6 analog input pins. There is a USB connector for talking to the host computer and a DC power jack for connecting an external 6-20 V power source, for example a 9 V battery, when running a program while not connected to the host computer. Headers are provided for interfacing to the I/O pins using 22 pin solid wire or header connectors.

Arduino programming language is a simplified version of C/C++. If you know C, programming the Arduino will be familiar. If you do not know C, no need to worry as only a few commands are needed to perform useful functions.

An important feature of the Arduino is that you can create a control program on the host PC, download it to the Arduino and it will run automatically. Remove the USB cable connection to the PC, and the program will still run from the top each time you push the reset button. Remove the battery and put the Arduino board in a closet for six months. When you reconnect the battery, the last program you stored will run. This means that you connect the board to the host PC to develop and debug your program, but once that is done, you no longer need the PC to run the program.

Figure 4.1 Arduino UNO microcontroller



4.2. Servo Motors

Servo; Detects the operation error of a mechanism, provides feedback and corrects faults. The servo motor can have alternating current (AC), direct current (DC) or stepper motors. In addition to these, there are drive and control circuits. 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.

Servo motors are used in control systems such as fast operation, excessive axis movement, condition control and so on. Servo motors are the last control element of a mechanism. They are highly sensitive and servo motors are used in conjunction with electronic or programmable circuits. These engines are divided into AC and DC. When the AC servo motors are brushless type motors, the servo motors brush. Servo motors are mostly three cables. These are a red cable for power, black for grounding and yellow cables for control (data, data). One of the servomotors used in the production phase of the project is shown in Fig.1

Figure 4.2DC servo motor



10

The Servo Motors come with three wires or leads. Two of these wires are to provide ground and positive supply to the servo DC motor. The third wire is for the control signal. These wires of a servo motor are color coded. The red wire is the DC supply lead and must be connected to a DC voltage supply in the range of 4.8 V to 6V. The black wire is to provide ground. The color for the third wire (to provide control signal) varies for different manufacturers. It can be yellow (in case of Hitec), white (in case of Futaba), brown etc.

Futaba provides a J-type plug with an extra flange for proper connection of the servo. Hitec has an S-type connector. A Futaba connector can be used with a Hitec servo by clipping of the extra flange. Also a Hitec connector

can be used with a Futaba servo just by filing off the extra width so that it fits in well.

4.3. RF Transmitter and receiver Module

In general, the wireless systems designer has two overriding constraints: it must operate over a certain distance and transfer a certain amount of information within a data rate. The RF modules are very small in dimension and have a wide operating voltage range i.e. 3V to 12V.

Basically the RF modules are 433 MHz RF transmitter and receiver modules. The transmitter draws no power when transmitting logic zero while fully suppressing the carrier frequency thus

consume significantly low power in battery operation. When logic one is sent carrier is Tully on to about 4.5mA with a 3volts power supply. The data is sent serially from the Transmitter which is received by the tuned receiver. Transmitter and the receiver are duly interfaced To two microconTrollers 1or data transfer.

RF modules To transmitting and receive the data because it has a high volume a] applications than IR. RF signals travel in the transmitter and receiver even when there is an obstruction. It operates at a specific frequency o] 433MHz.

RF transmitter receives serial data and transmits to the receiver through an antenna which is connected to the 4th pin of The transmitter. When logic 0 applied to transmitter Then there is no power supply in the transmitter. When logic 1 is applied to transmitter then the transmitter is ON and there is a high power supply in the range of 4.5mA with 12V voltage supply.

Fig 4.3.R F Transmitter and receiver Moduleblock diagram

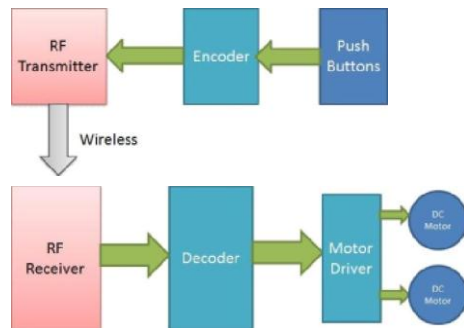
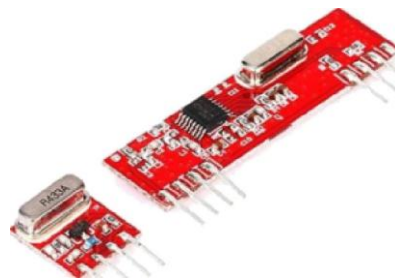


Fig 4.3.1. RF Transmitter and receiver Module

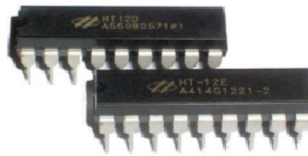


4.4 H12 E encoder IC with base&H 12 D decode IC with base

It is an encoder IC of 2⁴ series of encoders. Mainly used in interfacing RF and Infrared circuits. Encoders and decoders should have same no of address and data format. Converts the parallel input's into serial output.

HT12D is 12 decoder integrated circuit that belongs to 2⁴ series of decoders. This series of decoders are mainly used for remote control system applications, like burglar alarm, car door controller, security system etc. HT12D converts the serial input into parallel outputs.

Figure 4.4 HT12 E encoder IC with base & HT12 D decode IC with base



4.5 Principles of Rover

The robot is a moving vehicle remotely controlled by one transmitting unit and a receiving unit for its movement. In this, we used an HT12E encoder which converts 4-bit data to serial output. As explained above this is then fed to the RF module for transmitting the same to be received by the receiver. The RF module the output is fed to HT12D the serial decoder IC, the output of which is fed to microcontroller pin 1 to 4. The transmitting end microcontroller is connected to a set of pushbutton switches to its port 3 of 20 pin microcontroller AT89C2051. Thus while a particular button is pressed the program is executed to deliver corresponding 4-bit data which are then transmitted serially at port 1 as explained above. The data so received at the receiver end of port 1 of the Microcontroller.

Laser light is driven by transistor Q1 from the output of microcontroller pin 15, while the robotic vehicle is maneuvered to the location by operating the left, right, forward and backward button, etc. after it reaches the site the laser mounted on it takes position to throw the beam by operating specific action button.

4.6 Circuit Diagram servo robotic arm (Above Board)

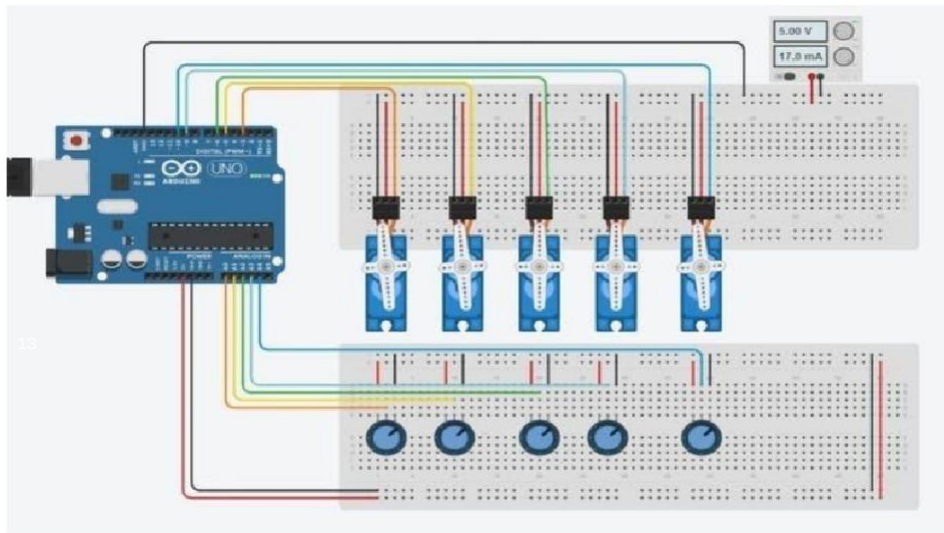
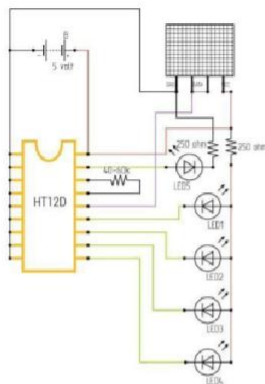
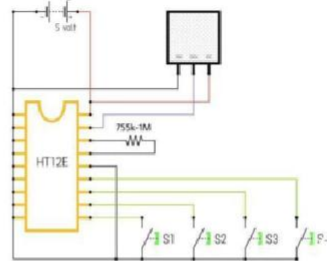


Figure 4.6.1.CIRCUIT DIAGRAM FOR SERVO ROBOTIC ARM

Receiver



Transmitter



9v to 5v

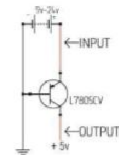


Figure4.6.2. CIRCUIT DIAGRAM FOR ROVER

4.7 Power

The power supply selected for feeding the control circuit of the servomotors is capable of delivering the same current even if all the synchronous servomotors are operating. When all servo motors are operated at the same time, they draw 0.5A current. In addition, 5 V was needed for the Arduino used for robot movement in the project. This requirement is provided by a 5V power supply

In spite of lead acid battery we are using lithium iron battery to reduce battery weight. For constant output we are using battery magnificent.

CHAPTER 5

5.ROBOT ARM MECHANIC

5.1. General Characteristics of Robot Arm Mechanics

Kinematics in robotics is the science of motion investigation. Robot arm links can be rotated or offset according to the reference coordinate frame. A systematic and general approach developed by Denavit and Hartenberg establishes the relationship between the robot endpoint and the total displacement of robot arm links (1). Angular and linear displacements between limbs are called joint coordinates and are defined by limb variables. In order to determine the amount of rotation and displacement according to the reference coordinate system of the endpoint, the matrices A which represent the amounts of each limb rotation and displacement are multiplied in turn. If the coordinates of the end point are given, limb variables can be obtained by going backward. These operations are called forward and inverse kinematics. The next section will explain how to determine forward and reverse kinematics. The general transformation matrix can be quite complex even for simple robots. It can be found in standard textbooks such as the Jacobian matrix for standard robots (2) and (3).

Coordinate Frames and Transformation Matrices for a General Robot Arm

An n -dimensional position vector is denoted by an $n + 1$ -dimensional vector and is called a homogeneous coordinate representation. In the following, a matrix of 4×4 is shown which shows a position vector in the homogeneous coordinates between the coordinate frames (4).

$$R_{TH} = \left[\begin{array}{c|c} (3*3) & (3*1) \\ \hline 0 & 1 \\ \hline (1*3) & (1*1) \end{array} \right] = \left[\begin{array}{cccc} x_x & y_x & z_x & p_x \\ x_y & y_y & z_y & p_y \\ x_z & y_z & z_z & p_z \\ 0 & 0 & 0 & 1 \end{array} \right]$$

$p = p_i + p_j + p_k$ The vector of the origin of the new frame,
 z
 $x = x_i + x_j + x_k$ The contour vector of the x-axis of the new
 z frame,
 $y = y_i + y_j + y_k$ The contour vector of the y-axis of the new
 z frame,
 $z = z_i + z_j + z_k$ Represents the contouring vector of the z-axis of
 z the
 new frame.

Column 4 of the transformation matrix has 3 elements corresponding to displacement in the x, y, and z directions.

$$\text{Trans}(p_x, p_y, p_z) = \begin{bmatrix} 1 & 0 & 0 & p_x \\ 0 & 1 & 0 & p_y \\ 0 & 0 & 1 & p_z \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

If any of the 3 coordinate axes is possible to rotate, there are 3 rotational transforms corresponding to the rotations in the x, y, and z-axes up to the θ angle. The following matrix can be written for x-axis;

$$\text{Rot}(x, \theta) = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos(\theta) & -\sin(\theta) & 0 \\ 0 & \sin(\theta) & \cos(\theta) & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

The matrices representing only the revolutions around the y and z-axes can be written in a similar manner.

$$\mathbf{Rot}(y, \theta) = \begin{bmatrix} \cos(\theta) & 0 & \sin(\theta) & 0 \\ 0 & 1 & 0 & 0 \\ -\sin(\theta) & 0 & \cos(\theta) & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$\mathbf{Rot}(z, \theta) = \begin{bmatrix} \cos(\theta) & -\sin(\theta) & 0 & 0 \\ \sin(\theta) & \cos(\theta) & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

The elements of the transformation matrix can be found by the arithmetic multiplication of pure rotation and displacement matrices. This can be obtained by a sequence of rotations about the axes of the stationary reference frame if the orientation is desired according to the reference frame of the Cartesian space endpoint. Although there are many ways to do this, one of the best known is the "roll-pitch-yaw" transformation. 3 turns. First turn around the x-axis, then y and then around the z-axis.

$$\mathbf{RPY}(\phi, \theta, \Psi) = \mathbf{Rot}(z, \phi) \mathbf{Rot}(y, \theta) \mathbf{Rot}(x, \Psi)$$

$$\begin{bmatrix} C(\phi)C(\theta) & C(\phi)S(\theta)S(\Psi) - S(\phi)C(\Psi) & C(\phi)S(\theta)C(\Psi) + S(\phi)S(\Psi) & 0 \\ S(\phi)C(\theta) & S(\phi)S(\theta)S(\Psi) + C(\phi)C(\Psi) & S(\phi)S(\theta)C(\Psi) - C(\phi)S(\Psi) & 0 \\ -S(\theta) & C(\theta)S(\Psi) & C(\theta)C(\Psi) & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Kinematics in robotics is the science of motion investigation. The robot examines the positions of the limb limbs, the relationships between velocities and accelerations, ignoring forces and other factors that affect movement.

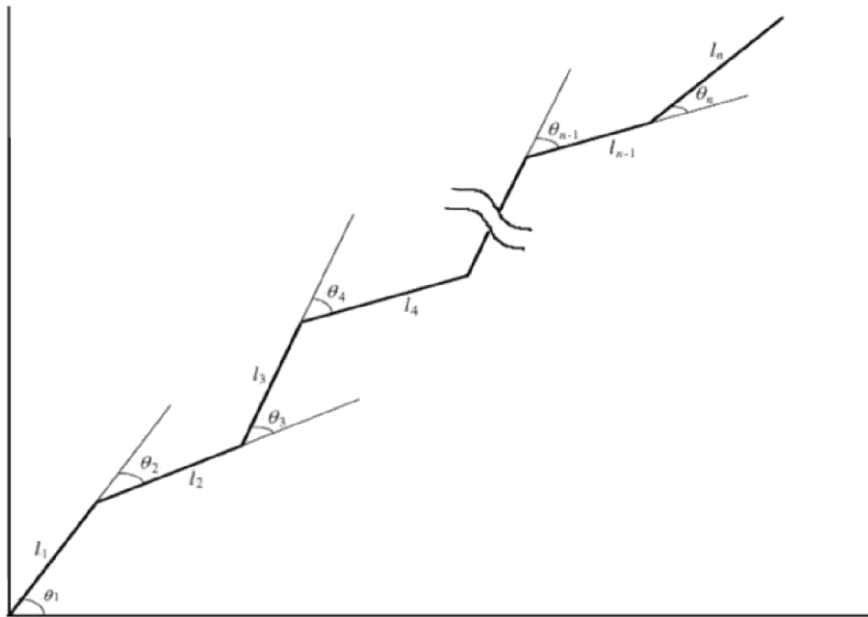


Figure 5 Serial robot arm with n links showing relative angles

The position and orientation of one of the links, or the orientation of the links between this link and the end point, will change when the serial link robot arm is shown in

Fig. When the positions and orientations of the links change, it is generally desirable to determine the position and orientation of the end point according to the basic reference frame.

When each mobile station is connected to a coordinate frame, the transformation between both links can be defined by a homogeneous transformation matrix, called the matrix A . For example, the first link is connected to the base frame by A_1 , which is the matrix 1.A. The transformation matrix of the end point can be expressed according to the reference frame by the arithmetic product of matrices A from the matrices 1.A of the matrices A to the matrix A of the endpoints.

$${}^0T_n = A_1 A_2 \dots A_n$$

When this equation is in closed form, any term can be expressed by another and is very important in the kinematic analysis of the robot arm. Because the robot is used to analyze the forward and inverse kinematics of the arm.

6. DESIGN BRIEF

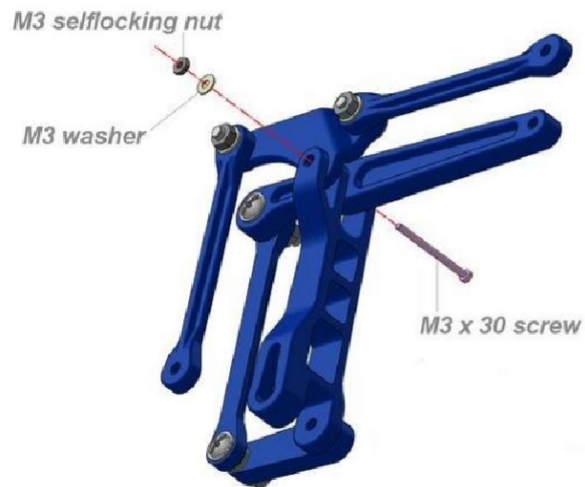
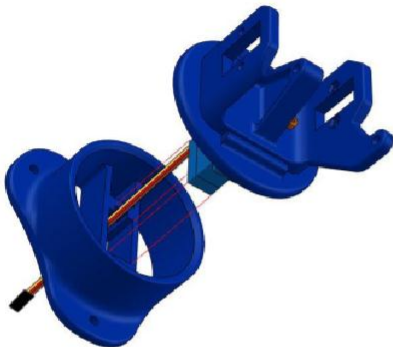


Figure 6.1 | robotic arm assemble(step1)

Connect now the two preassembled links to the forward drive arm (004).

Punt in position horizontal arm (005) and triangular link (006) aligned with the upper connection of the forward drive arm (004). Fix all parts with the M3x30 screw, locked by the nut on the other side.

Verify the freedom of movement and If everything is ok, proceed to the next step.



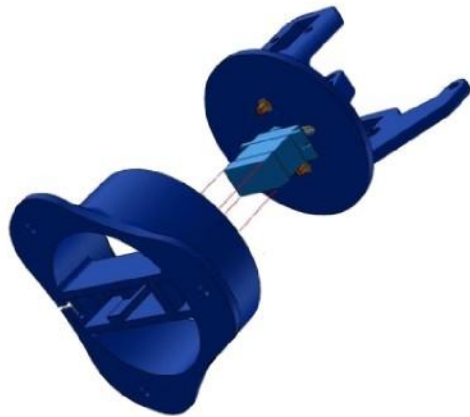
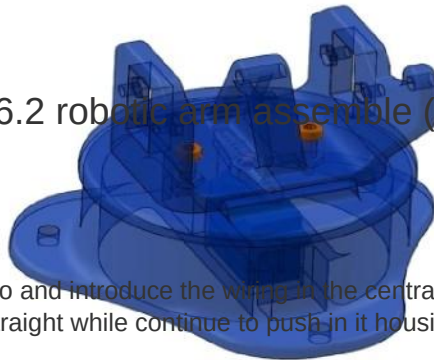


Figure 6.2 robotic arm assemble (step2)



Align the servo and introduce the wiring in the central part of the basement. Gently pull the wire to make it straight while continue to push in it housing the servo
The wire is then kept in position making it pass through a frontal hole



Figure 6.3 robotic arm

assemble(step3)

Insert the two pin of the driven gear into the dedicated holes on the left finger the driven gear has also a shoulder that has to be aligned with the lateral side of the finger. If you find difficulties coupling them, reduce interference using a file.

Once coupled insert an M3 screw in the central hole and attach the finger to the claw support

Now the gripper is ready to be installed on the horizontal arm of the EEzybot

Verify freedom of movement of the gripper manually or using a servo tester.



Figure 6.4 robotic arm assemble

Now we have the three main sub assembly ready to be connected each other



7 RESULT AND DISCUSSION

Experimental studies are within themselves; the method followed in the project, robot arm control system, and programming. In the method and robot arm control system part of the project, the basic commands are explained after the basic information is given and the robot can perform the required tasks. In the program section, there is the software information required for the movement of the robot. The programming part of the program is given in Appendix to the project to make the project more regular.

7.1. Projected Method

First, a historical research on robot arms was carried out and the basic information needed to establish the system was obtained. The robot used in the project has 4 axis joint and can move in 4 axis directions (left and right, up and down) and also can hold and swing motion thanks to the holder on it. The microcontroller Arduino UNO is used to provide optimal control of the robot arm. The reason for preferring this microcontroller is that it is more accessible to be able to get a solution to a possible error because the open source code is easier to use than the other microcontrollers and the number of users is higher.

After these studies, detailed information has been obtained about the servo motors to be used. The servomotor is preferred because it can be carried out smoothly in the robot project, the motor can be operated precisely and it must be at high torque. The robot arm, 5 servo motors are formed. Servo motors are numbered from top to bottom in order to explain their tasks because of the excess

7.2. Robot Arm Control

The connection box is made to distribute the 5V voltage from the supply source to the servo motors. In doing so, servo motor inputs, Arduino pin inputs, and communication circuit elements are used. The mechanical part of the robot arm is designed by combining the pre-selected parts appropriately. In order to move the robot arm properly, software with the selected Arduino microcontroller has been implemented and then the experiment with the control with the potentiometer and servo motors has been done to learn about the system operation. The software has been implemented with the appropriate Arduino microcontroller selected so that the robot arm can be moved appropriately for the intended purpose. Control of the robot arm with potentiometer. For movement of the arm we are using 12v DC (four) gear motors.

8. CONCLUSION

Robotic arms, many areas are developable. Thanks to the robotic arms, many tasks are made easier and the resulting error level has been reduced to a minimum. For example; some pharmacy-based drug-giving robots and a projected robot arm have been developed. In addition to this, the ability to move the robot arm is further increased, and when the camera is placed in the finger area and the sensitivity is increased, it can be used in a wide range

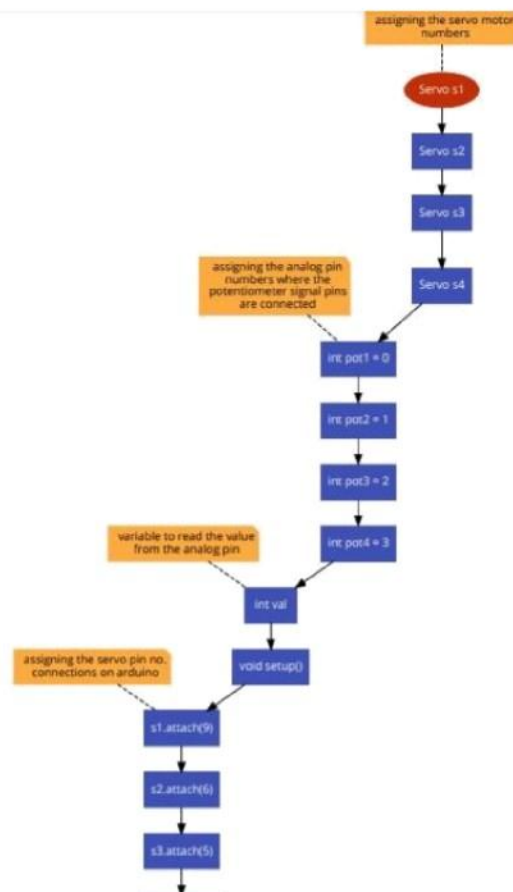
of applications from the medical sector to the automation systems. With the robotic arms developed in this way, the risk a) infecting the patient in the medical sector is minimized, while the human errors are minimized during the surgical intervention. Despite the fact that the robotic arm made by this project is o1 prototype quality, it has a quality that can be improved for more robotic systems. Besides these, robotic arm sector, which is open to development, will keep its importance in the future.

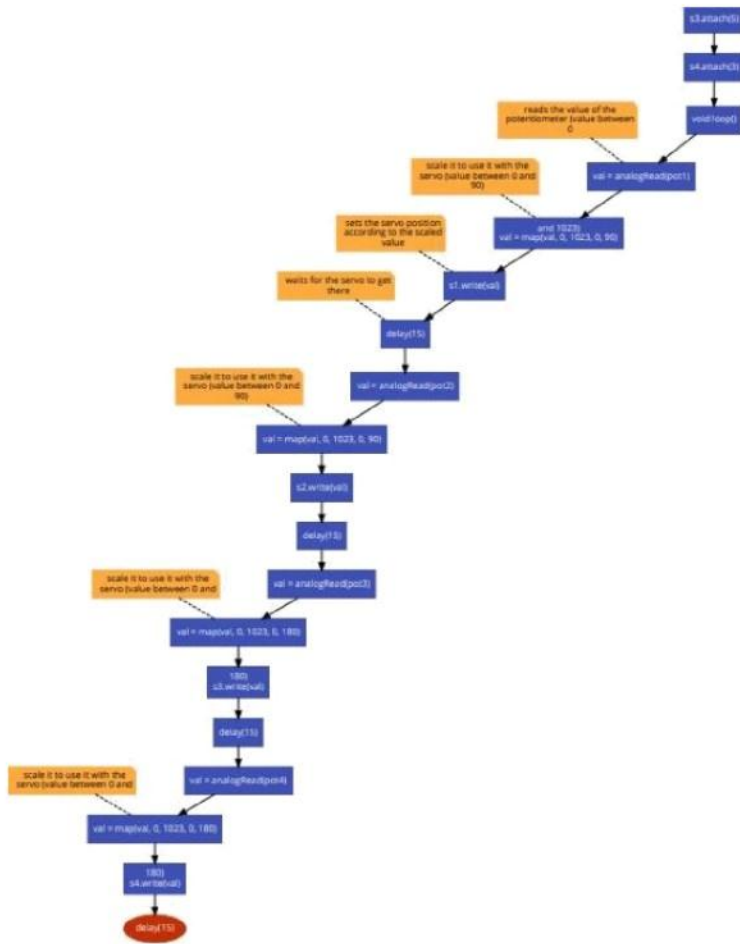
The purpose a) the project is to provide control a) 4 axes moving robot arm design and this robot arm with a suitable microcontroller and Bluetooth module with android application. The necessary theoretical and practical information for this purpose has been obtained and the necessary infrastructure has been established for the project. During the process of making and developing the project, a lot of theoretical knowledge has been transferred to the practice and it has been ensured that it is suitable for the purpose o) the project.

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