21MHC101P

Elements of Mechatronics Systems

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Manipulator with three degrees of freedom for pick and place applications

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BONAFIDE CERTIFICATE

Certified that this project report titled "**Manipulator with three degrees of freedom used for pick and placing**" is the bonafide work of

"**Athul Mathew Thomas, Dinesh Sastha, Paurnami Parakkattil**", who carried out the project work under my supervision as part of the course 21MHC101P – Elements of Mechatronics Engineering during the Even Semester of the Academic Year 2022-23.

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Signature of the Internal Examiner Signature of the External Examiner

ABSTRACT

The Three degrees of freedom manipulator is a representation of industrial automation techniques, as the majority of the work, especially in the automotive and mechanical industry, is carried out by manipulators with multiple degrees of freedom. These machines are designed by analyzing the requirement of the client they are made for and with utmost precision to perfection in their design. The aim of this project was to create a three degree freedom manipulator significantly smaller in size compared to the industrial standards to portray a demonstration of their working. In order to reduce the cost, the entire mechanical structure is made out of aluminum sheets. It was quite challenging to design the model with perfect stability.The next step was to integrate all the electronic components to the bread board by fixing arduino nano controls the manipulator . Coding is one of the most important aspects as it involves integrating and reciprocating according to the attributes received by the IR sensor. After successfully running the code and observing the test runs of the manipulator, it was observed that the manipulator picked up the object detected by the sensor and placed it in a different area that it is assigned to keep.

Hence once again the project is a miniature representation of a larger manipulator with multiple degrees of freedom .They are effectively being used in industry to carry out work more efficiently than man and for long hours. With further improvement in technology, they may even be used in medical industry to perform surgeries..etc

ACKNOWLEDGEMENT

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We would like to express our sincere gratitude to our course in-charge, Prof.Dr.K.Sivanathan for helping us out throughout the project and giving the right solutions and advice to our problem while making the project .

We like to thank the fab lab incharges for helping us out by providing the required tools and resources for the project . We also want to thank our friend Chirag Telisara for guiding us with his technical knowledge for the project .

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INTRODUCTION

1.1 Three Degree Of Freedom Manipulator

The three degrees of freedom is made to function as a pick and place robot .This manipulator is a miniature model of industrial manipulator with multiple degrees of freedom. An **IR sensor** is used to detect the object, and on the sensor receiving the signal it reciprocates an action to pick the object placed in front of the sensor and replace it into another place. Figure 1.1 shows the fabricated model of pick and place manipulator.

These manipulators are really useful and soon makes makes manufacturing ,automobile and various Other industries are completely automated.Hence it is a necessity to take up research to improve the current technology to produce much advanced technology to make it more efficient and make the user-interface more stable and reliable. Hence the project may even be considered on a major project terms in its working.

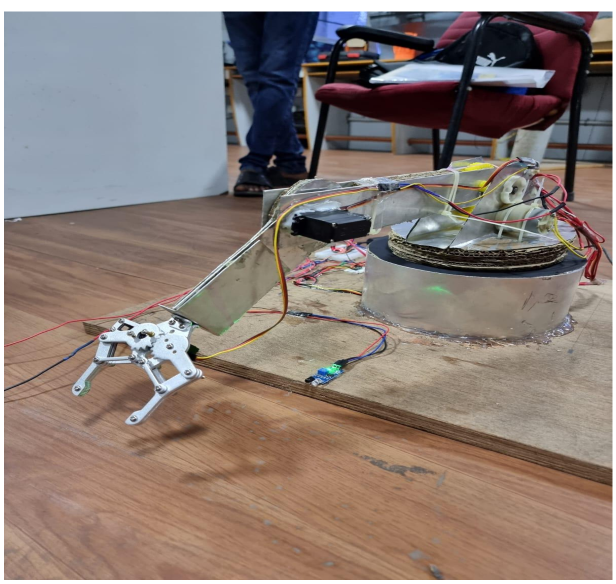

Figure 1.1 Completed image of the three degrees of freedom manipulator

1.2 OBJECTIVE

The objective of the manipulator is to sense an object placed in front of the ir sensor and reciprocate according to the attribute received by the sensor.The manipulator on receiving the signal will pick the object placed in front of the ir sensor and and place it in a different area. It involves the integrations of all the circuits,sensors and the mechanical structure.

1.3 MECHATRONICS PERSPECTIVE

The project carried out is an integration of various sub-domains such as mechanical,electrical and computing technology to work to efficiently.The mechanical aspects includes the motors functioning to move the arm to pick up the object and placing to another place which in turn controlled using microcontroller such as arduino uno which is programmed to control the working according to clients needs, hence Arduino Uno IDE is used to code the microcontroller. Since there is an system integration of various sub-domains mechanical,electrical and computing technology to make the project work, the project may be considered fit when looking in terms of a mechatronics perspective.

1.4 CONTEXT DESCRIPTION

After turning on the SMPS(i.e.Power Supply) , the IR sensor placed for detecting whether the object is around detects the presence of an object creates reciprocating action by sending signals to the microcontroller that an object has been detected.The microcontroller on receiving this signal sends the reciprocation actions required by following the instructions given through the program to lift the object placed in front of the microcontroller and place it in another alternative place.

1.5 ASSUMPTIONS

The objected detected must be lightweight as the manipulator won't be able to carry much weight.So the weight factor of the object the manipulator can carry are ruled out to be lightweight.The lightweight object is then picked by the manipulator and placed in a certain different area.

CHAPTER-2

DESIGN AND FABRICATION

The base of the whole robotic arm is attached to a wooden plank as shown in Figure 2.1. The base is made with a combination of both aluminum sheet and cardboard. A custom servo motor is made for the rotational part of the base and 10rpm DC motor with potentiometer so that it can provide more torque (basically a high torque DC motor). Potentiometer is used here because the motor gives rotating position, and potentiometer reads the angle. Potentiometer sends angle status to Arduino and then there is a reference input angle which is input desired angle to rotate the base. Then the motor will rotate until and unless the Potentiometer reaches that reference desired angle. To provide enough strength to carry the object sensed by the IR sensor, aluminum sheets are used. The length of arm 1 is about 15 cm. Arm 2 is made out of aluminum sheet but with a lesser length(around 5cm) to reduce the weight of the whole model.
At last, the gripper (made of aluminum) is attached to Arm 2.

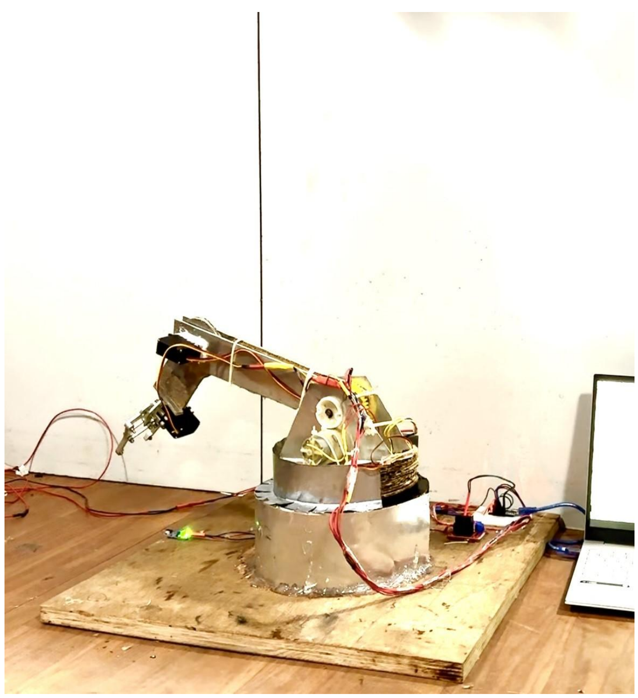

Figure 2.1 Wooden Slab for base

1. STRUCTURAL ELEMENTS

Structural elements used for the project are wooden plank, aluminum sheet and cardboards.

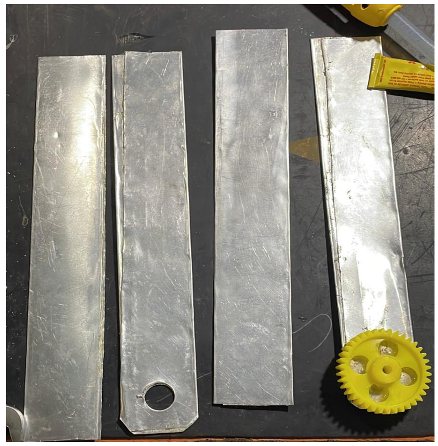

Figure 2.2 Arms for the manipulator

2. MECHANICAL ELEMENTS

Mechanical elements include gears (small and big), caster free wheels.

Gears are used to control the arms. The small gear is connected to the motor and the big gear is aligned with the small gear. This is done in order to provide high torque.

Figure 2.3 Gears

3. ELECTRICAL ELEMENTS

The electrical components in this project are:

-DC motors(x2)

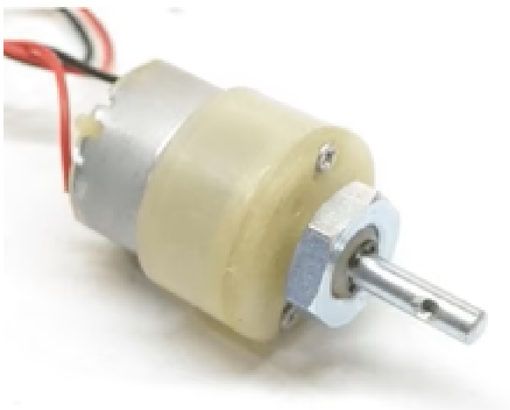

Figure 2.4 12 rpm DC motors(x2)

-Servo mg995 motor(x2)

Figure 2.5 Servo mg995 motor(x2)

-Potentiometers 10k(x2)

Figure 2.6 Potentiometers 10k

4. ELECTRONIC ELEMENTS

The electronic elements used in this project are:

-Arduino NANO:

Microcontroller used here is the Arduino NANO.

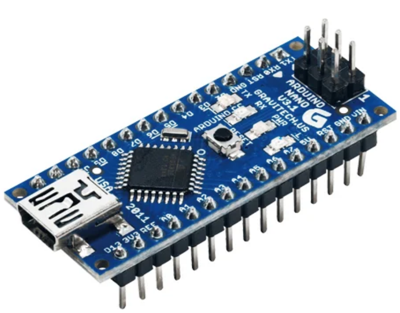

Figure 2.7 Arduino NANO

- L298N motor driver:

To control the actuators, a l298n Motor driver is used.

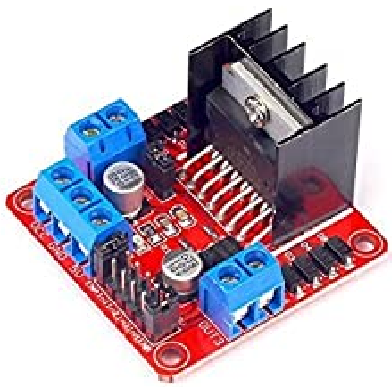

Figure 2.8 L298N motor driver

-IR Sensor

IR sensor is used to detect any object or obstacles placed in the plane.

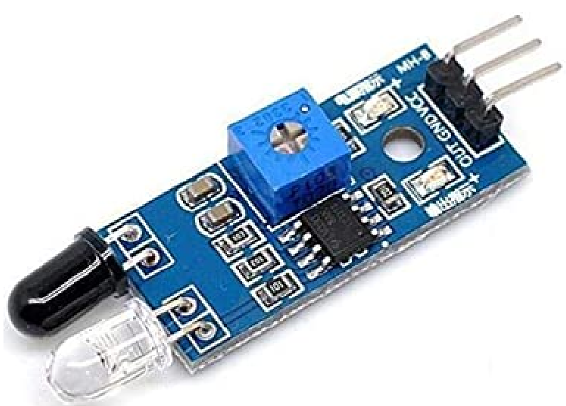

Figure 2.9 IR sensor

5. HARDWARE BLOCK DIAGRAM

The figure 2.10 shows the hardware block diagram of the Manipulator.
Here, the arduino NANO is used as the microcontroller that controls all the processes.
When an object is sensed by the IR sensor, it sends a signal to the Arduino and then the process begins. The base motor (rotation part) is controlled by a motor driver (l298n). To the elbow joint, a custom servo motor is made by connecting a DC motor and a potentiometer to a Servo circuit.
And for the joint2 part , a servo mg995 is used for the control and also another servo mg995 for the gripper part.

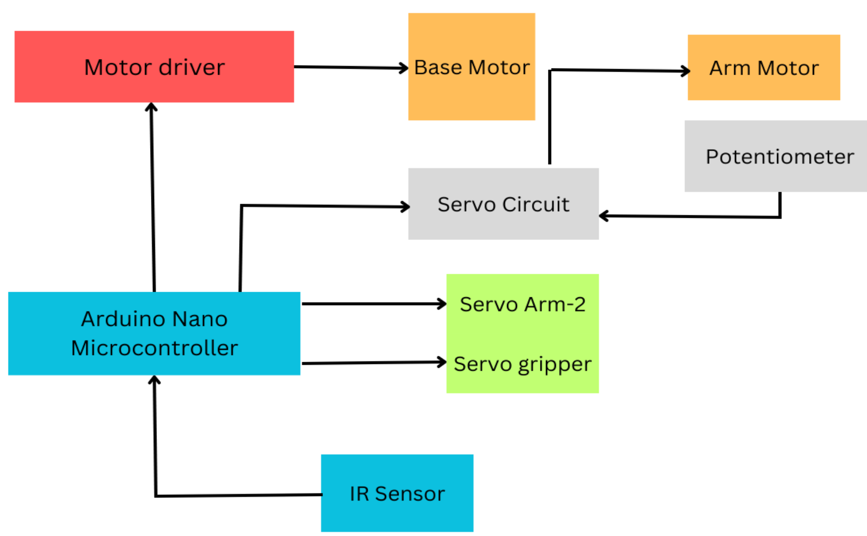

Figure 2.10 Hardware block diagram

6. ELECTRICAL CIRCUIT DIAGRAM

The figure 2.11 shows the electrical circuit diagram of the manipulator. The base motor is connected to OUT3 and OUT4 pins of the motor driver(l298n). The input pins are connected to arduino nano for power supply.

At the elbow joint part of the manipulator, a custom servo motor is made by connecting a potentiometer and a DC motor to the servo circuit. The servo circuit is powered by an arduino. The wrist part of the manipulator and the gripper is controlled by servo mg995. Even the IR sensor is connected to the arduino nano.

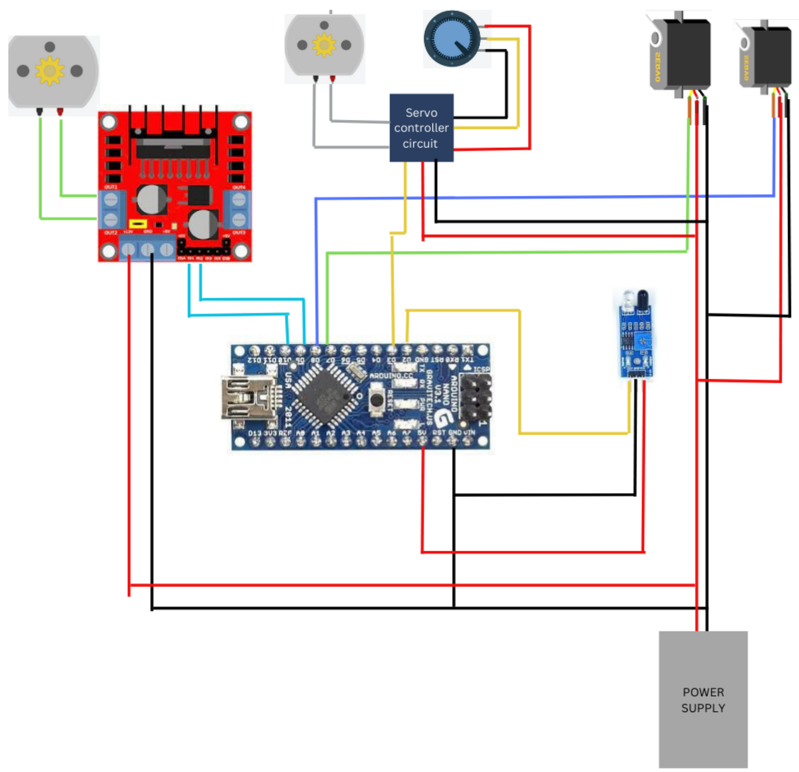

Figure 2.11 Electrical circuit diagram

CHAPTER-3

FUNCTIONAL INTEGRATION

1. Type of Control

i). Control system block diagram.

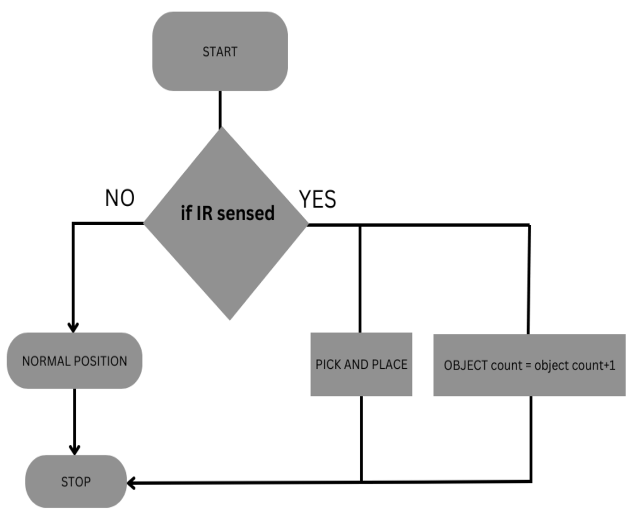

Figure 3.1 Control system block diagram

The figure 3.1 shown above is the control system block diagram of the Manipulator.
If the IR sensor senses any object, the pick and place process will start. And also the object count will be increased (as per the number of objects sensed).
If nothing is sensed by the sensor, the manipulator will be in normal position and no process takes place.

2. COMMENTS ON PERFORMANCE

The project “3-DOF robotic manipulator” was built and demonstrated successfully.
The proper working of the IR sensor was seen as it told the correct number or objects or obstacles sensed. Improper alignment of the base motor gear was one of the problems that we faced.
The whole body was not able to twist smoothly because of the improper alignment.

In conclusion, we tried our best in planning, execution and control of the robot and we were adequate enough for the completion and operation of the robot.

CHAPTER-4

CONCLUSION AND FUTURE SCOPE

1. **FUTURE SCOPE**

Robotic arms or manipulators have a wide scope of development in future. The arms are able to perform human tasks in a more efficient and in a much better way. The robotic arms can be used in industries for making work more easy and fast. They can be designed in a way that it carries heavy loads. The time of the work done by a robotic manipulator is very fast compared to humans.

2. **CONCLUDING REMARKS**

The whole report we have prepared tells about how to prepare a robotic arm, it’s connections,
It's working and what it does.
Here we have prepared an Arm that picks up light objects and drops it in a place where we desire.
The design is limited to 3 degrees of freedom.
The whole body is made up of aluminium and cardboard in order to get good stability, less cost and light in weight.

During the whole process, we have faced many difficulties, but we took this as an opportunity and did our maximum in completing the task.
We completed building the whole prototype and it was also functional.

APPENDIX

(CODE Related to the Project)

```
#include <Servo.h>

Servo servo2; //ARM 1
Servo servo3; //ARM2
Servo servo4; //GRIPPER
int object = 0;
const int m1=6;
const int m2=7;

  int dx= 10000;

const int irsensor = 2;

int val;

void setup() {

  Serial.begin(9600);
  servo2.write(50);
  servo3.write(90);
  servo2.attach(3);
  servo3.attach(4);
  servo4.attach(5);

  pinMode(irsensor, INPUT);
  pinMode(m1, OUTPUT);
  pinMode(m2, OUTPUT);

}

void loop() {

val=digitalRead(irsensor);

if (val== LOW){

  capture();

}
if (val== HIGH){
  normal();
}
```

```
Serial.print(" No. of objects : ");
Serial.println(object);
}
void normal(){

}

void  capture(){

  object=object+1;

  servo2.write(110);   // ARM1
  delay(2000);
  servo3.write(45);    // ARM2
  delay(5000);
  servo4.write(150);   // GRIPPER PICK
  delay(2000);


  ////////////////////////////////////////////

  servo2.write(50);   // ARM1
  servo3.write(45);
   digitalWrite(m1, HIGH);   // BASE MOTOR
  digitalWrite(m2, LOW);
  delay(dx);
  digitalWrite(m1, LOW);   // BASE MOTOR
  digitalWrite(m2, LOW);
  delay(dx);
  servo4.write(90);   // GRIPPER DROP
  delay(5000);

//////////////////////////////

  servo2.write(50);
  servo3.write(45);
  servo4.write(100);      // GRIPPER OPEN
  delay(1000);
  servo3.write(90);
  digitalWrite(m1, LOW);   // BASE MOTOR
  digitalWrite(m2, HIGH);
  delay(dx);
  digitalWrite(m1, LOW);   // BASE MOTOR
  digitalWrite(m2, LOW);
  delay(dx);
  servo2.write(50);
 //////////////////////////////////////////

}
```

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Report Formatting Checklist and Compliance Report

(Place a Tick (√) mark against each points after ensuring the compliance of the same)

Title case for all subtopics, figure title, table title

One tab space during start of a new paragraph
Italics for all notations and programming constructs such as function names, header files etc
Consistency of bullets (style, size) across report
Consistency of figure numbering e.g. **Fig. 1.5 Schematic Diagram.** The same must be followed while citing inside the text
All figures and tables must be cited inside the main text material, denoting what it contains or illustrates
Active voice such as we, our project, for us etc. must not be used
Ensure labeling of contents inside figure if required.
All arrow marks used must follow the arrow head convention ⟶
Check for unnecessary capitalization of words
All physical units must be in SI and SI unit must be capitalized wherever required e.g. Hertz and mm is fine
All plots must have axis labels with physical units (if any)
Check all the spacing above and below to be consistent across various sections of a chapter
Ensure page number correctness in Table of Contents List of Figures, Tables, etc
Check if the numbering of figures and tables are near the figure, above the Table and below the figure.
Ensure readability of fonts inside figures assuming printed condition
Ensure subscripts for notation (if any)
Plots with multiple functions must include legend inside the boundary of the plot itself
All topics and sub-topics must start with some text content, direct figures and tables to be avoided
Do not use letter 'x' for something like A x B instead use A × B
Italicize the use of letters *X, Y, Z*

We hereby attest that the report submitted on________________to the course instructor __________________ is compliant to all the stipulated guidelines for preparation and the checklist aforementioned.

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