VISVESVARAYA TECHNOLOGICAL UNIVERSITY

JNANAJNANASANGAMA, BELGAVI – 590018.

MINI PROJECT REPORT ON

COMPUTER NUMERIC CONTROL

Submitted in partial fulfilment of the requirement for the award of the degree

BACHELOR OF ENGINEERING IN

ELECTRICAL AND ELECTRONICS ENGINEERING

Submitted by

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SAPTHAGIRI COLLEGE OF ENGINEERING

(Recognized by AICTE, New Delhi & Affiliated to VTU, Belagavi)
An ISO 9001:2015 & 14001:2015 certified institution
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14/5, Chikkasandra, Hesaraghatta Main Road, Bengaluru – 560 057.

2022-23

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CERTIFCATE

Certified that the project work entitled_**COMPUTER NUMERICAL CONTROL**_ carried out by **JAYASHREE B G** bearing **USN [1SG20EE013], MADHUSUDANA K J** bearing **USN [1SG20EE016], NANDINI N** bearing **USN [1SG20EE020], SUJAY** bearing **USN [1SG20EE031],** bonafide students of **Sapthagiri College of Engineering** in partial fulfilment for the award of **Bachelor of Engineering** in department of **Electrical and Electronics Engineering** of Visvesvaraya Technological University, Belagavi during the academic year **2022-23**. It is certified that all corrections/suggestions indicated in the Internal Assessment have been incorporated in the report deposited. The project report has been approved as it satisfies the academic requirements in respect of project work prescribed for the Bachelor of Engineering Degree.

Sign. of the Internal Guide	Signature of the HOD	Signature of the Principal
Mrs. Ramya M	**Dr. Rekha S N**	**Dr. H. Ramakrishna**
Asst. Professor	Professor & H.O.D	Principal

External Viva

Name of the examiners Signature with date

1……………………….

2……………………......

ABSTRACT

CNC machines are widely used to manufacture different parts in different types of materials. It is a highly precise way for manufactures to make sure all their parts are within the set tolerances. CNC is computer controlled whereas in the past it was manually controlled by the operator. Some of the first manual milling machines in the early 1900's used manual dials to make parts to specific measurements. Cranks would also be used to raise the chuck and collet to meet the table, which would also be moved in the x and y directions using a crank.

The Purpose of this experiment is to understand CNC code to program it into the milling machine to create a part with different types of materials. It is a highly precise way for manufactures to make sure all their parts are within the set tolerances. CNC is computer controlled whereas in the past it was manually controlled by the operator. Some of the first manual milling machines in the early 1900's used manual dials to make parts to specific measurements. Cranks would also be used to raise the chuck and collet to meet the table, which would also be moved in the x and y directions using a crank. The Purpose of this experiment was to understand CNC code to be able to program it into the milling machine to create a outline diagram of the provided Gcode.

ACKNOWLEDGEMENT

Firstly, we are very grateful to the management of our esteemed institution "**SAPTHAGIRI COLLEGE OF ENGINEERING**" for providing us an opportunity to pursue our degree course.

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We would like to thank **Dr. REKHA S N**, Prof.& H.O.D. of Electrical and Electronics Engineering Department and **Mrs. RAMYA M** Assistant Professor, Electrical and Electronics Engineering Department for providing us an opportunity and for their invaluable support. We would also like to take this opportunity to express our gratitude for the support and guidance extended to us by the faculty members of the Electrical and Electronics Engineering Department.

And lastly, we would hereby acknowledge and thank our **parents** and **friends** who have been a source of inspiration and also instrumental in the successful project work.

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CHAPTER NO 1

INTRODUCTION:

Computer numerical control, or CNC machining, is a computer-aided, high-accuracy manufacturing process. Pre-programmed CAD software is used to automate the controlled machining and eliminate the need for an operator. The main advantage of CNC machines is their ability to run unattended during the machining cycle and manufacturing process, allowing the operator to carry out other tasks elsewhere.

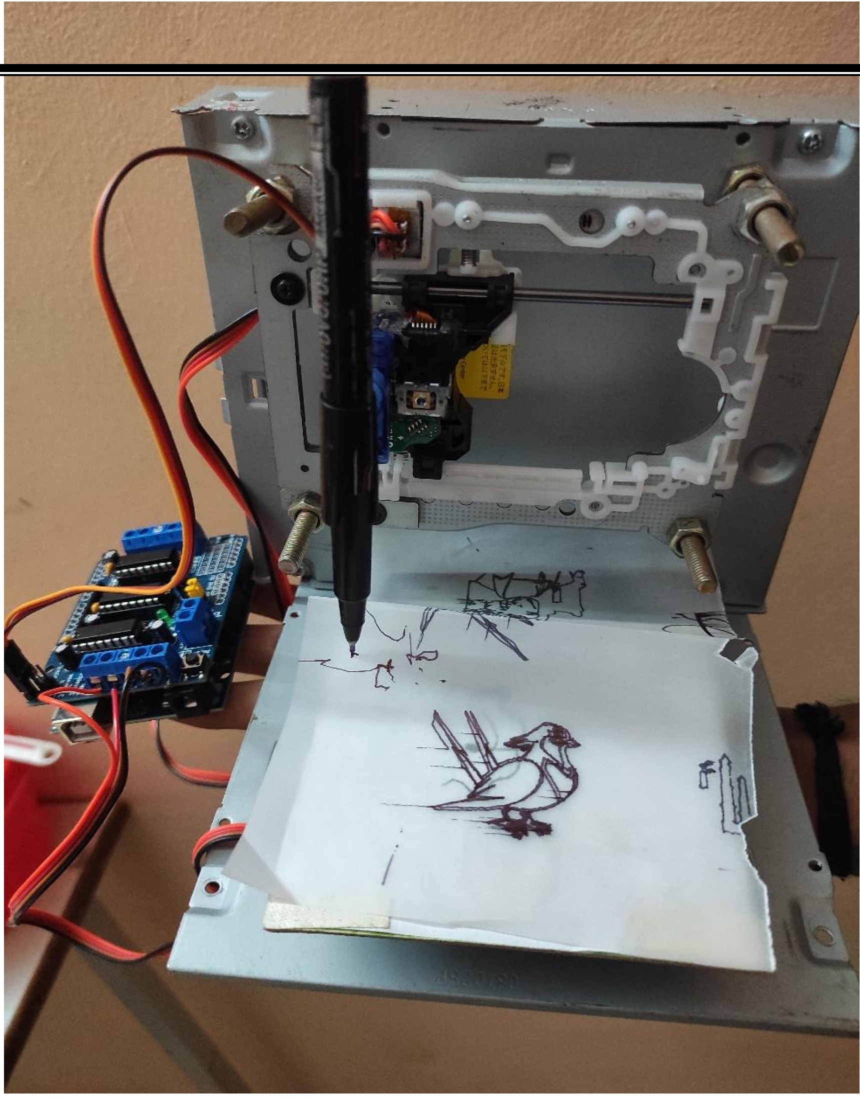
This drastically reduces human error during the controlled machining process and allows for high accuracy manufacture of the different parts. Another benefit of CNC machining is consistent and accurate workpieces.

The CNC machining operations of today benefit from not only high accuracy machine tools and code controls, but also the ability to repeat multiple manufacturing processes on separate occasions. The flexibility of CNC programming easily allows CAD files to be tweaked and changed to produce multiple different parts.

Mini CNC plotter machine is described as it is based on Arduino controller and CNC shield. CNC is computer numerical control machine. G codes are preparatory Function. G codes are pre-defining Function Associated with the movement on axes. In CNC Plotter Machine only G codes are used. G codes are giving the direction to move the pen in X, Y, Z directions.

Drilling, laser cutting tool, milling it can be worked, if it is made in large size. The aim

of over is to make a mini CNC plotter machine which is capable to draw difficult design in paper or surface of metal, To cut it with a great accuracy. We have used 3 stepper motors with lead screw in Cartesian coordinate X, Y, Z directions. Stepper motor is convert digital pulse into lead screw rotations. Stepper drivers are used to give command to the system. The main aim is to fabricate a MINI CNC plotter Machine to draw an object with using G codes. We also work on to reduce.



1.1 Assembly and circuit of the Project

1.2 OBJECTIVES:

A machining center refers to a computer numerical control, or CNC, machine used in the production of industrial components. CNC machines are basically automated milling machines that operate without direct human assistance.

The operator will use programmable language called G code to input desired project dimensions and work conditions, such as feed rate and speed. This information is relayed to the CNC machine's integrated computer system as work instructions that control the machining process. These machines can be used for specialized and complex applications, including engraving and die sinking, or making impressions in die blocks.

Accuracy:

Machining center usually fabricate parts with a level of precision that is nearly impossible to achieve with conventional hand-operated equipment. So a major selling point for a machining center is accuracy, as the objective is to complete work within strict tolerances. The machine follows a set of instructions via a computer program, thus eliminating errors that might otherwise be introduced by a machine operator. This greatly minimizes waste, as fewer parts are discarded.

Increased Productivity:

The CNC machine can perform the same task repetitively for extended hours, saving a lot of time. Because the machines are driven by digital designs, the need for preliminary blueprints is eliminated, freeing up man hours for other tasks. In a typical industrial setting, machining centers will run nonstop for days once the work program detailing all necessary parameters has been fed into the CNC computer. More sophisticated models will alert the operator via text message if a malfunction requires human intervention. Overall, these machines realize higher factory floor productivity than humans do.

Versatility:

CNC machines are versatile and have applications in the aeronautical, automobile and plastics industries and in medical device manufacturing. Their adaptability stems from their ability to create many types of objects from different materials. Although the choice of a CNC machine will depend primarily on product type, size and configuration and the required level of precision, they can process work over a number of axes (three to more than five), which means they easily adjust to the complexity of the parts to be manufactured.

CHAPTER NO.2

LITRETURE REVIEW:

- **S.S. Abuthakeer et al.** discussed about the functional requirement of machine tool which are high static stiffness and damping. They suggested that the composite material of steel and polymer concrete can be used for replacement of conventional cast iron for bed structure. Experimental modal and static analysis proved that steel-polymer composite is suitable for replacement of cast iron.

- **B. Malleswara et al.** analyzed the machine tool bed for static and dynamic loading. For machine tool bed, the stiffness and rigidity can be improved by better structural design. Author optimized the machine tool bed using Opti struct and analyzed in ANSYS workbench. Study shows that, machine structural behavior can be influenced by adding ribs at the suitable locations.

- **P. Mohanram et al.** presented that material distribution plays an important role in the structural strength and by utilizing proper material at required place can increase static stiffness with lower mass. They modified the existing supporting structure by adding vertical ribs and analyzed both structures. Study shows that Vertical ribs in the machine tool structure can be useful in improving the static and dynamic behavior of machine tool.

- **Linyan Liu et al**. presents a knowledge-centric process management framework for the CNC machine tool design and development (D&D) with the integration of process and knowledge. Requirements for the framework are generated based primarily on the nature of the machine tool design practice.

  The proposed framework consists of process integration model, process simulation, process execution and knowledge objects management modules. Each of these modules is elaborated to support the knowledge-centric machine tool development process management. The prototype development is also presented by the author.

  Results of this study facilitate the knowledge integration in CNC machine tool D&D, and thus increase machine tool development capability, reduce development cycle time and cost, and ultimately speed up the effectiveness and ensure the excellent machine tool development. Finally the study has outlined a framework within which designers are encouraged to participate in the machine tool development efficiently and conveniently, for the benefit of each individual and the company. Compared with the existing references, the proposed framework of knowledge-centric CNC machine tool D&D process management includes the following

- **Dr. J.B. Jayachandraiah et al (2014)** provide the idea to develop the low cost Router system which is capable of 3 axis simultaneous interpolated.

  The low cost is prototyping is achieved by incorporating the features of standard PC interface with microcontroller base CNC system in an Arduino based embedded system. With limited budget the author conclude that small machine tools to fabricate small parts can provide flexibility and efficiency in manufacturing approach and reduce the capital cost, which is beneficial for small business owners.

- **Ahmed A.D.Sarhan et al. (2015)** in this paper, an initial CNC gantry milling machine structure with the potential to produce high surface finish has been designed and analyzed. The target of the author is to achieve lowest natural frequency of 202Hz corresponding to 12000 rpm at all motion amplitudes with a full range of suitable frequency responses. Modal analysis of the initial gantry structure design was performed and its natural frequency was 102.36HZ. To improve the dynamic behavior of the gantry structure so it can endure at frequencies above 200HZ, a modification process was carried out to increase stiffness.

The above enhancement, appropriate behavior was attained. Deformation of less than 10 microns ensued at the tip of the spindle when the minimum natural frequency of the gantry structure rose slightly above 200Hz. An increase in the structure's weight was the significant factor for the identified deformation. However, the variation did not have a negative impact on the precision of the machine. As a result, the weight increased after modifications to the gantry structure were made, while the amount of deformation and overall dynamic behavior improved. In addition, the efficacy of the Z-axis part's position on the dynamic behavior of the gantry structure was studied. By displacement of the spindle position, the dynamic behavior of gantry structures will change. The research results shows that the designed CNC gantry machine is capable of functioning at a speed of 12,000rpm.

- **Sundar Pandian et al. (2014)** develop low cost 3 axis CNC machine using of- the- shelf component, stepper motors with drivers, Arduino open source, microcontroller and open source motor control software. Author used ready to assemble kit from Zen Tool works, USA. Kit provided stepper motor, lead screw, guide rod, anti-backlash falans and spring. He made the Body with high density PVC.

  The machine has fix gantry and mobile bed so there is restriction in working area. Author develop Low cost CNC machine only for educational purpose

- **B.Malleswara Swami et al. (2012)** in this paper author describe the method for static and dynamic analysis. Author used standard bed for analysis.

  The investigation is carried to reduce the weight without changing the structural rigidity and the accuracy by adding the ribs at the suitable location. Static analysis is done for 1g i.e. gravitational force is consider with external load on structure and 5g that is gravitational force 5 times 'g' value is applied on structure along with external load .In modal analysis ,the natural frequency of the body is evaluated to find the dynamic and vibration characteristics. Then the optimize design is generated using optistruct tool. The results which gets after optimization reduces the weight by 1.55% with original value and average frequency shifted by appx. 8.8 % with 1st natural frequency.

- **Monika Nowak et al. (2012)** formulated methods of selection of geometric and physical structure of the mobile machine by specifying the design requirements and the development of the elimination conditions based on these requirements.

  The selection procedure was based on an analysis of the functional description of the required shaping movements, carefully developing appropriate conditions for the elimination of alternatives using the information concerning the needs of future portable machine operators.

- **Grzegorz szwengier et al. (2012)** gives the results of research on selection on geometric-kinematic structure of newly designed milling machine.

  There was various types of structure combination available for milling machine, author suggested best procedure and help to select useful combination of machine parts with desired output provided with constraints of machine.

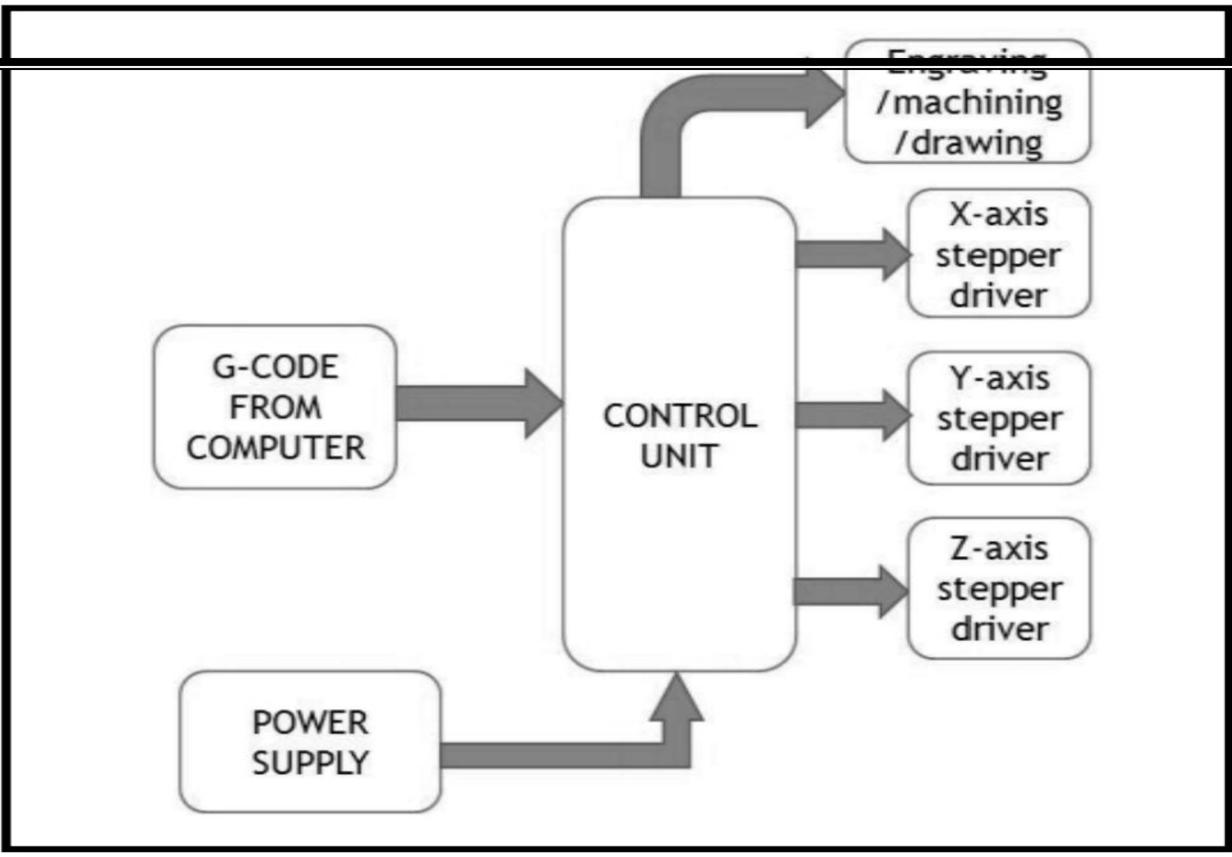
- **Venkata Krishna pabolu et al (2010)** discuss the design and implementation of low cost three dimensional computerised numerical control system (CNC) for industrial application.

  In this paper prototyping an Embedded CNC machine was created.Detail description of different modules such as software development, Electronic/Electrical development, along with technical details of their implementation have been given.

CHAPTER NO.03

BLOCK DIAGRAM OF PROCESS:

In this idea of project, Arduino microcontroller platform with ATMEGA 328 core is used. It can be easily interfaced with PC using FTDI module whereas also with the easy drivers and stepper motors to manipulate and control the total working using only stepper driver controller. The basic block diagram is as shown in fig below .The explanation is given as follows

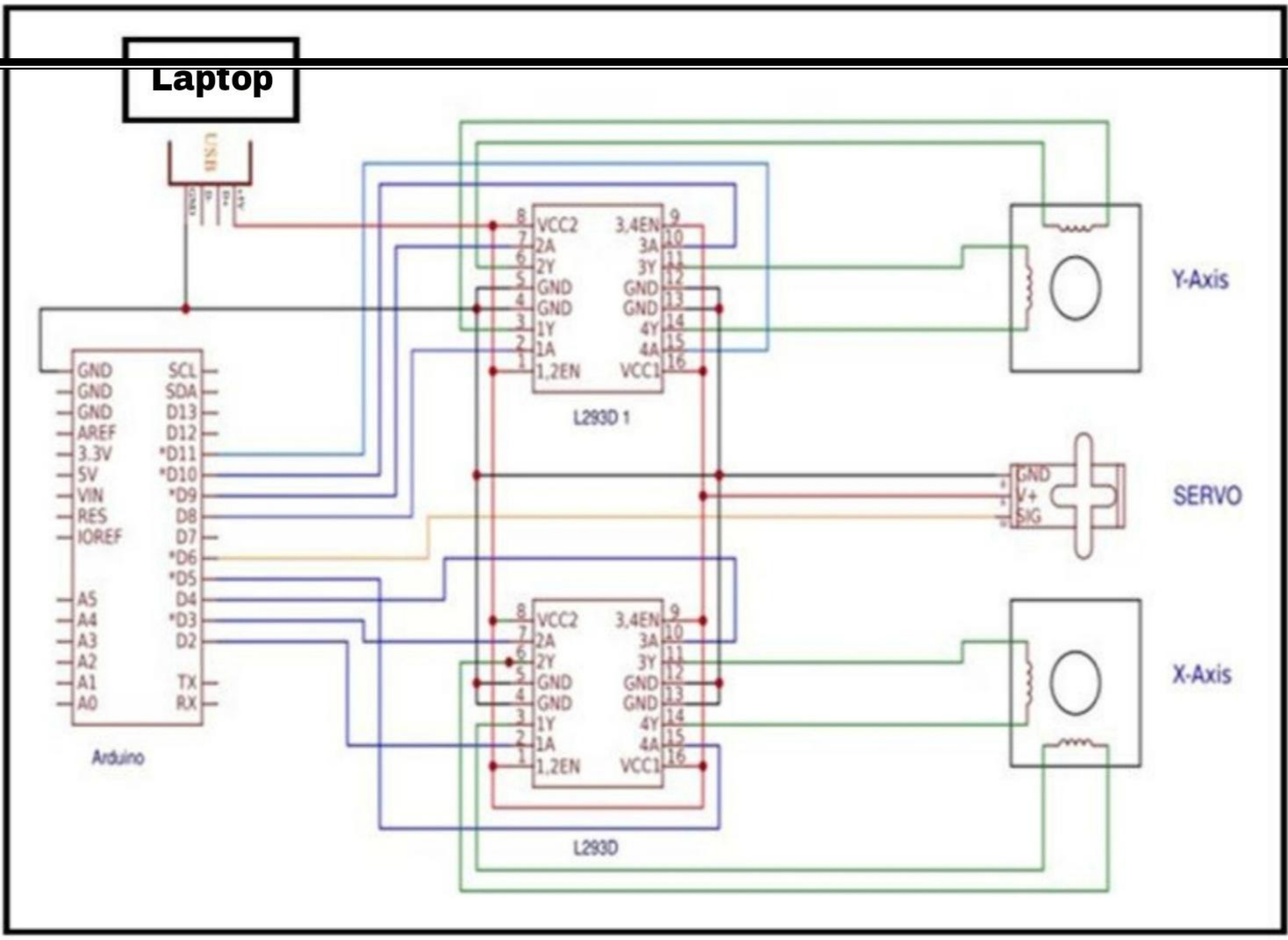


3.1 BLOCK DIAGRAM

We have supply the current in Arduino with USB DATA cable to transfer Data from Computer to Arduino Board , here we have used 3 Stepper Drivers to supply the G codes in Sequence to the stepper motors. Arduino will be mounted on CNC shield. CNC shield will be distributing the Current in the command of Arduino. CNC shield will be converting the command of G codes in digital pulse by Stepper motor. In X direction Stepper motor will be move left and Right ,Y direction stepper motor will be move in front and back direction, Z direction Stepper motor will be move in Up and down[2]. We have make many difficult design via using this machine. The accuracy of these machines results is very high. So we have used in industry to reduce the cost of design printing and maintain accuracy level. Drafting and Scaling of CNC Plotter machine is very precious.

CHAPTER NO. 04

4. CIRCUIT DIAGRAM:



4.1 Circuit Diagram

Now that we have our contraction ready, it's time to build the circuit and test stepper motors(X and Y axis).Watch the above image with breadboard circuit schematic. Steppers motors wiring is something that need patient. On next step you will find a 'testing' code for x and y axis. If yours steppers doesn't work properly you must find correct working combination by changing the cables between them and the L293D IC On mine CNC , X axis motor connection are: L293 A: Pins 1 and 3 & B: 2 and 4, but on Y axis motor connection are A: 1 and 2 & B: 3 and 4.

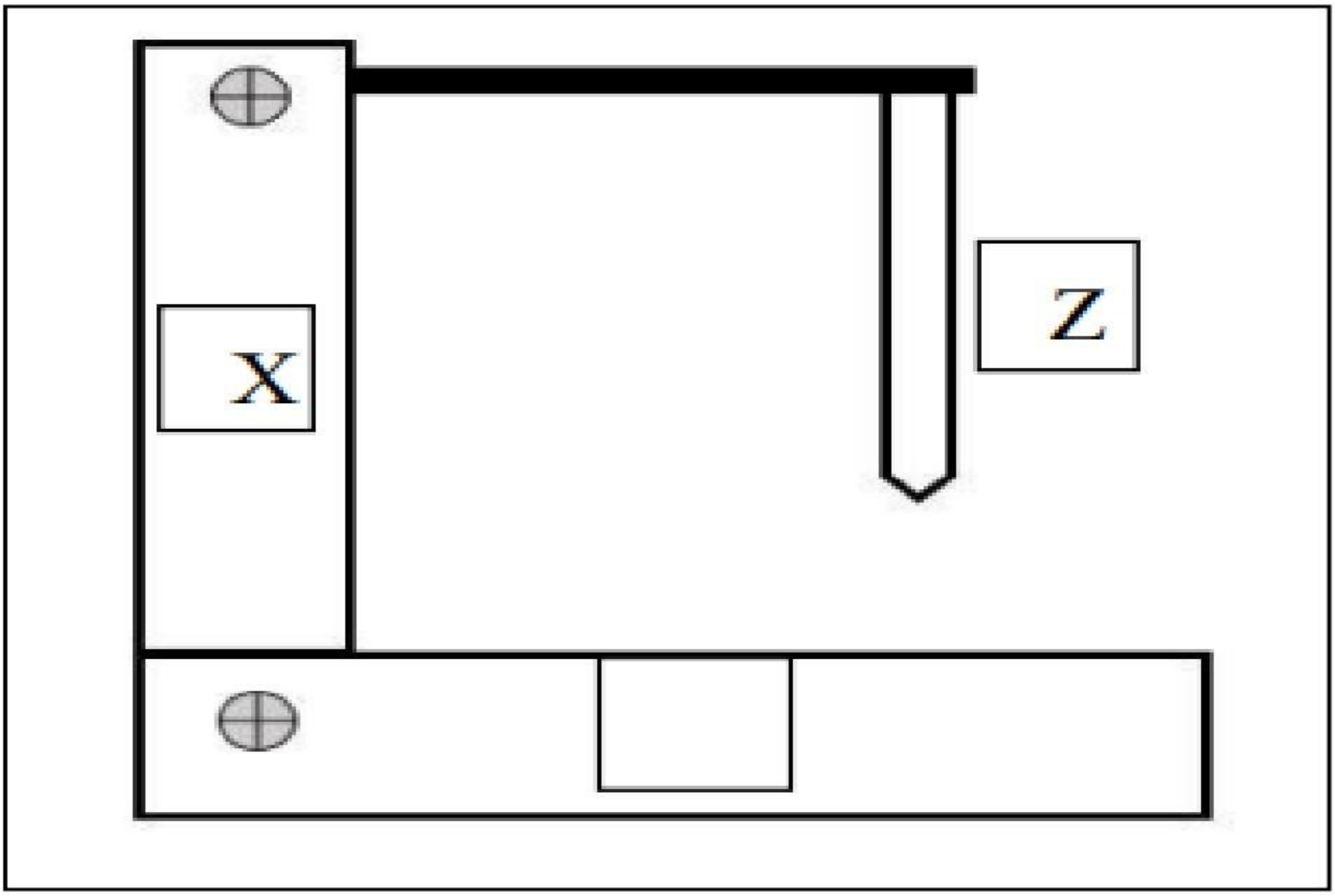
CHAPTER NO. 05

METHODOLOGY:

We have supply the current in Arduino with USB DATA cable to transfer Data from Computer to Arduino Board , Here we have used 3 Stepper Drivers to supply the G codes in Sequence to the stepper motors. Arduino will be mounted on CNC shield. CNC shield will be distributing the Current in the command of Arduino. CNC shield will be converting the command of G codes in digital pulse by Stepper motor. In X direction Stepper motor will be move left and Right ,Y direction stepper motor will be move in front and back direction, Z direction Stepper motor will be move in Up and down. We have made much difficult design via using this machine. The accuracy of this machines result is very high. So we have used in industry to reduce the cost of design printing and maintain accuracy level. Drafting and Scaling of CNC Plotter machine is very precious.

5.1 DESIGN OF CNC MACHINE:

There are 3 movements of using 3 CD ROMs. The horizontal movement(X) i.e. forward & backward movement is provided by the lower CD Rom. The 2nd CD Rom is mounted between the 2 columns which provide side movements(Y) i.e. left and right hand side movements. The spindle which is mounted on the 3rd CD Rom provides vertical movement (Z) for feed of tool.



PROBLEM DEFINITION:

The available Arduino controlled CNC machines are having only 2 axis movement. The structure is weak and can machine foam only.

5.2 Main parts of CNC plotter:

Mini CNC Plotter Machine is worked on input as a G codes of Design and Converting it via use of Arduino, Stepper Drivers, CNC Shield, Stepper Motor in to a Rotation of Lead screw. We have work on to maintain lowest cost of our project. We have design a simple construction of our project. This is easier way to use stepper motor with lead screw, CNC shield, Stepper drivers, Arduino Board, etc. The Setup of machine is flexible that's why it will be easily transported and Maintenance time is short. The basic diagram of CNC Plotter machine is shown in figure.

5.1 Main parts of CNC plotter

CHAPTER NO.06

COMPONENTS DESCRIPTION:

6.1 ARDUINO UNO:

Arduino will be define as, it is received the command or data from the computer and with the help of USB cable. It is mounted on CNC shield, it will be transfer data from Arduino to CNC shield with using stepper driver. Arduino UNO is a microcontroller board, it contains everything needed to support the microcontroller, simply connect it to a computer with a USB cable and a power source. It controls the position of stepper motor with help of a program. It is open source platform based on easy to use hardware and software. T have digital and analog input/output pins which can interface into various expansion board and other circuits and microcontroller with complementary components that helps in programming and incorporation into other circuits. Current supplied 5 volts with USB cable.

6.1 ARDUINO UNO

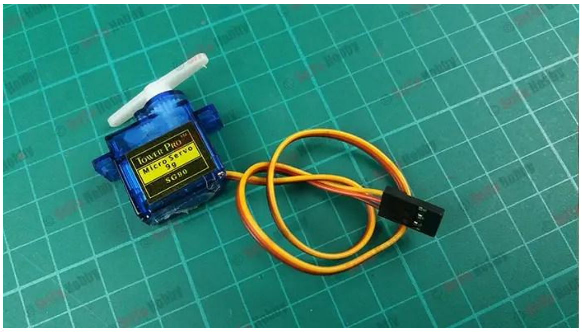
6.2 L293D MOTOR DRIVER:

L293D is a typical motor driver or motor driver LC which allow DC motor to drive on either direction L293D is a 16-pin LC which can control a set of two DC motor simultaneous inn any direction .it means that you can control two DC motor with a single L293D.

6.2 L293D MOTOR DRIVER

6.3 MINI SERVO MOTOR:

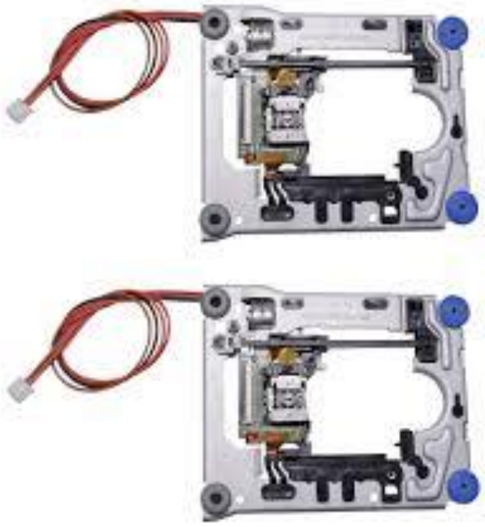
A servo motor is an entirely different story the function of the servo is to receive a control signal that represents a desired output position of the servo shift and apply power to its Dc motor until its shaft turns to that position.



6.3 MINI SERVO MOTOR

6.4 STEPPER MOTOR:

Stepper can be converted digital pulse in to a movement of pen with respect to axis X, Y, Z direction. A stepper motor is a brushless motor that divides a full rotation into a number of equal steps, the stepper motor is known by its property to convert a number of impulses into a defined increment in the shaft position. Each pulses move the shaft through a fixed angle. We have used 3 stepper motors with lead screw. Motor output will be in the form of rotation of lead screw.



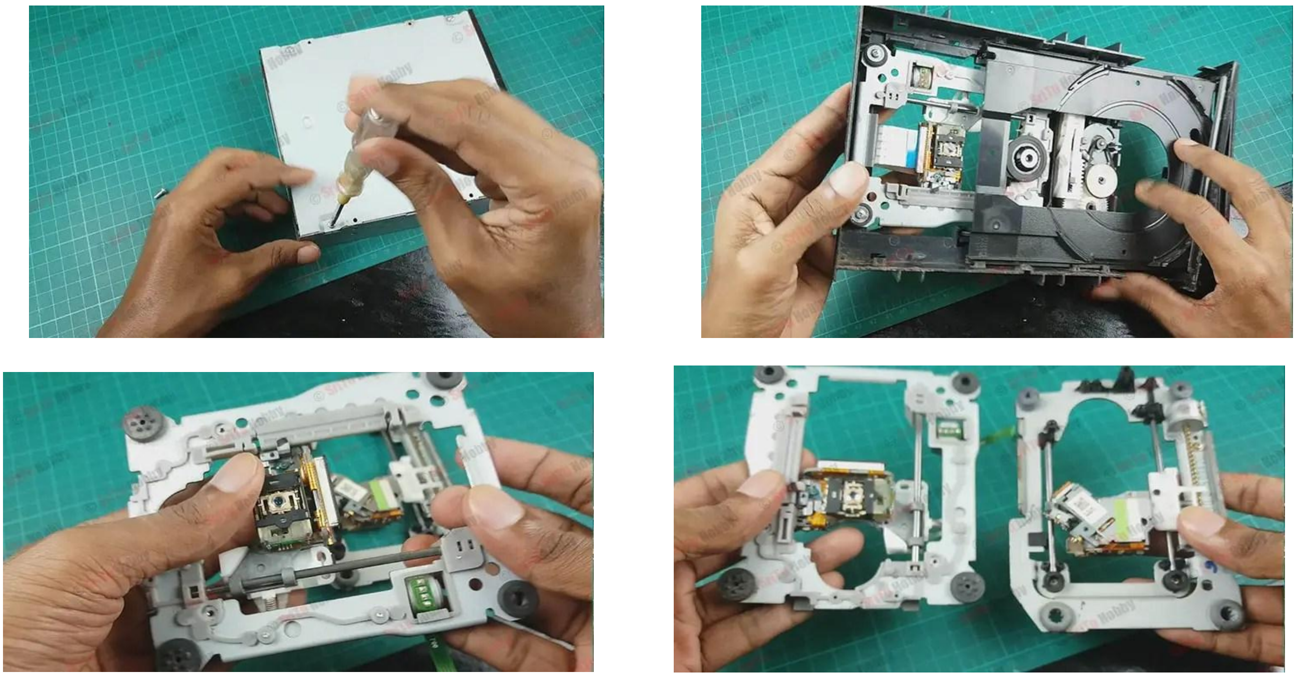
6.4 STEPPER MOTOR

CHAPTER NO. 07

7.PROJECT PLANNING:

Step 1: Disassembly DVD/CD Drives.

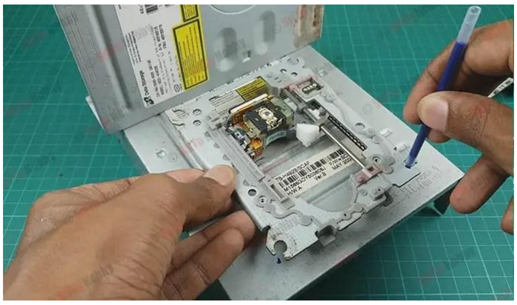
First step to start building this CNC machine is to disassemble two DVD/CD drives and take off them the stepper motors. Use the screwdriver to open them and take off them the rails. Next step is to choose our base for this CNC machine. I used one surface from remaining DVD garbage' stuff. Finally we will need to find something to attach the one of the stepper-rails vertically to our construction. (you will understand what I mean in our next step) Watch the above image.



7.1 Step 1

Step 2: X and Y axis.

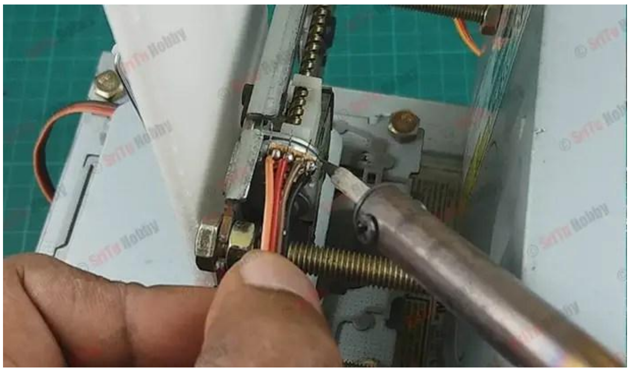
Attach it on your surface, in this part you will need some screws and nuts in second image you will see the X and Y axis. The X axis is attached to two plastic parts that I took from remaining 'garbage' stuff. I cut it to fit the construction. This is an easy procedure. Just make sure to put the Y axis straight to CNC base and the X axis vertically in this (90 degrees)



7.2 Step 2

STEP 3:

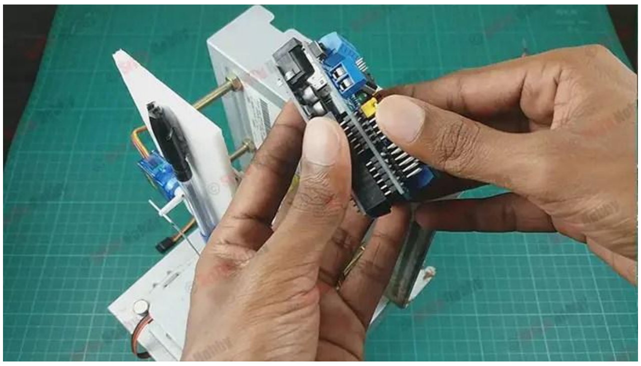
Soldering the stepper motors

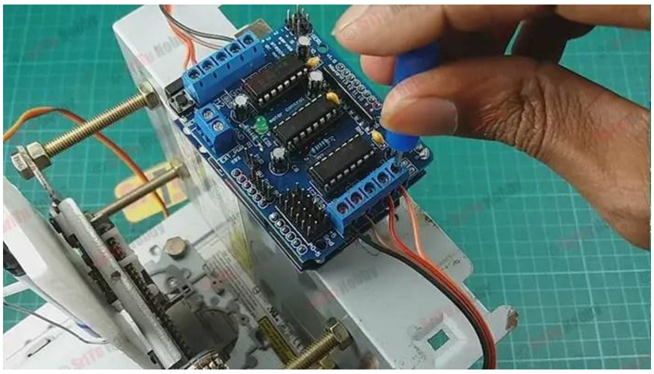


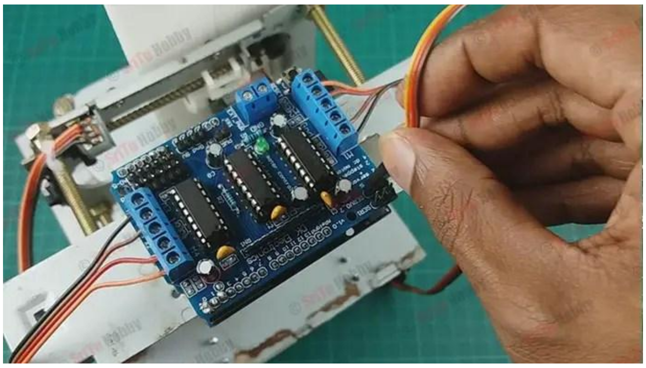
7.3 Step 3

Step 4:

Assembling L239D stepper driver and connecting it to stepper motors.







7.4 Step 4

Step 5:

Adjusting the pen and its position using servomotor.

CHAPTER NO. 08

8.0 ARDUINO AND GCTRL PROGRAMS:

8.1 Arduino (CNC) Program:

Now, connect this project to the computer and upload the Arduino program. It is as follows:

```
#include <Servo.h>
 #include <AFMotor.h>
#define LINE_BUFFER_LENGTH 512
  char STEP = MICROSTEP ;
 // Servo position for Up and Down
 const int penZUp = 115;
 const int penZDown = 83;
 // Servo on PWM pin 10
 const int penServoPin =10 ;
 // Should be right for DVD steppers, but is not too important here
 const int stepsPerRevolution = 48;
 // create servo object to control a servo
 Servo penServo;
// Initialize steppers for X- and Y-axis using this Arduino pins for the L293D H-bridge
 AF_Stepper myStepperY(stepsPerRevolution,1);
 AF_Stepper myStepperX(stepsPerRevolution,2);
/* Structures, global variables    */
 struct point {
   float x;
   float y;
   float z;
 };
truct point actuatorPos;
float StepInc = 1;
 int StepDelay = 0;
 int LineDelay =0;
```

```
int penDelay = 50;

// Motor steps to go 1 millimeter.
// Use test sketch to go 100 steps. Measure the length of line.
float StepsPerMillimeterX = 100.0;
float StepsPerMillimeterY = 100.0;

// Drawing robot limits, in mm
// OK to start with. Could go up to 50 mm if calibrated well.
float Xmin = 0;
float Xmax = 40;
float Ymin = 0;
float Ymax = 40;
float Zmin = 0;
float Zmax = 1;
float Xpos = Xmin;
float Ypos = Ymin;
float Zpos = Zmax;

// Set to true to get debug output.
boolean verbose = false;

void setup() {
  Serial.begin( 9600 );

  penServo.attach(penServoPin);
  penServo.write(penZUp);
  delay(100);
  myStepperX.setSpeed(600);
  myStepperY.setSpeed(600);

  //  Notifications!!!
  Serial.println("Mini CNC Plotter alive and kicking!");
  Serial.print("X range is from ");
  Serial.print(Xmin);
  Serial.print(" to ");
  Serial.print(Xmax);
  Serial.println(" mm.");
  Serial.print("Y range is from ");
```

```
  Serial.print(Ymin);
  Serial.print(" to ");
  Serial.print(Ymax);
  Serial.println(" mm.");
}

/**********************
 * void loop() - Main loop
 ***********************/
void loop()
{

  delay(100);
  char line[ LINE_BUFFER_LENGTH ];
  char c;
  int lineIndex;
  bool lineIsComment, lineSemiColon;

  lineIndex = 0;
  lineSemiColon = false;
  lineIsComment = false;

  while (1) {

    // Serial reception - Mostly from Grbl, added semicolon support
    while ( Serial.available()>0 ) {
      c = Serial.read();
      if (( c == '\n') || (c == '\r') ) {             // End of line reached
        if ( lineIndex > 0 ) {                        // Line is complete. Then execute!
          line[ lineIndex ] = '\0';                   // Terminate string
          if (verbose) {
            Serial.print( "Received : ");
            Serial.println( line );
          }
          processIncomingLine( line, lineIndex );
          lineIndex = 0;
        }
        else {
          // Empty or comment line. Skip block.
```

```
        }
        lineIsComment = false;
        lineSemiColon = false;
        Serial.println("ok");
      }
      else {
        if ( (lineIsComment) || (lineSemiColon) ) {   // Throw away all comment characters
          if ( c == ')' )  lineIsComment = false;     // End of comment. Resume line.
        }
        else {
          if ( c <= ' ' ) {                           // Throw away whitepace and control characters
          }
          else if ( c == '/' ) {                    // Block delete not supported. Ignore character.
          }
            else if ( c == '(' ) {                    // Enable comments flag and ignore all characters                until ')'
       or EOL.
            lineIsComment = true;
          }
          else if ( c == ';' ) {
            lineSemiColon = true;
          }
          else if ( lineIndex >= LINE_BUFFER_LENGTH-1 ) {
            Serial.println( "ERROR - lineBuffer overflow" );
            lineIsComment = false;
            lineSemiColon = false;
          }
          else if ( c >= 'a' && c <= 'z' ) {        // Upcase lowercase
            line[ lineIndex++ ] = c-'a'+'A';
          }
          else {
            line[ lineIndex++ ] = c;
          }
        }
      }
    }
  }
}

void processIncomingLine( char* line, int charNB ) {
```

```
  int currentIndex = 0;
  char buffer[ 64 ];                          // Hope that 64 is enough for 1 parameter
  struct point newPos;

  newPos.x = 0.0;
 newPos.y = 0.0;

  while( currentIndex < charNB ) {
    switch ( line[ currentIndex++ ] ) {              // Select command, if any
    case 'U':
      penUp();
      break;
    case 'D':
      penDown();
      break;
    case 'G':
      buffer[0] = line[ currentIndex++ ];          // /!\ Dirty - Only works with 2 digit commands
      //      buffer[1] = line[ currentIndex++ ];
      //      buffer[2] = '\0';
      buffer[1] = '\0';

      switch ( atoi( buffer ) ){                   // Select G command
      case 0:                                  // G00 & G01 - Movement or fast movement. Same here
      case 1:
        // /!\ Dirty - Suppose that X is before Y
        char* indexX = strchr( line+currentIndex, 'X' );  // Get X/Y position in the string (if any)
        char* indexY = strchr( line+currentIndex, 'Y' );
        if ( indexY <= 0 ) {
          newPos.x = atof( indexX + 1);
          newPos.y = actuatorPos.y;
        }
        else if ( indexX <= 0 ) {
          newPos.y = atof( indexY + 1);
          newPos.x = actuatorPos.x;
        }
        else {
          newPos.y = atof( indexY + 1);
          indexY = '\0';
          newPos.x = atof( indexX + 1);
```

```
        }
        drawLine(newPos.x, newPos.y );
        //        Serial.println("ok");
        actuatorPos.x = newPos.x;
        actuatorPos.y = newPos.y;
        break;
      }
      break;
    case 'M':
      buffer[0] = line[ currentIndex++ ];        // /!\ Dirty - Only works with 3 digit commands
      buffer[1] = line[ currentIndex++ ];
      buffer[2] = line[ currentIndex++ ];
      buffer[3] = '\0';
      switch ( atoi( buffer ) ){
      case 300:
        {
          char* indexS = strchr( line+currentIndex, 'S' );
          float Spos = atof( indexS + 1);
          //        Serial.println("ok");
          if (Spos == 30) {
            penDown();
          }
          if (Spos == 50) {
            penUp();
          }
          break;
        }
      case 114:                                // M114 - Repport position
        Serial.print( "Absolute position : X = " );
        Serial.print( actuatorPos.x );
        Serial.print( "  -  Y = " );
        Serial.println( actuatorPos.y );
        break;
      default:
        Serial.print( "Command not recognized : M");
        Serial.println( buffer );
      }
    }
  }
```

```
}
```

```
void drawLine(float x1, float y1) {

  if (verbose)
  {
    Serial.print("fx1, fy1: ");
    Serial.print(x1);
    Serial.print(",");
    Serial.print(y1);
    Serial.println("");
  }

  //  Bring instructions within limits
  if (x1 >= Xmax) {
    x1 = Xmax;
  }
  if (x1 <= Xmin) {
    x1 = Xmin;
  }
  if (y1 >= Ymax) {
    y1 = Ymax;
  }
  if (y1 <= Ymin) {
    y1 = Ymin;
  }

  if (verbose)
  {
    Serial.print("Xpos, Ypos: ");
    Serial.print(Xpos);
    Serial.print(",");
    Serial.print(Ypos);
    Serial.println("");
  }

  if (verbose)
  {
    Serial.print("x1, y1: ");
```

```
  Serial.print(x1);
  Serial.print(",");
  Serial.print(y1);
  Serial.println("");
}

//  Convert coordinates to steps
x1 = (int)(x1*StepsPerMillimeterX);
y1 = (int)(y1*StepsPerMillimeterY);
float x0 = Xpos;
float y0 = Ypos;

//  Let's find out the change for the coordinates
long dx = abs(x1-x0);
long dy = abs(y1-y0);
int sx = x0<x1 ? StepInc : -StepInc;
int sy = y0<y1 ? StepInc : -StepInc;

long i;
long over = 0;

if (dx > dy) {
  for (i=0; i<dx; ++i) {
    myStepperX.onestep(sx,STEP);
    over+=dy;
    if (over>=dx) {
      over-=dx;
      myStepperY.onestep(sy,STEP);
    }
  delay(StepDelay);
  }
}
else {
  for (i=0; i<dy; ++i) {
    myStepperY.onestep(sy,STEP);
    over+=dx;
    if (over>=dy) {
      over-=dy;
      myStepperX.onestep(sx,STEP);
```

```
      }
      delay(StepDelay);
    }
  }

  if (verbose)
  {
    Serial.print("dx, dy:");
    Serial.print(dx);
    Serial.print(",");
    Serial.print(dy);
    Serial.println("");
  }

  if (verbose)
  {
    Serial.print("Going to (");
    Serial.print(x0);
    Serial.print(",");
    Serial.print(y0);
    Serial.println(")");
  }

  //  Delay before any next lines are submitted
  delay(LineDelay);
  //  Update the positions
  Xpos = x1;
  Ypos = y1;
}

//  Raises pen
void penUp() {
  penServo.write(penZUp);
  delay(penDelay);
  Zpos=Zmax;
  digitalWrite(15, LOW);
    digitalWrite(16, HIGH);
  if (verbose) {
    Serial.println("Pen up!");
```

```
  }
}
// Lowers pen
void penDown() {
  penServo.write(penZDown);
  delay(penDelay);
  Zpos=Zmin;
  digitalWrite(15, HIGH);
    digitalWrite(16, LOW);
  if (verbose) {
    Serial.println("Pen down.");


  }
}
```

8.2 GCTRL Program:

now let’s run the G-code code file. For that, download and install the Processing IDE.

Processing IDE — Download

Now, open the processing code. It is as follows:

```
import java.awt.event.KeyEvent;
import javax.swing.JOptionPane;
import processing.serial.*;

Serial port = null;

// select and modify the appropriate line for your operating system
// leave as null to use interactive port (press 'p' in the program)
String portname = null;
//String portname = Serial.list()[0]; // Mac OS X
//String portname = "/dev/ttyUSB0"; // Linux
//String portname = "COM6"; // Windows

boolean streaming = false;
float speed = 0.001;
String[] gcode;
```

```
int i = 0;
```

```
void openSerialPort()
{
  if (portname == null) return;
  if (port != null) port.stop();

  port = new Serial(this, portname, 9600);

  port.bufferUntil('\n');
}

void selectSerialPort()
{
  String result = (String) JOptionPane.showInputDialog(frame,
    "Select the serial port that corresponds to your Arduino board.",
    "Select serial port",
    JOptionPane.QUESTION_MESSAGE,
    null,
    Serial.list(),
    0);

  if (result != null) {
    portname = result;
    openSerialPort();
  }
}

void setup()
{
  size(500, 250);
  openSerialPort();
}

void draw()
{
  background(0);
  fill(255);
  int y = 24, dy = 12;
```

```
  text("INSTRUCTIONS", 12, y); y += dy;
  text("p: select serial port", 12, y); y += dy;
  text("1: set speed to 0.001 inches (1 mil) per jog", 12, y); y += dy;
  text("2: set speed to 0.010 inches (10 mil) per jog", 12, y); y += dy;
  text("3: set speed to 0.100 inches (100 mil) per jog", 12, y); y += dy;
  text("arrow keys: jog in x-y plane", 12, y); y += dy;
  text("page up & page down: jog in z axis", 12, y); y += dy;
  text("$: display grbl settings", 12, y); y+= dy;
  text("h: go home", 12, y); y += dy;
  text("0: zero machine (set home to the current location)", 12, y); y += dy;
  text("g: stream a g-code file", 12, y); y += dy;
  text("x: stop streaming g-code (this is NOT immediate)", 12, y); y += dy;
  y = height - dy;
  text("current jog speed: " + speed + " inches per step", 12, y); y -= dy;
  text("current serial port: " + portname, 12, y); y -= dy;
}

void keyPressed()
{
  if (key == '1') speed = 0.001;
  if (key == '2') speed = 0.01;
  if (key == '3') speed = 0.1;

  if (!streaming) {
    if (keyCode == LEFT) port.write("G91\nG20\nG00 X-" + speed + " Y0.000 Z0.000\n");
    if (keyCode == RIGHT) port.write("G91\nG20\nG00 X" + speed + " Y0.000 Z0.000\n");
    if (keyCode == UP) port.write("G91\nG20\nG00 X0.000 Y" + speed + " Z0.000\n");
    if (keyCode == DOWN) port.write("G91\nG20\nG00 X0.000 Y-" + speed + " Z0.000\n");
    if (keyCode == KeyEvent.VK_PAGE_UP) port.write("G91\nG20\nG00 X0.000 Y0.000 Z" + speed +
"\n");
    if (keyCode == KeyEvent.VK_PAGE_DOWN) port.write("G91\nG20\nG00 X0.000 Y0.000 Z-" + speed
+ "\n");
    if (key == 'h') port.write("G90\nG20\nG00 X0.000 Y0.000 Z0.000\n");
    if (key == 'v') port.write("$0=75\n$1=74\n$2=75\n");
    //if (key == 'v') port.write("$0=100\n$1=74\n$2=75\n");
    if (key == 's') port.write("$3=10\n");
    if (key == 'e') port.write("$16=1\n");
    if (key == 'd') port.write("$16=0\n");
    if (key == '0') openSerialPort();
```

```
    if (key == 'p') selectSerialPort();
    if (key == '$') port.write("$$\n");
  }

  If  (!streaming && key == 'g') {
    gcode = null; i = 0;
    File file = null;
    println("Loading file...");
    selectInput("Select a file to process:", "fileSelected", file);
  }

  if (key == 'x') streaming = false;
}

void fileSelected(File selection) {
  if (selection == null) {
    println("Window was closed or the user hit cancel.");
  } else {
    println("User selected " + selection.getAbsolutePath());
    gcode = loadStrings(selection.getAbsolutePath());
    if (gcode == null) return;
    streaming = true;
    stream();
  }
}

void stream()
{
  if (!streaming) return;

  while (true) {
    if (i == gcode.length) {
      streaming = false;
      return;
    }

    if (gcode[i].trim().length() == 0) i++;
    else break;
  }
```

```
    println(gcode[i]);
    port.write(gcode[i] + '\n');
    i++;
  }

  void serialEvent(Serial p)
  {
    String s = p.readStringUntil('\n');
    println(s.trim());

    if (s.trim().startsWith("ok")) stream();
    if (s.trim().startsWith("error")) stream();
```

8.3 G code file:

To make g code files that are compatible with this CNC machine you have to use the Inkscape. Inkscape is professional quality vector graphics software which runs on Windows, Mac OS X and Linux. It is used by design professionals and hobbyists worldwide, for creating a wide variety of graphics such as illustrations, icons, logos, diagrams, maps and web graphics. Inkscape uses the W3C open standard SVG (Scalable Vector Graphics) as its native format, and is free and open-source software. Download and install Inkscape from here (Important: download 0.48.5 version) Now you need to install an Add-on that enables the export images to g code files. This add on can be found here with installation notes.

Setup Inkscape for first use . Open the Inkscape, go to File menu and click "Document Properties". See the 1st image above and make the changes, make sure to change first to "cm". Now close this window. We will use the area within 4 to 8 cm. See the 2nd image above.How to print texts Put text, change font to Times New Roman and size to 22. Now click on cursor icon and center the text like the 3rd image above. Select Path from menu and "Object to Path".

How to print images? This is more difficult than texts. Images must have a transparent background. Drag and drop the arduino logo image (download it from files) in Inkscape. Click ok to the next window. Now you have to re-size the image to fit our printing area, see the 4th image above. Click path from menu and "Trace Bitmap". Make changes as the 5th image above. Click ok and close the window. Now, move the gray scale image, and delete the color one behind it. Move the grey image to the correct place again and click from Path menu "Object to path". The 6th image above show how to delete image outline.

Export as g code. Final, go to file menu, click save as and select g code. Click ok on next window. That's it! Ready to go! Use the gctrl.pde app to print the g code file on your new Arduino CNC Plotter!

CHAPTER NO. 09

Inkscape 0.48.5:

Inkscape is used to design the plotted diagram or text. In this project by using this software G-code file of a selected image or text is created G-code is a commonly used numerical control programming language which includes X, Y, Z coordinates.

9.1 Creating G-Code File Using Inkscape:

The CNC plotter of our project will work within 20cm×20cm area So we choose the document properties of the Inkscape 40cmx40cm (Width × Height) which is four times the working area of the plotter because the plotter can draw only in the first quadrant. So we have initially kept the axes at the nearest end of the motors which is considered as origin to easily modify the design. In fig the working area of CNC plotter is shown with the text written in the pre-defined area. The text is selected using cursor and then select “object to path” from the drop down window to save the G code form of the selected text. To create G-code of an image, the file must have a transparent background. The image should be dragged into the selected area then select “trace bitmap” from drop down window to create a transparent image. Scans are selected as 8 and “Edge detection” is selected to create black & white image. After adding this transparent image in the predefined area we`ve used “object to path command to create the G-code file of the selected image by following the steps described earlier.

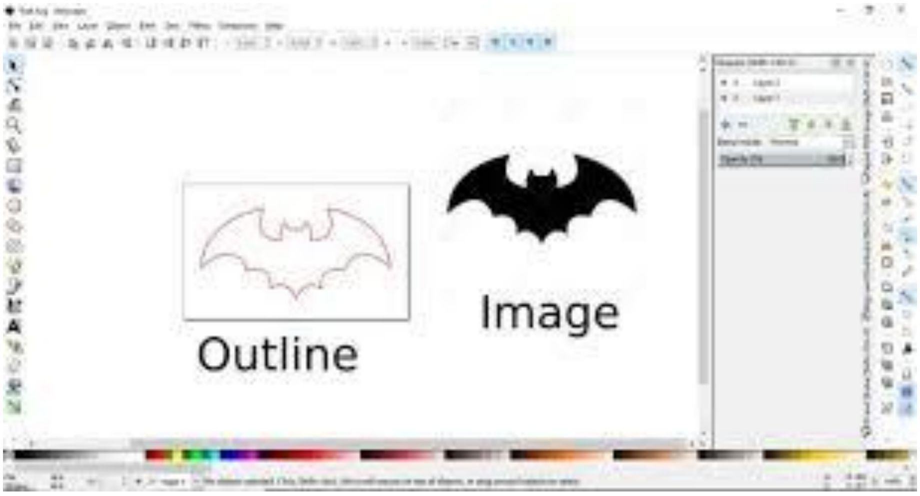


Fig No 9.1 INKSPACE 0.48.5

9.2 Processing:

Processing is open source programming language software which is used for electronic drawings. GTCRL processing program is used to send G-code file from user interface to CNC plotter. The Fig. 6 shows the user interface of processing 2.2.1 software after running GTCRL program. The port of Arduino Uno is selected by pressing „P" button on keyboard hence button is used to upload our desired G-code file. Immediately CNC machine will start sketching selected G-code file. Sketching can be stopped by pressing X button.

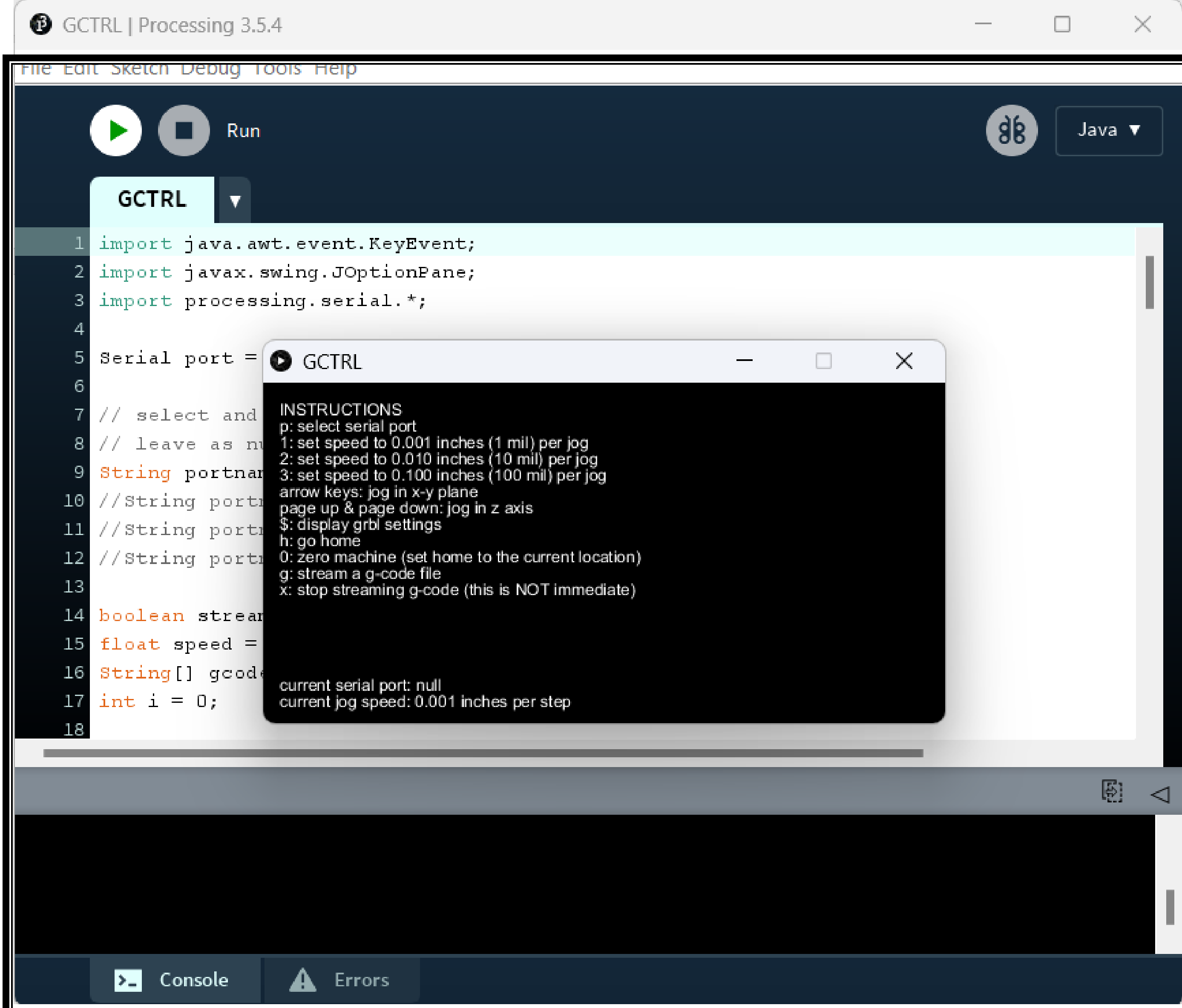


Fig No 9.2 PROCESSING

CHAPTER NO. 10

ANALYSIS AND IMPLEMENTATION:

Analysis and implementation of CNC involves several steps and considerations to ensure successful integration and utilization of CNC technology in the manufacturing environment.

NEEDS ASSESSMENT:

The first step is to assess the needs and requirements of manufacturing process. This involves identifying the specific task and operations that could benefit from CNC technology. considerations include the complexity of parts, desired precision ,production volume ,and cost effectiveness.

FLEXIBILTIY STUDY: This includes analysing the current manufacturing setup, evaluating the potential benefits estimating costs and assessing the impact of productive, quality, and return on investment.

EQUIPEMNT SELECTION: Based on the needs assessment and feasibility study, select the appropriate CNC machine that align with the specific requirements.

TESTING AND OPTIMIZATION: Run a test program to ensure that the machine performs as expected and that the machining operations are excluded accurately.

PRODUCTION: once the CNC system has been_properly setup and optimized , we can start using it for production. Monitor the machine processing ,periodically inspect the quality of the produced parts ,and make any necessary adjustments to maintain accuracy and efficiency.

CHAPTER 11

Advantages, Disadvantages & Application:

11.1 CNC Machine Advantages:

- CNC machines can be used continuously 24×7 throughout the year and only need to be switched off for occasional maintenance.
- CNC machines are programmed with a design which can then be manufactured hundreds or even thousands of times. Each manufactured product will be exactly the
- same.
- Less skilled/trained people can operate CNC machines unlike manual lathes / milling machines etc. which need skilled engineers.
- CNC machines can be updated by improving the software used to drive the
- machines
- Training for correct use of CNC machines is available through the use of ‘virtual software’. This software is like a computer game that allows the operator to practice using the CNC machine on the screen of a computer.

- Modern design software allows the designer to simulate the manufacture of his/her idea. There is no need to make a prototype of a model. This saves time and money.
- One person can supervise many CNC machines as once they are programmed they can usually be left to work by themselves. Only the cutting tools need replacement occasionally.

11.2 CNC Machine Disadvantages:

The machine runs in a slow pace and generates excess heat which causes the heat sink to be heated quickly. A slight error may remain on the image file after it has been plotted due to one side of the Y-axis fixed to the moving mechanism and the other end is free to move. The Z-axis is not very rigid so it causes slight vibration.

11.3 Applications:

CNC machine uses and applications:

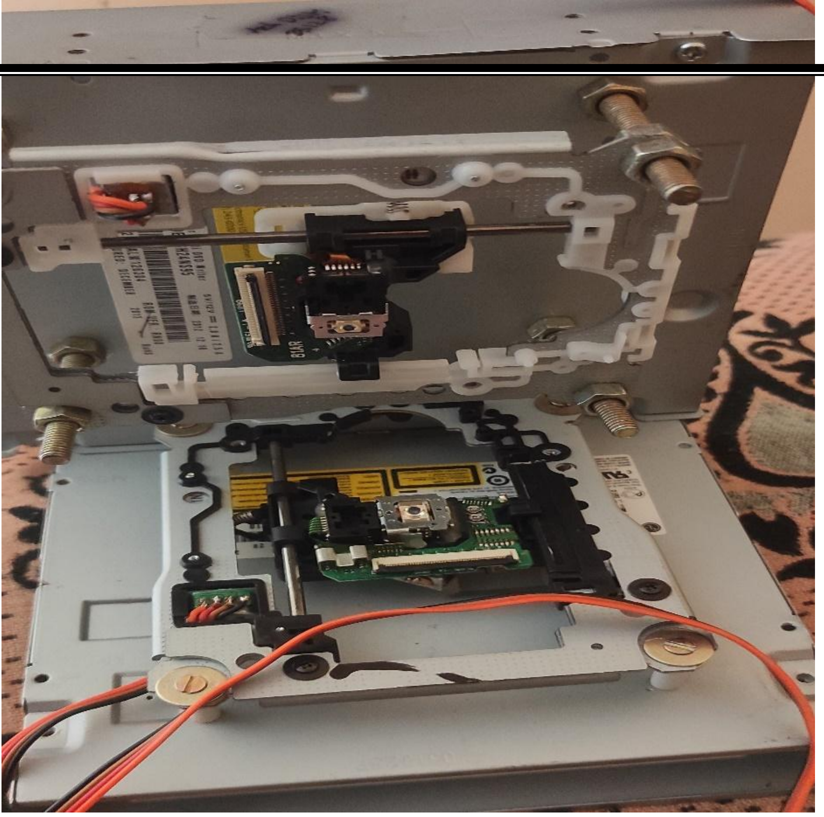
- Signage.
- Cabinets and furniture.
- Aluminum and brass machining.
- Prototyping and 3D modeling.
- Musical instruments.

CHAPTER 12

12.1 RESULTS:

CNC, which stands for Computer Numerical Control, is a manufacturing technology that utilizes computerized systems to control and automate machine tools. CNC machines are commonly used in various industries, including manufacturing, automotive, aerospace, and woodworking, among others. The specific results achieved through CNC operations depend on the type of machine and the desired application.

CNC Machine plotter draws the exact image which is converted into Gcode. Precision is the main and the best part of the CNC plotter and automatic , non – physical work is achieved only by some programming language.



12.1 Final Circuit

12.2 CONCLUSION:

The existing CNC machines are of high cost, difficult to maintain and requires highly skilled operators. Our CNC plotter overcomes these problems. It is of low cost and easy to control and there is no need of highly skilled operators. It can be used for long hours at a stretch which is not possible in existing ones. It is hoped to extend this work for future development.

The pen of the machine can be replaced by a laser to make it work like a laser engraving or cutting machine. Engraving machine can be used on wood. The pen can also be replaced with a powerful drill so that it can be used for both milling and drilling purposes. The servo can be replaced with a stepper motor and the pen with a 3-D pen to make it a 3-D printer which can print objects with dimensions. By extrapolation of the axes, the working area of the machine can be extended keeping the algorithm .

12.3 REFERENCES:

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[5] Nikita R. Saharkar design the CAD Model in Solidworks and Done the FEA analysis in hyper mesh tool providing the appropriate constrains, loads, and moment values. According to the author he got the stress value around 14 Mpa which is less than the allowable stress value of M.S. concluding the design is safe.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY

JNANASANGAMA, BELGAVI – 590018.

REPORT ON MINI PROJECT TITLED

“Li-Fi (LIGHT FIDELITY)”

Submitted in the partial fulfillment for the award of the degree of

BACHELOR OF ENGINEERING

IN

ELECTRICAL AND ELECTRONICS ENGINEERING

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For the Academic year of 2021 – 2022

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

CERTIFICATE

Certified that the MINI PROJECT entitled **"**Li-Fi (LIGHT FIDELITY)**"** is carried out by CHETAN KUMAR,HARSHITH M K,MADHUSUDANA K J,MADHUSUDHAN V**,** bonafide students of **Sapthagiri College of Engineering** in partial fulfilment for the award of **Bachelor of Engineering** in department of **Electrical and Electronics Engineering** of Visvesvaraya Technological University, Belagavi during the academic year **2020-2021**. It is certified that all corrections/suggestions indicated in the Internal Assessment have been incorporated in the report deposited. The mini project report has been approved as it satisfies the academic requirements in respect of mini project prescribed for the Bachelor of Engineering Degree.

Sign. of the Internal Guide	**Signature of the HOD**
Mrs PREETHA N P	**Dr. NARAYANAPPA**
Designation	Professor & H.O.D

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

OBJECTIVES OF MINI PROJECT

This mini project is carried out to meet the following objectives

1. Demonstrate the design and solution of the selected objectives

2. Build the critical thinking and use problem solving skills in societal and environment contexts.

3. Develop on their own,reflect on their learning and take appropriate actions to improve it.

4. Develop team work for conducting the mini project and communicate effectively through reports and presentation.

CONTENTS

1. ABSTRACT

LI-FI (LIGHT FIEDILITY)

Li-Fi stands for Light-Fidelity. The technology is very new and was proposed by the German physicist Harald Haas in 2011.

Li-Fi provides transmission of data through illumination by sending data through an LED light bulb that varies in intensity faster than human eye can follow. In this paper, the authors will discuss the technology in detail and also how Wi-Fi can be replaced by Li-Fi. Wi-Fi is useful for general wireless coverage within buildings while Li-Fi is ideal for high density wireless data coverage in confined areas where there are no obstacles. Li-Fi is a wireless optical networking technology that uses light emitting diodes (LEDs) for transmission of data.

The term Li-Fi refers to visible light communication (VLC) technology that uses as medium to deliver high-speed communication in a manner similar to Wi-Fi. Li-Fi provides better bandwidth, efficiency, availability and security than Wi-Fi and has already achieved high speeds in the lab. In the present paper the authors will give a detailed study on Li-Fi technology, its advantages and its future scope.

2.INTRODUCTION

Professor Harald Haas, the Chair of Mobile Communications at the University of Edinburgh, is recognized as the founder of Li-Fi. He coined the term Li-Fi and is the co-founder of pureLiFi. He gave a demonstration of a Li-Fi prototype at the TED Global conference in Edinburgh on 12th July 2011. He used a table lamp with an LED bulb to transmit a video of a blooming flower that was then projected onto a screen. During the talk, he periodically blocked the light from the lamp with his hand to show that the lamp was indeed the source of the video data.

Li-Fi can be regarded as light-based Wi-Fi, i.e. instead of radio waves it uses light to transmit data. In place of Wi-Fi modems, Li-Fi would use transceivers fitted with LED lamps that could light a room as well as transmit and receive information. It makes use of the visible portion of the electromagnetic spectrum which is underutilized. Li-Fi can be considered better than Wi-Fi because there are some limitations in Wi-Fi. Wi-Fi uses 2.4 – 5 GHz radio frequencies to deliver wireless internet access and its bandwidth is limited to 50-100 Mbps. With the increase in the number of Wi-Fi hotspots and volume of Wi-Fi traffic, the reliability of signals is bound to suffer. Security and speed are also important concerns. Wi-Fi communication is vulnerable to hackers as it penetrates easily through walls. In his TED talk, Professor Haas highlighted the following key problems of Wi-Fi that need to be overcome in the near future:

a) Capacity: The radio waves used by Wi-Fi to transmit data are limited as well as expensive. With the development of 3G and 4G technologies, the amount of available spectrum is running out.

b) Efficiency: There are 1.4 million cellular radio masts worldwide. These masts consume massive amounts of energy, most of which is used for cooling the station rather than transmission of radio waves. In fact, the efficiency of such stations is only 5%.

c) Availability: Radio waves cannot be used in all environments, particularly in airplanes, chemical and power plants and in hospitals.

Li-Fi addresses the aforementioned issues with Wi-Fi as follows:

a) Capacity: The visible light spectrum is 10,000 times wider than the spectrum of radio waves. Additionally, the light sources are already installed. Hence Li-Fi has greater bandwidth and equipment which is already available.

b) Efficiency: LED lights consume less energy and are highly efficient.

c) Availability: Light sources are present in all corners of the world. Hence, availability is not an issue. The billions of light bulbs worldwide need only be replaced by LEDs.

Table-1: Advantages of Li-Fi

Light	LEDs produce more light per watt than do incandescent bulbs
ON-OFF Time	LEDs can light up very quickly
Toxicity	Unlike fluorescent lamps, LEDs do not contain mercury
Free Band	Li-Fi makes use of a free band that does not need any licensing
High Speeds	It offers theoretical speeds in the order of Gigabits per second
Airlines	Li-Fi can be used safely in aircrafts without affecting airline signals unlike Wi-Fi
Healthcare	It can be integrated into medical devices and in hospitals as no radio waves are involved
Underwater	Wi-Fi does not work underwater but Li-Fi does and hence can be used for undersea explorations
Traffic Control	Li-Fi can be used on highways for traffic control applications. Cars can have LED based headlights and LED based backlights that can communicate with those of other cars and prevent traffic accidents
Street Lamps	Every street lamp can be converted into a free data access point
Spectrum Relief	The issues of the shortage of radio frequency bandwidth can be sorted out by Li-Fi

Frank Deicke, who leads Li-Fi development at Fraunhofer Institute for Photonic Microsystems in Dresden, Germany, has said that Li-Fi can achieve the same data rates as USB cables which is challenging for wireless technologies such as Bluetooth and Wi-Fi. He also cites another advantage of Li-Fi being that the latency of Li-Fi is in the order of microseconds where as that of Wi-Fi is in the order of milliseconds.

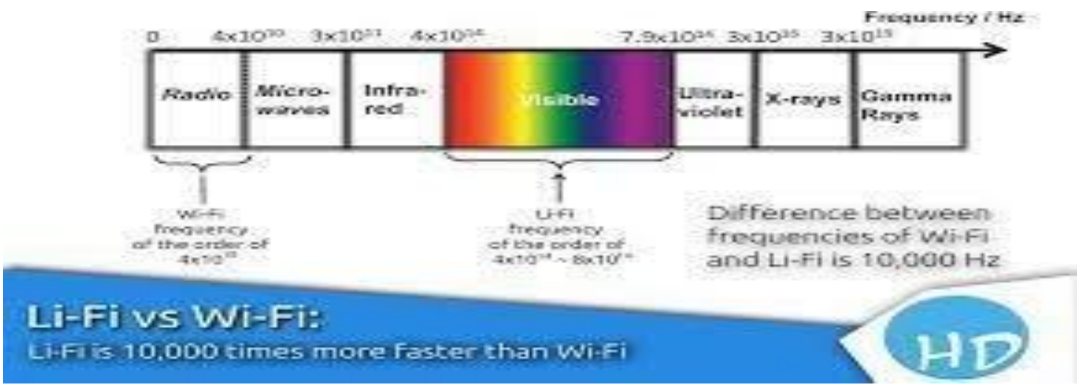


Fig-1: Li-Fi and Wi-Fi Spectrum Usage

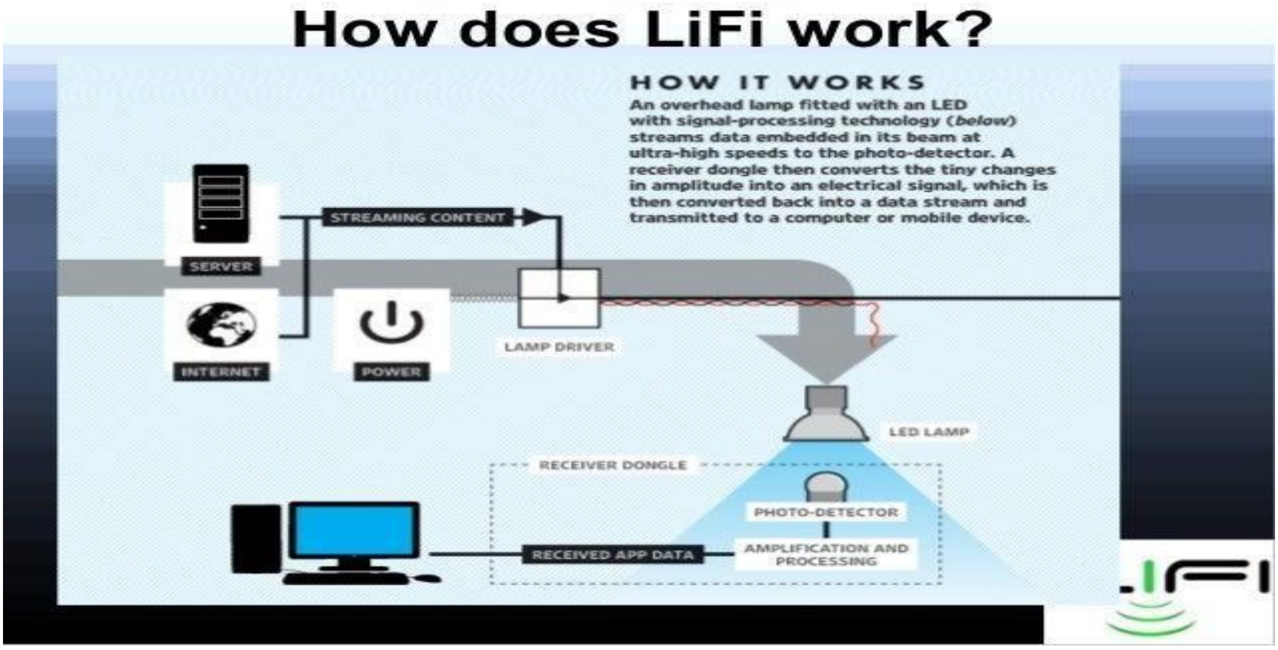
Table-2: Comparison between Li-Fi and Wi-Fi

Parameter	**LI-FI**	**WI-FI**
Speed	High	High
Spectrum	10,000 times broader than that of WI-FI	Narrow spectrum
Data density	High	Low
Security	High security due to non-penetration of light through walls	Less secure due to transparency
Reliability	Medium	Medium
Bandwidth	High due to broad spectrum	Low
Transmit/receive power	High	Medium
Ecological impact	Low	Medium
Device-to-device connectivity	High	High
Obstacle interference	High	Low
Bill of materials	High	Medium
Market maturity	Low	High
Latency	In the order of microseconds	In the order of milliseconds

3. WORKING OF LI-FI

General Working Principle

Light emitting diodes (LEDs) can be switched on and off faster than the human eye can detect since the operating speed of LEDs is less than 1 μs, thereby causing the light source to appear to be continuously on. This invisible on-off activity enables data transmission using binary codes. Switching on an LED is binary ‘1’, switching it off is binary ‘0’. It is possible to encode data in light by varying the rate at which LEDs flicker on and off to give different strings of 1s and 0s. Modulation is so rapid that humans cannot notice it. A light sensitive device (photo detector) then receives the signal and converts it back into original data.



Usage Models

Within a local Li-Fi cloud, several data based services are supported through a heterogeneous communication system. Initially, the Li-Fi Consortium defined different types of technologies to offer secure, reliable and ultra-high-speed wireless communication interfaces. These included giga-speed technologies, optical mobility technologies and navigation, precision location and gesture recognition technologies. For giga-speed technologies, the Li-Fi Consortium defined Giga Dock, Giga Beam, Giga Shower, Giga Spot and Giga MIMO models to tackle different user scenarios for wireless indoor and indoor-like transfers of data. Giga Dock is a wireless docking solution that includes wireless charging for smart phones tablets or notebooks, with speeds up to 10 Gbps. Meanwhile, the Giga Beam model is a point-to-point data link for kiosk applications or portable-to-portable data exchanges. Thus a two-hour full HDTV movie (5 GB) can be transferred from one device to another within four seconds.

Giga Shower, Giga Spot and Giga-MIMO are the other in-house communication models. On one side, a transmitter or receiver is mounted into the ceiling connected to, say, a media server. On the other side are portable or fixed devices on a desk in an office, in an operating room, in a production hall or at an airport. Giga Shower provides unidirectional data services via many channels to multiple users with gigabit-class communication speed over several meters. This is like watching TV channels or listening to different radio stations where no uplink channel is needed. In case Giga Shower is used to sell books, music or movies, the connected media server can be accessed via Wi-Fi to process payment via a mobile device. Giga Spot and GigaMIMO are optical wireless single- and multi-channel Hot Spot solutions offering bidirectional gigabit-class communication in a room, hall or shopping mall for example.

Implementation of Li-Fi:

The main components of a simple system based on Li-Fi are:

i) High brightness LED which acts as the communication source

ii) Silicon photodiode which serves as the receiving element

Data from the sender is converted into an intermediate data representation i.e. byte format and then converted into light signals which are emitted by the transmitter. The light signal is received by the photodiode at the receiver side. The reverse process takes place at the destination computer to retrieve the data back from the received light.

LEDs are employed as the light sources. The model transmits digital signal by means of direct modulation of the light. The emitted light is detected by an optical receiver.

Transmitter Module◊Data Conversion Module◊Source Computer: Data Reading Module Data Display (GUI)◊ Data Interpretation Module ◊Destination Computer: Receiver Module

The different components serve the following functions:

Data Conversion Module – converts data into bytes so that it can be represented as a digital signal. It can also encrypt the data before conversion.
Transmitter Module – generates the corresponding on-off pattern for the LEDs.

Receiver Module – has a photo diode to detect the on and off states of the LEDs. It captures this sequence and generates the binary sequence of the received signal

Data Interpretation Module – converts data into the original format. If encryption was done, it also performs decryption.

Fig: Overview of Li-Fi

4.APPLICATIONS OF LI-FI

Li-Fi technology can find application in a wide variety of fields. A detailed discussion of its various applications is given below.

(i) Medical and Healthcare

Due to concerns over radiation, operating rooms do not allow Wi-Fi and even though Wi-Fi is in place in several hospitals, interferences from computers and cell phones can block signals from medical and monitoring equipment. Li-Fi solves these problems. Lights are an essential part of operating rooms and Li-Fi can thus be used for modern medical instruments. Moreover, no electromagnetic interference is emitted by Li-Fi and thus it does not interfere with any medical instruments such as MRI scanners.

(ii) Airlines and Aviation

Wi-Fi is often prohibited in aircrafts. However, since aircrafts already contain multiple lights, thus Li-Fi can be used for data transmission.

(iii) Power Plants and Hazardous Environments

Wi-Fi is not suitable for sensitive areas like power plants. However, power plants still require fast and interconnected data systems for monitoring grid intensity, demand, temperature etc. In place of Wi-Fi, Li-Fi can provide safe connectivity throughout the power plant. Li-Fi offers a safe alternative to electromagnetic interference due to radio waves in environments such as petrochemical plants and mines.

(iv) Underwater Explorations and Communications

Remotely operated underwater vehicles or ROVs work well except in situations when the tether is not long enough to fully explore an underwater area or when they get stuck. If instead of the wires, light were used then the ROVs would be freer to explore. With Li-Fi, the headlamps could also then be used to communicate with each other, data processing and reporting findings back to the surface at regular intervals, while also receiving the next batch of instructions. Radio waves cannot be used in water due to strong signal absorption. Acoustic waves have low bandwidth and disrupt marine life. Li-Fi offers a solution for conducting short-range underwater communications.

(v) Traffic

Li-Fi can be used for communications between the LED lights of cars to reduce and prevent traffic accidents. LED headlights and tail-lights are being implemented for different cars. Traffic signals, signs and street lamps are all also transitioning to LED. With these LED lights in place, Li-Fi can be used for effective vehicle-to-vehicle as well as vehicle-to-signal communications. This would of course lead to increased traffic management and safety.

(vi) GigaSpeed Technology

The Li-Fi Consortium provides the fastest wireless data transfer technology presently available. Our current solutions offer effective transmission rates of up to 10 Gbps, allowing a 2 hour HDTV film to be transferred in less than 30 seconds. This can be extended to several 100 Gbps in future versions.

(vii) Smart Lighting

Street lamps can in the future be used to provide Li-Fi hotspots and can also be used to control and monitor lighting and data.

5. SOME LIMITATIONS OF LI-FI

Despite its many advantages, Li-Fi like any other technology also comes with a number of limitations and disadvantages.
These are enumerated below:

1) The main problem is that light cannot pass through objects, so if the receiver is inadvertently blocked in any way, then the signal will immediately be cut out. If the light signal is blocked one could switch back over to radio waves.

2) Reliability and network coverage are the major issues to be considered by the companies while providing VLC services. Interference from external light sources like sunlight, normal bulbs; and opaque materials in the path of transmission will cause interruption in the communication.

3) High installation cost of the systems can be complemented by large-scale implementation of VLC though adopting this technology will reduce further operating costs like electricity charges, maintenance charges etc.

4) We still need Wi-Fi and we still need radio frequency cellular systems. You can’t have a light bulb that provides data to a high-speed moving object or to provide data in a remote area where there are trees, walls and obstacles.

6. CONCLUSION AND FUTURE SCOPE OF LI-FI

Li-Fi is still in its incipient stages and thus offers tremendous scope for future research and innovation. The following is a brief overview of some of the research work being conducted in the field and the future scope for this technology. Researchers are developing micron sized LEDs which flicker on and off 1000 times faster than larger LEDs. They provide faster data transfer and also take up less space. Moreover, 1000 micron sized LEDs can fit into area required by 1 sq. mm large single LED. A 1 sq. mm sized array of micron sized LEDs could hence communicate 1000×1000 (i.e. a million) times as much information as a single 1mm LED. The Li-Fi Consortium asserts that it is possible to achieve speeds greater than 10Gbps. Researchers at the Heinrich Hertz Institute in Berlin, Germany, have achieved data rates of over 500 megabytes per second using a standard white-light LED.

Currently, the University of Edinburgh is immersed in researching Li-Fi to solve many of the problems we have highlighted in this paper. The university has achieved 10 Gbps speed and also demonstrated that line of sight may not be a necessity for LiFi transmission. Research is underway on wireless system concepts based on Li-Fi. The university website lists the following projects currently in progress:

1) Optical Multiuser MIMO – It involves exploiting the facts that LEDs offer very directional beams and that intensity modulation (IM) does not suffer from multipath fading. The aim here is to develop new algorithms for multiuser, networked Li-Fi systems.

2) Interference Management in Cellular Li-Fi Networks – It is directed towards developing interference cancellation techniques specific to Li-Fi. The project also studies cell cooperation and interference avoidance techniques.

3) The Internet of Things – This is based on the fact that due to the inexpensive nature of photodetectors and LEDs, it is possible to develop small and low-complex transceiver units that allow any LED light to act as a high speed data transmitter.

4) Li-Fi Spatial Modulation – This is a new digital modulation and MIMO technique which allows for highly energyefficient transmitters since it only needs a single transmitter chain. The project looks into how spatial modulation could be used to support dimming of light in Li-Fi systems and the impact of lenses and polarizers on the performance of optical spatial modulation.

5) Novel Digital Modulation Techniques for Li-Fi – The digital modulation techniques are constrained by the fact that signals must be real valued and positive since Li-Fi uses direct detection and intensity modulation. These constraints cause losses in spectrum and power efficiency. This project attempts to overcome these limitations by developing new Li-Fi modulation techniques such as Orthogonal Frequency Division Multiplexing (OFDM), Carrier-less Amplitude Modulation (CAP) and Pulse-Amplitude Modulation.

6) Self-Powered Li-Fi – This project looks at energy harvesting concepts along with energy-efficient transceiver technologies for Li-Fi systems and requires algorithms of low computational complexity as well as energy efficient techniques for digital modulation. New circuit designs and new synchronization and MAC techniques fall within the scope of this project.

Further research in the field can look into the following issues:

1) Driving illumination grade LEDs at high speed.
2) Increasing data rate with parallelism/arrays.
3) Achieving low complexity/low cost modulation.
4) Overcoming the line of sight constraint.
5) Achieving seamless interoperability with other networks.
6) Making Li-Fi work in environments with little or no light.

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VISVESVARAYA TECHNOLOGICAL UNIVERSITY

JNANASANGAMA, BELGAVI – 590018.

REPORT ON MINI PROJECT TITLED

"ROBOTIC ARM"

Submitted in the partial fulfilment for the award of the degree of

BACHELOR OF ENGINEERING

IN

ELECTRICAL AND ELECTRONICS ENGINEERING

Submitted by

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Under the supervision of

Assistant Prof.SWETHA

Designation, Dept. of EEE

For the Academic year of 2022 – 2023

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CERTIFICATE

Certified that the mini project entitled **"ROBOTIC ARM"** is carried out by **HEMANTH S(1SG20EE012), NITEESH SS(1SG20EE021), SUMANTH Y(1SG20EE032), SUJAY R (1SG20EE031)** bonafide student of **Sapthagiri College of Engineering** in partial fulfilment for the award of **Bachelor of Engineering** in department of **Electrical and Electronics Engineering** of Visvesvaraya Technological University, Belagavi during the academic year **2022-2023**. It is certified that all corrections/suggestions indicated in the Internal Assessment have been incorporated in the report deposited. The mini project report has been approved as it satisfies the academic requirements in respect of mini project prescribed for the Bachelor of Engineering Degree.

Signature of the Internal Guide	Signature of the HOD	Signature of the Principal
Assistant Prof .SWETHA	**Dr. REKHA S N**	**Dr. H. RAMAKRISHNA**
	Professor & H.O.D	Principal

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Finally, I would like to express my sincere thanks to all the staff members of Department of Electrical and Electronics Engineering, Sapthagiri College of Engineering for their valuable guidance and support.

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CONTENTS

Introduction

Now a Days, Robotic arms had been mostly used for industry automation and operation in the hazardous environment. Many robotic controls are very expensive, due to high-precision actuators and custom machining of components. We recommend that robotic control research can advance more rapidly if robotic arms of valuable performance were highly reduced in price. Increased affordability can lead to wider acceptance, which in turn can lead to faster progress. However, drastic cost reduction will require design trade-offs and compromises.

There are number of dimensions on which robotic arms can be evaluated, such as backlash, payload, speed, repeatability, compliance, human safety, and cost. In robotics research, some of these dimensions are more important than others: for grasping and object manipulation, high repeatability and low backlash are important. Human-safety is difficult if the manipulator is to be used in close to the people. Arduino UNO A000066 is used as the brain of the robotic arm, force sensors are placed at the gripper for finding the force applied on the object, and potentiometers are used at the joints for detecting the position of the motor shaft. We used the exact model of the developed robotic arm built using Aluminium due to its characteristics such as light weight, do not wear out easily, cheaper and machining is easier.

Literature Survey

In this paper a 5 Degree of Freedom (DOF) robotic arm have been developed. It is controlled by an Arduino Uno microcontroller which accepts input signals from a user by means of a set of potentiometers. The arm is made from four rotary joints addend effector also, where rotary motion is provided by a servomotor. Each link has been first designed using Solid Works Sheet Metal Working Toolbox and then fabricated using a 2mm thick Aluminium sheet. The servomotors and links thus produced assembled with fasteners produced the final shape of the arm. The Arduino has been programmed to provide rotation to each servo motor corresponding to the amount of rotation of the potentiometer shaft. A robot can be defined according to the nature of the relative movements between the links that constitute.

- Review on development of industrial robotic arm, this selective operation robotic control method is need to be overcome the problem such as placing or picking object that at distant from the worker. The robotic arm has been developed successfully as the movement of the robot can be controls precisely. It is expensive to change the cable and therefore the designing to reduce the friction on table, is crucial to increase time between maintenance.

- Survey on Design and Development of competitive low cost Robot Arm with Four Degrees of Freedom, this paper the representation of the design, development and implementation of robot arm is done, which has the ability to perform simple tasks, such as light material handling. The robotic arm is designed and made from acrylic material where servo motors are used to perform links between arms. The servo motors consist of encoder so that no need to use controller. However, the rotation range of the motor is less than 180º span, which greatly decreases the region reached by the arm and the possible positions. The design of the robot arm was for four degrees of freedom. The end effector is not considered while designing because a readily available gripper is used as it is much easier and economical to use a commercial.

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OBJECTIVES OF MINI PROJECT

This mini project is carried out to meet the following objectives.

1. Demonstrate the design and solution of the selected mini-project.
2. Build the critical thinking and use problem solving skills in societal and environmental contexts.
3. Develop on their own, reflect on their learning and take appropriate actions to improve it.
4. Develop team work for conducting the mini-project and Communicate effectively through reports & presentations.

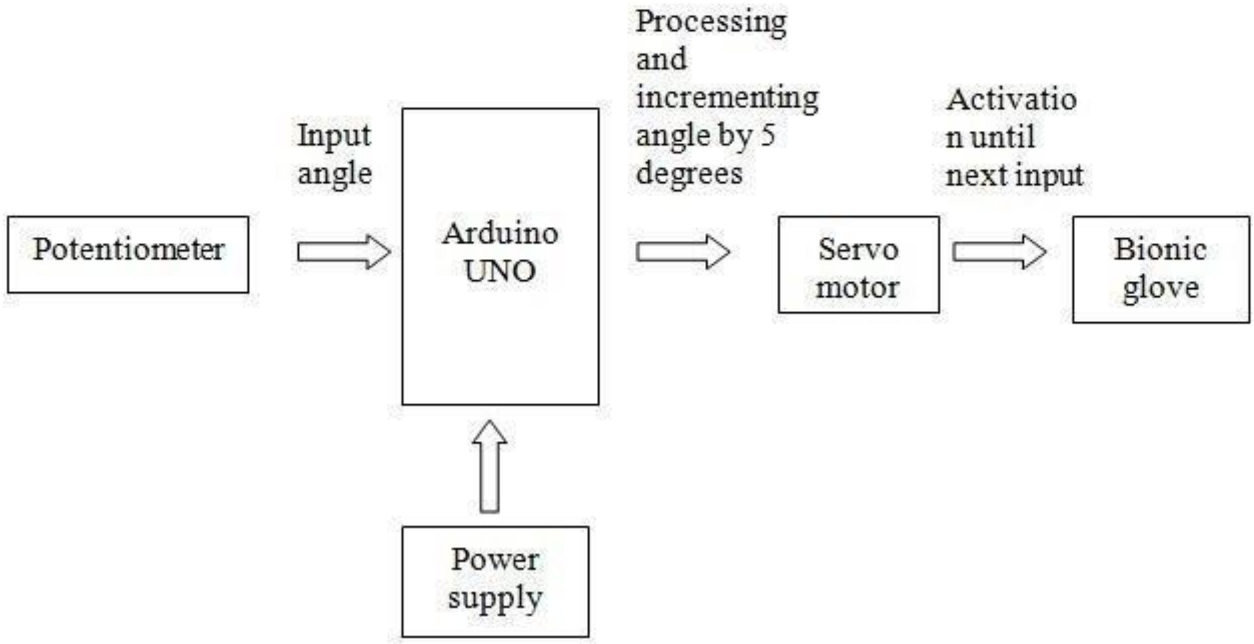
Methodology

We studied the servo motors so to control them, we need to use the pulse width modulation PWM. we will use in variable resistance Potentiometers (10K) using variable resistance will change the angle of the servo motor, in the code we will define the motors and resistors and determine the range from 0 to 1024 according to the motor and Arduino datasheet. But what is potentiometer?

Potentiometer it is variable resistance but its value can be changed manually using knob since the increase of resistance will reduce the current, this piece is used for example in the control of the volume in radio, in our project we use to control the degree of servo motor. There are many types of them, some of which moves in a linear and some moves in a rotating, the following picture shows some types:

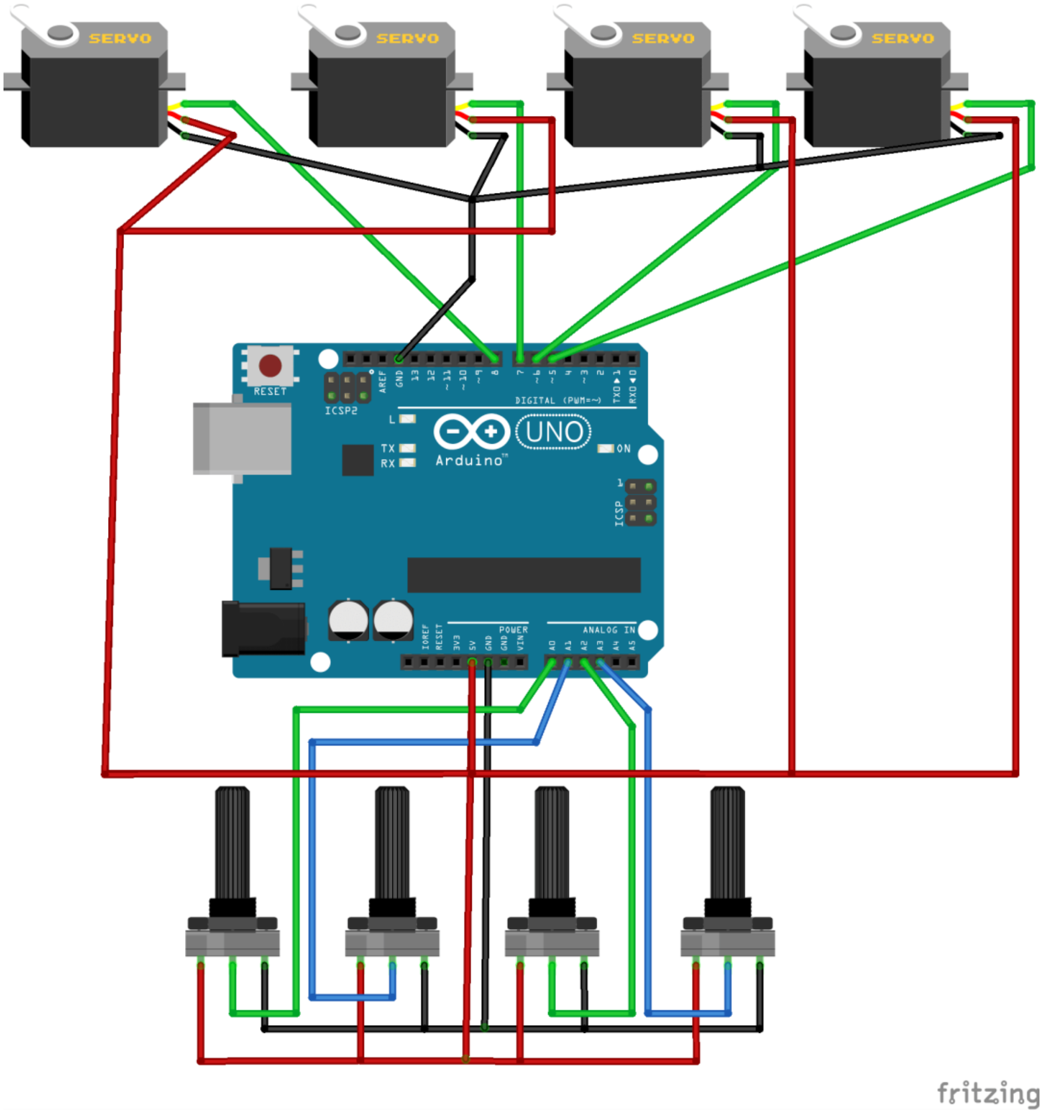
The Arduino takes the input from the potentiometers, the change in resistance of pot gives input to the servo motors. And the motors rotates accordingly.

Block Diagram



block diagram of the proposed Bionic glove prototype consists of the potentiometer input unit, Arduino interfacing unit and the servo motor controlled glove as shown in Figure 1. The power supply is given by a 9V battery to the Arduino UNO board. As per the robotic arm developed by Katal et al., 2013 a servo motor with a stall torque of 10kg/cm is employed to perform pick and place operations with precision [12]. The bionic glove employs a metal gear servo motor with a torque of 11kg/cm, operating on 4.8V to achieve better motion and flexibility. According to Krishna.R etal., 2012, the pick and place robot is operated using a servo motor with better accuracy in medical and industrial applications. In our proposed design, the servo motor, potentiometer and the Arduino board is permanently fixed on a plastic plate which is attached to the wearable glove and can be placed on the forearm of the patient during therapy. The glove is made of a light weight synthetic material which is easy to wear and includes an adjustable Velcro band. Nylon strings are used to pull the fin- gears of the glove upwards with the help of a servo motor. One end of the four nylon strings is sewn to the glove material and the other end is tied together with the rim of the servo motor.

Connection Diagram



We provide variable voltage at the ADC channels of arduino UNO using Pot. So the digital values of Arduino are under control of user. These digital values are mapped to adjust the servo motor position, hence the servo position is in control of user and by rotating these Pots user can move the joints of Robotic arm.

Components Description

Arduino Mega 2560 is an open source development board based on Atmega2560 AVR microcontroller. This microcontroller is an 8- bit Microcontroller. It uses ATmega16U2 Microchip Technology. This board can be programmed using programmed using wiring/ processing language. It includes: -

1. 54 digital input/ output pins out of which 14 pins can be used as PWM outputs
2. 16 analog pins
3. 4 UARTs (hardware serial ports)
4. A 16 MHz crystal oscillator
5. A USB connection
6. A power Jack
7. An ICSP Header
8. A reset button

The revision 3 of the Arduino Mega 2560 has come up with some more additional features, they are as:

1. SDA and SCL pins besides AREF pin
2. IOREF and one more extra pin besides RESET

Don't know how to use the above features? Don't worry I'll give you a brief idea of the purpose of the major pins and ports.

Digital Input/ Output Pins: It is used to transmit and receive the digital signals respectively.

PWM Outputs: PWM (Pulse Width Modulation) pin is used to control the signals. For example, controlling the speed of the motors, brightness of LED.

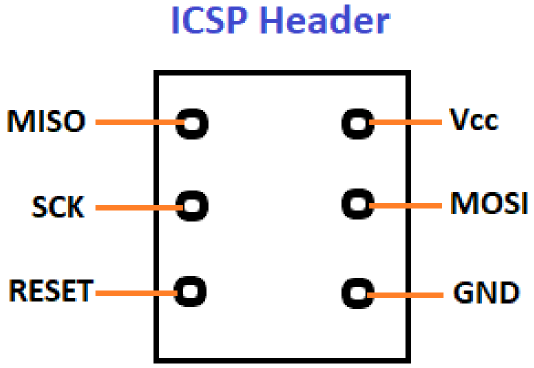
Analog Pins: It performs the function of reading analog signals. For example, reading the sensors data. Also it serves as general purpose Input/ output pins.

UART (Universal Asynchronous Receiver/Transmitter): It is used for serial communication purpose.

USB: It serves two purpose i.e. it can connect Mega 2560 board to your PC in order to program your board as well as it can be used to dram power to the board.

Power Jack: It is used to supply power to the board externally.

ICSP Header: In Circuit Serial Programming (ICSP) is one of the way to program the Arduino Board. Generally, it is used to restore the missing or damaged bootloader of Arduino. You can have an idea of it by looking at the diagram below.

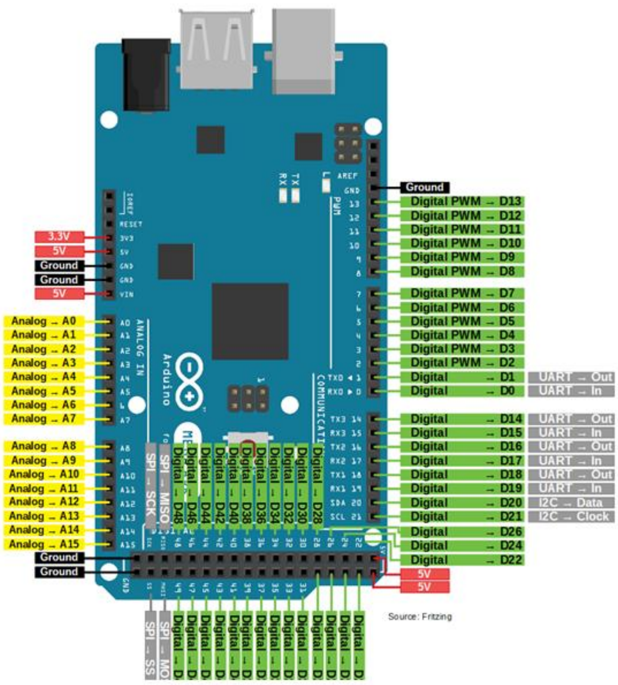


SDA (Serial Data): Used for exchanging data between Master and Slave device.
SCl (Serial clock): Used as synchronous clock between master and slave devices.
IOREF: It provides us with a voltage reference with which the board can operate.

Technical Features of Arduino Mega 2560

Microcontroller	ATmega2560
Operating Voltage	5V
Input Voltage (Recommended)	7 - 12V
Input Voltage (Limit)	6 - 20V
Analog Input Pins	16
Digital I/O Pins	54
DC Current for 3.3V Pin	50mA
DC Current per I/O Pin	20mA
Flash Memory	256 kB
SRAM	8kB
EEPROM	4kB
Clock Speed	16MHz
LED_BUILTIN	13

Pin Configuration



Pin 3.3V & 5V: This pins are used to provide regulated power supply to the Mega 2560 board.
GND Pin: Total 5 ground pins are provided on the Mega 2560 board.

Reset (RST) Pin: It is used to rearrange the functionality of the board.

Vin Pin: This pin serves the purpose of providing input voltage to the board. Remember! The range of input voltage through this pin should be in the range of 7V- 12V. In case you take output from this pin, the board will automatically set up the voltage to 5V.

Serial Communication: TXD and RXD are the serial pins of this board which is used to transmit & receive the serial data respectively.

We can make the group of this serial pins in four possible combinations:

	Pin No. for Tx	Pin No. for Rx
Serial 0	1	0
Serial 1	18	19
Serial 2	16	17
Serial 3	14	15

External Interrupts: These are six pins that provide number of ways to trigger an interrupt for example, Providing LOW value, rising or falling edge or changing the value to the interrupt pins. The pin numbers used for this interrupt is as follows:

Interrupts	Pin No.
Interrupt 0	2
Interrupt 1	3
Interrupt 2	21
Interrupt 3	20
Interrupt 4	19
Interrupt 5	18

AREF (Analog Reference Voltage): This pin is used as reference voltage for analog inputs.

Analog Pins: There are total of 16 Analog pins from A0 - A15. The high values of this pins can be altered using AREF pin.

Digital Pins: There are 54 digital Input/output pins on the Arduino Mega board from pin numbered from 0 to 53. Out of 54 pins, 15 pins numbered from D2 - D13 and D44 - D46 are PWM (Pulse Width Modulation) pins.

I2C: It is one way of communication to the board using pin number 20 & 21.

SPI (Serial Peripheral Interface) Communication: It is popularly used by the microcontrollers to communicate with one or more peripheral devices.

Advantages and Disadvantages

Out of many advantages, Arduino Mega 2560 has few disadvantages too. Let's see what they are.

Advantages of Arduino Mega 2560

1. It comes with more memory space, bigger size and more I/O pins.
2. Speedy communication can be achieved since there is a reset button and 4 hardware serial port (USART).
3. There are three ways to power the board i.e. either through USB cable, or by using Vin pin of the board, or through Power jack.
4. This board comes with resettable polyfuse that prevents the USB port of your computer from overheating in the presence of high current flowing through the board.
5. This board comes with two voltage regulator i.e. 5V and 3.3V which provides the flexibility to regulate the voltage as per requirements.

Disadvantages of Arduino Mega 2560

1. It is available only for 8-bits not for 32 bits.
2. Clock speed is limited to 20 MHz

Component	**Number**
Arduino Mega	1
Potentiometers 22K	4
Servo motors (any type support +5DC)	4
Bread board	1
wires	20

POTENTIOMETER

A potentiometer is a three-terminal resistor with a sliding or rotating contact that forms an adjustable voltage divider. If only two terminals are used, one end and the wiper moves, it acts as a variable resistor or rheostat.

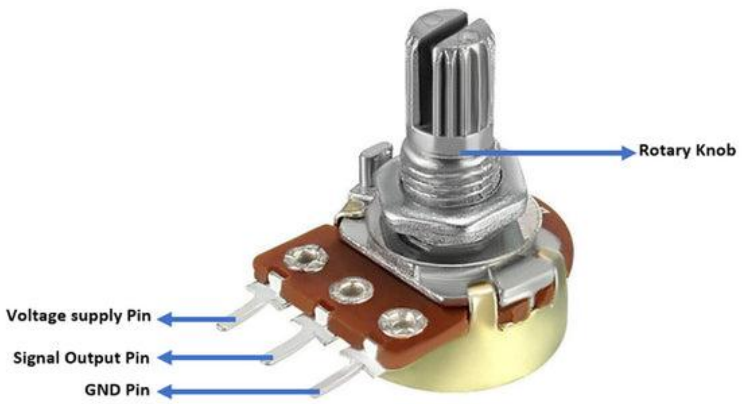
There are various types of potentiometers:

- digital potentiometer
- rotary potentiometer
- logarithmic potentiometer
- manually adjustable potentiometer
- linear potentiometer

The measuring instrument called a potentiometer. This is essentially an output voltage divider used for measuring the potential energy (voltage); the component measures the resistance of the potentiometer, hence its name.

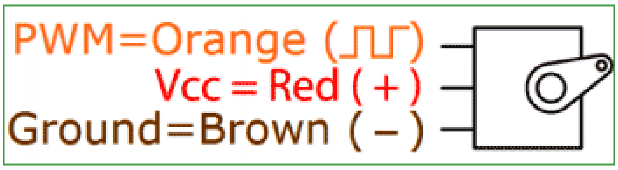
Potentiometers are commonly used to control electrical devices such as volume controls on audio equipment. Potentiometers operated by a mechanism can be used as position transducers, for example, in a game joystick. Potentiometers are rarely used to directly control significant power (more than a single watt), since the power dissipated in the potentiometer would be comparable to the power in the controlled load.

Figure 6-8 illustrates the construction geometry of a potentiometer, which acts as a variable resistor. A resistive tracks, similar to that found on film type fixed resistors, forms approximately 3/4 of a circle (an arc of 2700), with terminals connected to either end. This strip exhibits a fixed value of maximum resistance element. To obtain the variable resistance, a sliding contact, attached to a rotatable shaft and bearing, goes to a third (middle) terminal. The resistance between the middle terminal and either terminal can vary from zero up to the resistance of the whole strip. Most potentiometers can handle only low levels of current, at low to moderate voltages.



SERVO MOTOR

A **servo motor** is a type of motor that can rotate with great precision. Normally this type of motor consists of a control circuit that provides feedback on the current position of the motor shaft, this feedback allows the servo motors to rotate with great precision. If you want to rotate an object at some specific angles or distance, then you use a servo motor. It is just made up of a simple motor which runs through a **servo mechanism.**



Servo Motor Working Mechanism:

It consists of three parts:

1. Controlled device
2. Output sensor
3. Feedback system

It is a closed-loop system where it uses a positive feedback system to control motion and the final position of the shaft. Here the device is controlled by a feedback signal generated by comparing output signal and reference input signal.

Here reference input signal is compared to the reference output signal and the third signal is produced by the feedback system. And this third signal acts as an input signal to the control the device. This signal is present as long as the feedback signal is generated or there is a difference between the reference input signal and reference output signal. So the main task of servomechanism is to maintain the output of a system at the desired value at presence of noises.

Servo Motor Working Principle:

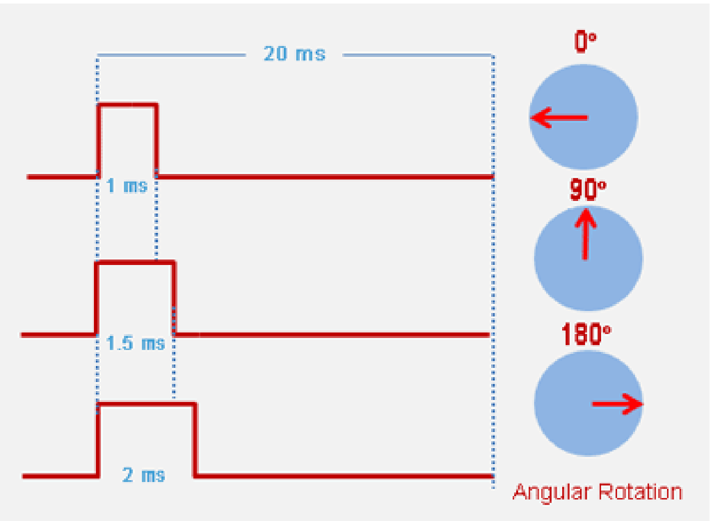
A servo consists of a Motor (DC or AC), a potentiometer, gear assembly, and a controlling circuit. First of all, we use gear assembly to reduce RPM and to increase torque of the motor. Say at initial position of servo motor shaft, the position of the potentiometer knob is such that there is no electrical signal generated at the output port of the potentiometer. Now an electrical signal is given to another input terminal of the error detector amplifier.

Interfacing Servo Motors with Microcontrollers:

Interfacing hobby Servo motors like s90 servo motor with MCU is very easy. **Servos have three wires coming out of them**. Out of which two will be used for Supply (positive and negative) and one will be used for the signal that is to be sent from the MCU.

Controlling Servo Motor:

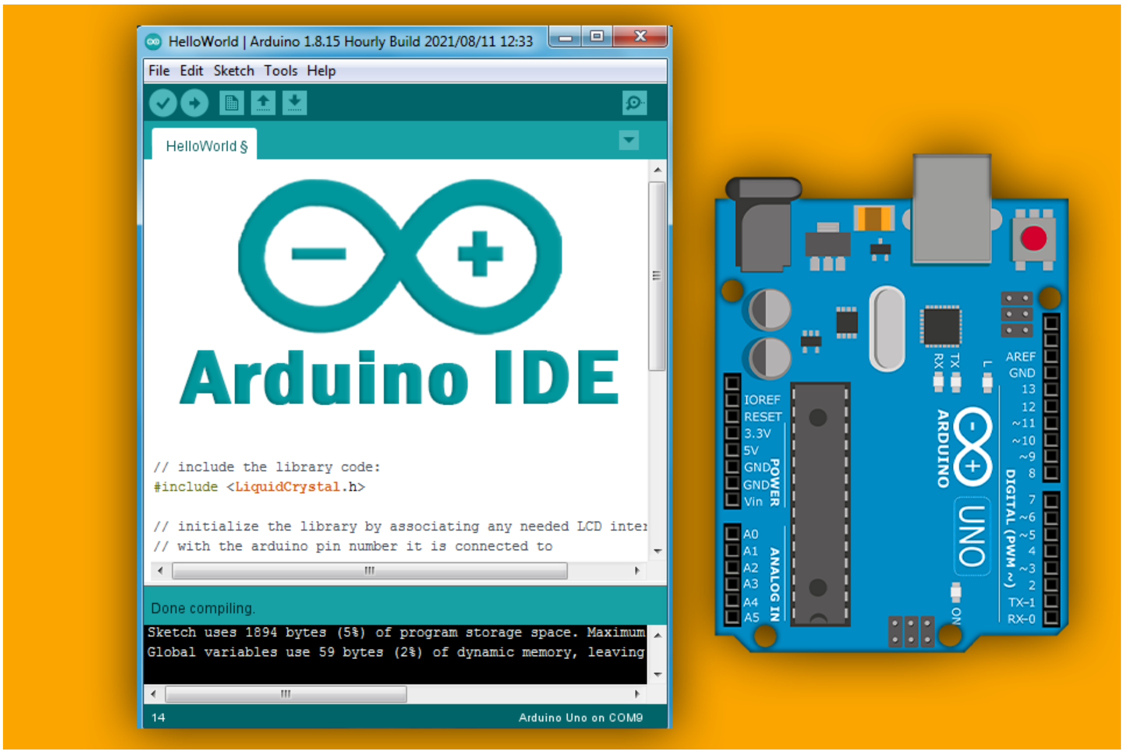
Servo motor works on **PWM (Pulse width modulation)** principle, means its angle of rotation is controlled by the duration of applied pulse to its Control PIN. Basically servo motor is made up of **DC motor which is controlled by a variable resistor (potentiometer) and some gears**. High speed force of DC motor is converted into torque by Gears. We know that WORK= FORCE X DISTANCE, in DC motor Force is less and distance (speed) is high and in Servo, force is High and distance is less. The potentiometer is connected to the output shaft of the Servo, to calculate the angle and stop the DC motor on the required angle.



Software Used

The Arduino Software (IDE) makes it easy to write code and upload it to the board offline. We recommend it for users with poor or no internet connection. This software can be used with any Arduino board.

There are currently two versions of the Arduino IDE, one is the IDE 1.x.x and the other is IDE 2.x. The IDE 2.x is new major release that is faster and even more powerful to the IDE 1.x.x. In addition to a more modern editor and a more responsive interface it includes advanced features to help users with their coding and debugging.



Arduino software (IDE) is compatible with different operating systems (Windows, Linux, Mac OS X), and supports the programming languages (C/C++)

The Arduino software is easy to use for beginners, or advanced users. It uses to get started with electronics programming and robotics, and build interactive prototypes.

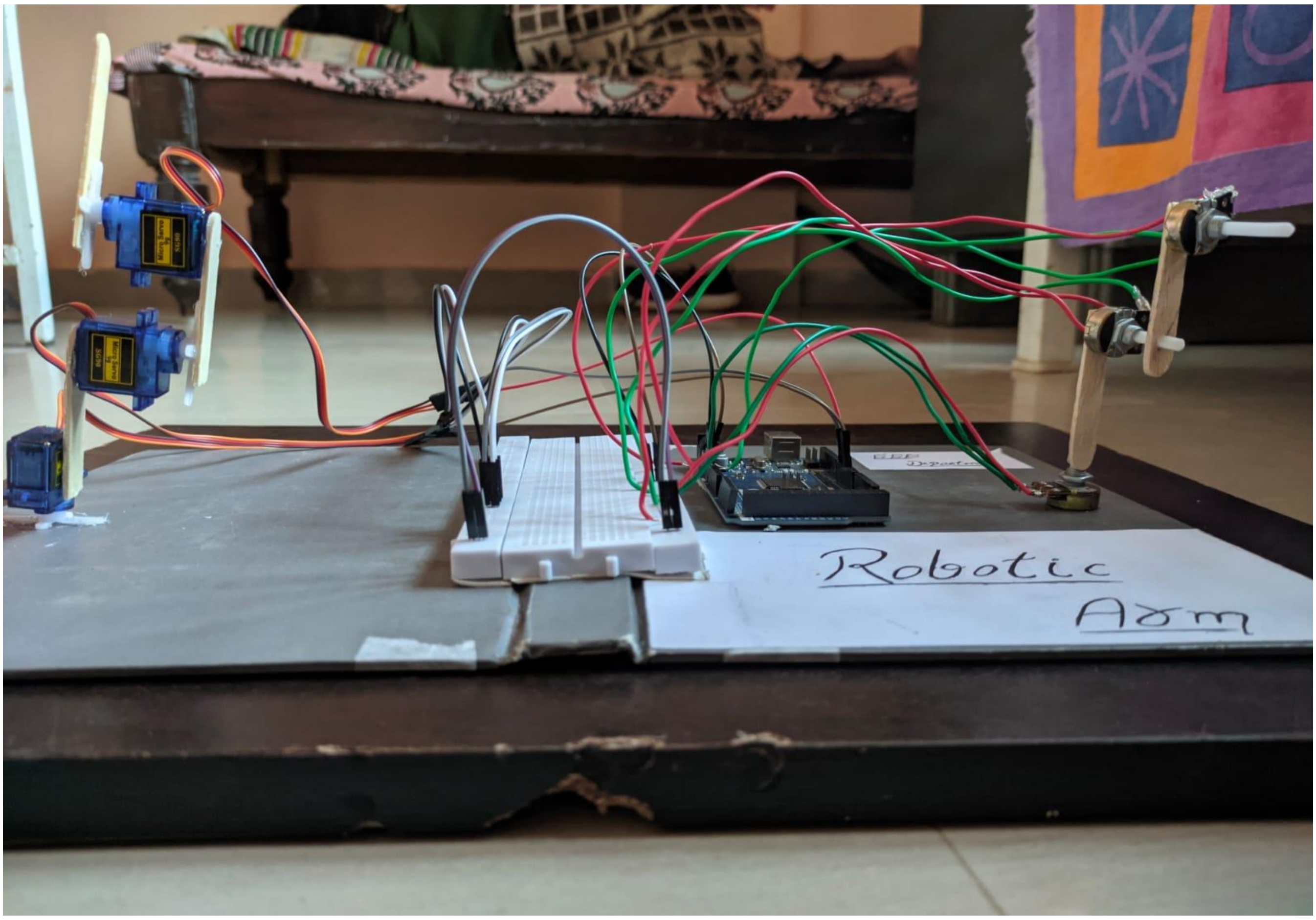
So Arduino software is a tool to develop new things. and create new electronic projects, by Anyone (children, hobbyists, engineers, programmers, … etc.)

Program Code Used

```
#include <Servo.h>
Servo servo1;
Servo servo2;
Servo servo3;
Servo servo4;

int pot1 = A0;
int pot2 = A1;
int pot3 = A2;
int pot4 = A3;

int valPot1;
int valPot2;
int valPot3;
int valPot4;

void setup()
{

servo1.attach(3);
servo1.write(0); //define servo1 start position
servo2.attach(5);
servo2.write(90); //define servo2 start position
```

```
servo3.attach(6);

servo3.write(90); //define servo3 start position

servo4.attach(9);

servo4.write(70); //define servo4 start position

}

void loop()

{

valPot1 = analogRead(pot1);

valPot1 = map (valPot1, 0, 1023, 90, 180); //(servo value between 0 and 180)

servo1.write(valPot1);


valPot2 = analogRead(pot2);

valPot2 = map (valPot2, 0, 1023, 0, 180);

servo2.write(valPot2);


valPot3 = analogRead(pot3);

valPot3 = map (valPot3, 0, 1023, 0, 180);

servo3.write(valPot3);

valPot4 = analogRead(pot4);

valPot4 = map (valPot4, 0, 1023, 0, 180);

servo4.write(valPot4);

}
```

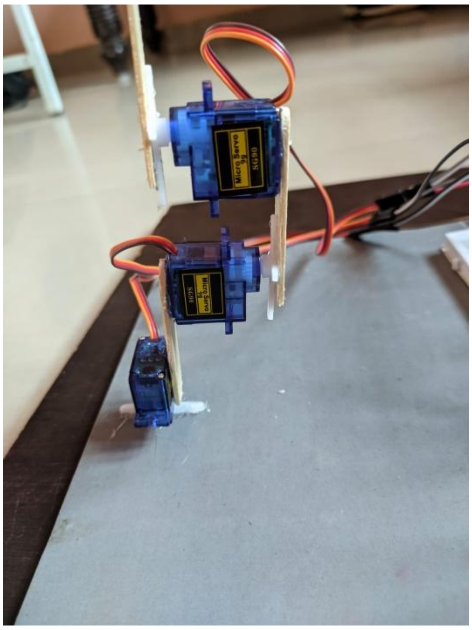
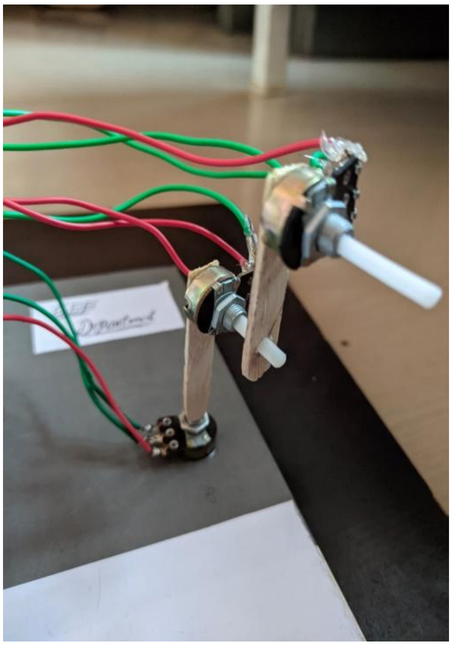
Project design



This Arduino Robotic Me Arm can be controlled by four Potentiometer attached to it, each potentiometer is used to control each servo. You can move these servos by rotating the pots to pick some object, with some practice you can easily pick and move the object from one place to another. We have used low torque servos with metal gear here but you can use more powerful servos to pick heavy objects.

Connecting the Servo Motor to the Arduino uno
Black wire of servo motor to the GND pin of Arduino uno
Red wire of servo motor to the 5V pin of Arduino uno
Orange wire of servo motor to the D5, D6,D7,D8 of Arduino uno

Conclusion

It is true that human arms can do many works at a time but it always involves risk of injury during work involving lifting of heavy items and picking of radioactive substances. Moreover, medical industry need an arm for people who lost it in accidents.

Also, it is seen that efficiency of a person decreases as his age advances due to which one involved in rough work becomes unproductive and inefficient. In manufacturing industry and nuclear industry, a large fraction of the work is repetitive and judicious application of automation will most certainly result in optimum utilization of machine and manpower. A pneumatic `Pick and Place ‘Robot has been developed to achieve automation in applications where great sophistication is not needed and simple tasks like picking up of small parts at one location and placing them at another location can be done with great ease. This robot is a mechanical arm, a manipulator designed to perform many different tasks and capable of repeated, variable programming. To perform its assigned tasks, the robot moves parts, objects, tools, and special devices by means of programmed motions and points. The robotic arm performs motions in space. Its function is to transfer objects or tools from point to point, as instructed by the controller. Robotic arm is an asset for those people who are involved in nuclear industry as by robotic arms, picking of the radio substances can be done by the instructions given by them and they don’t physical go at the site and pick these harmful substances. Also in manufacturing industry risk of injury is prevented as now these robotic arms are involved in doing repetitive work and people of all age can control it without any loss in efficiency

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Appendix

While robotic systems keep improving in terms of motor capabilities thanks to progress in mechatronics, developing control strategies and interfaces allowing a human to harness the full potential of an advanced robotic arm proves to be a key challenge in the field of humanoid robotics and in particular, rehabilitation engineering. Indeed, user surveys and reviews (Biddiss and Chau, 2007; Cordella et al., 2016) have already revealed that the lack of functionality and the necessity of a long and difficult training were some main reasons behind upper-limb prosthesis abandonment. As examples drawn from some of the most advanced devices currently on the prosthesis market, Michelangelo (Ottobock) and i-limb quantum (Touch Bionics) hands include too many actuators for an amputee to operate them independently, and their control relies a lot on pre-programmed grip patterns. Even in the case of an able-bodied human, the gap between robotic devices' complexity and available command signals highlights the need for efficient and usable control interfaces and strategies.

To bridge this gap, researchers have investigated techniques to retrieve additional input data from the human. One of these solutions is the sensor fusion approach, which intends to combine measurements from multiple sensors running at once. This approach can be used with various devices and sensing modalities (Novak and Riener, 2015), whether vision-based, kinematic, or physiological. In particular, as object recognition from egocentric videos can help grasping actions for neuroprostheses (de San Roman et al., 2017), recent works explored how a robotic system could be controlled by fusing eye-tracking with EMG (Corbett et al., 2013, 2014; Markovic et al., 2015; Gigli et al., 2017) or Electroencephalography (EEG) signals (McMullen et al., 2014; Wang et al., 2015). Other works also investigated how Augmented Reality (AR) can be employed to provide relevant visual feedback about a robotic arm's state (Markovic et al., 2014, 2017), with the aim of improving the control loop.

Another approach to overcome this limit is to reduce the need for command signals, by making the robotic system take charge of part of its own complexity. In this way, techniques are developed to allow a human to drive a robot through higher-level, task-relevant commands instead of operating the robot directly in actuator space. A common implementation of this approach is to perform endpoint control through Inverse Kinematics (IK), which convert command signals from the 3D operational space into the actuator space. IK solving is a key research topic in the whole field of robotics, including autonomous humanoid robotics (Bae et al., 2015; Rakita et al., 2018), but can also be employed to manage the kinematic redundancy of human-driven robots (Zucker et al., 2015; Rakita et al., 2017; Meeker et al., 2018).