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

Submitted by

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Under the supervision of

Mrs. PRRETHA N P

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For the Academic year of 2021 – 2022

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

SAPTHAGIRI COLLEGE OF ENGINEERING

(Affiliated to VTU, Belagavi and Recognized by AICTE, New Delhi)

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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.

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Mrs PREETHA N P
Designation

Signature of the HOD
Dr. NARAYANAPPA
Professor & H.O.D

ACKNOWLEDGEMENT

Team spirit and comradeship are the basic ingredients for the success of any task. Be it in education, sports arena, battlefield or even in our lives, similarly this project is the result of contribution from the students and staff. While doing this project many difficulties came in between but finally completed it with the guidance and suggestions from the following intelligentsia who gave generously of their time and expertise.

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We wish to express our deep sense of gratitude to **Mrs. PREETHA N P**, assistant Professor, Department of Electrical & Electronics Engineering, Sapthagiri College of Engineering, Bengaluru for her valuable guidance and perspicacious analytical suggestions throughout this project.

We are eternally grateful to our **Parents** for their affectionate cooperation and blessings for this great achievement.

Finally, we pray the Almighty, for our college to grow from strength to strength and let the students, staff and whoever helped us be exemplary with magnificent health, happiness and long life.

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OBJECTIVES OF MINI PROJECT

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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.

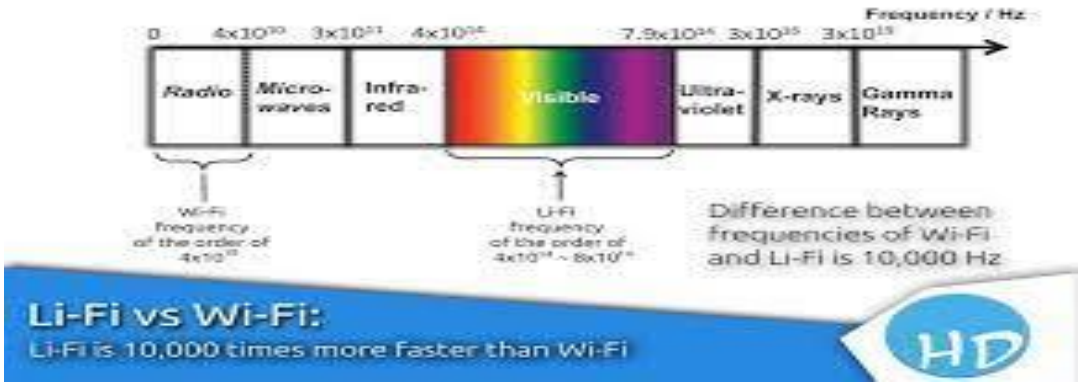


Fig-1: Li-Fi and Wi-Fi Spectrum Usage

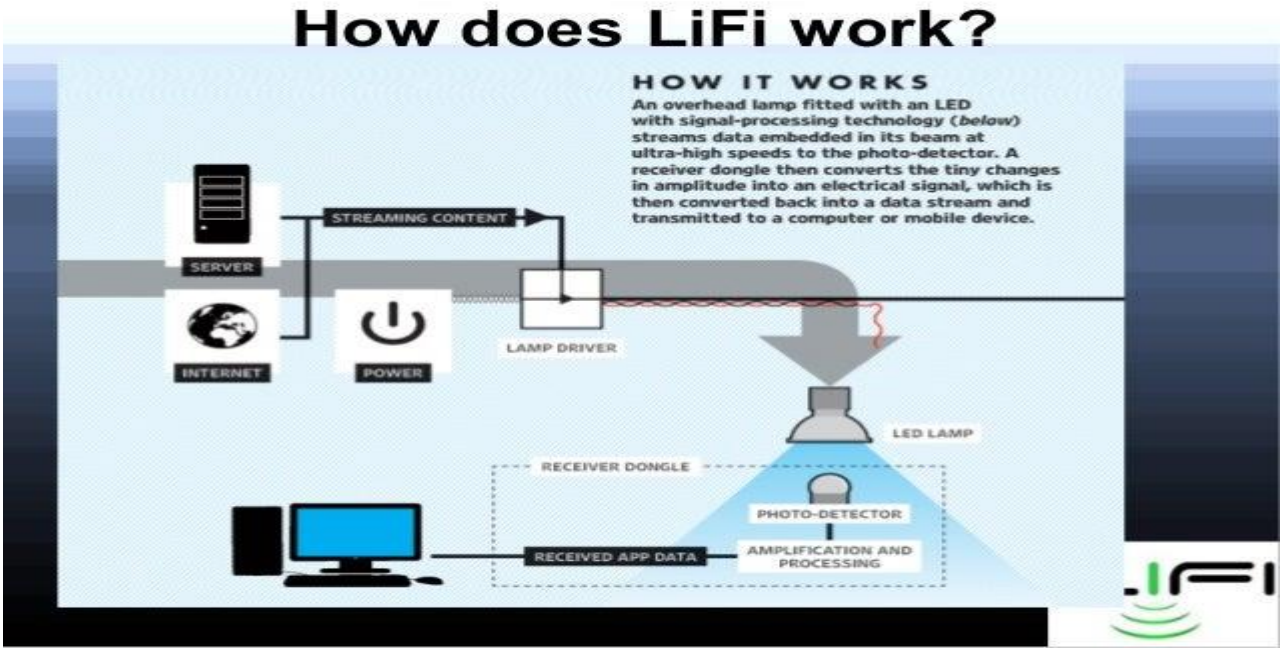
Table-2: Comparison between Li-Fi and Wi-Fi

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.

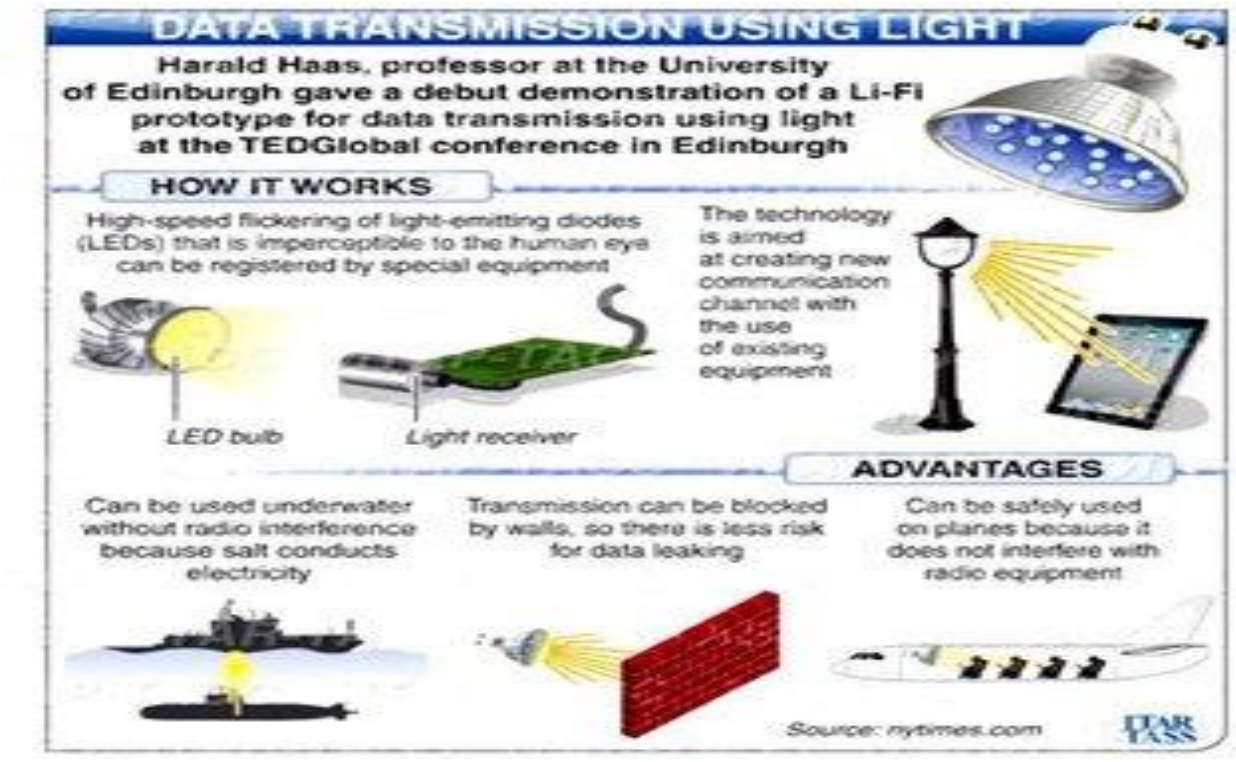


Fig: Overview of Li-Fi

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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Submitted by

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CERTIFICATE

Certified that the mini project entitled **"IR REMOTE CONTROL USING ARDUINO "** is carried out by **AKSHATHA B (1SG20EE002), HARSHITH MK (1SG20EE011), MADHUSUDANA KJ (1SG20EE016) ,YASHASWINI S (1SG20EE038)** 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.

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Dr. RAGHAVENDRA G	**Dr. REKHA S N**	**Dr. H. RAMAKRISHNA**
Designation	Professor & H.O.D	Principal

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I am deeply indebted and I would like to express my sincere thanks to our beloved Principal **Dr. H RAMAKRISHNA,** for providing me an opportunity to do this seminar.

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My sincere thanks to my guide **Dr. RAGHAVENDRA G,** Associate Professor, Department of Electrical and Electronics Engineering, Sapthagiri College of Engineering, for his guidance, constant encouragement and wholehearted support.

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CONTENTS

LIST OF FIGURES

1.INTRODUCTION:

In today's world need of automation is become necessary not only to reduce human effort but also to utilize maximum of the technology and to do everything smartly and efficiently in order to reduce both energy and time consumption. so, the idea of home automation is basically deals with such problems and provide home a smart system to operate household appliances conveniently this helps to advance the living standards of new age people and also helps the old age aged or handicapped person to perform their task without any trouble.

Infrared (IR) communication is a widely used and easy to implement wireless technology that has many useful applications. The most prominent examples in day to day life are TV/video remote controls, motion sensors, and infrared thermometers.

There are plenty of interesting Arduino projects that use IR communication too. With a simple IR transmitter and receiver, you can make remote controlled robots, distance sensors, heart rate monitors, DSLR camera remote controls, TV remote controls, and lots more.

In this tutorial I'll first explain what infrared is and how it works. Then I'll show you how to set up an IR receiver and remote on an Arduino. I'll also show you how to use virtually any IR remote (like the one for your TV) to control things connected to the Arduino.

1.1 WHAT IS INFRARED?

Infrared radiation is a form of light similar to the light we see all around us. The only difference between IR light and visible light is the frequency and wavelength. Infrared radiation lies outside the range of visible light, so humans can't see it:

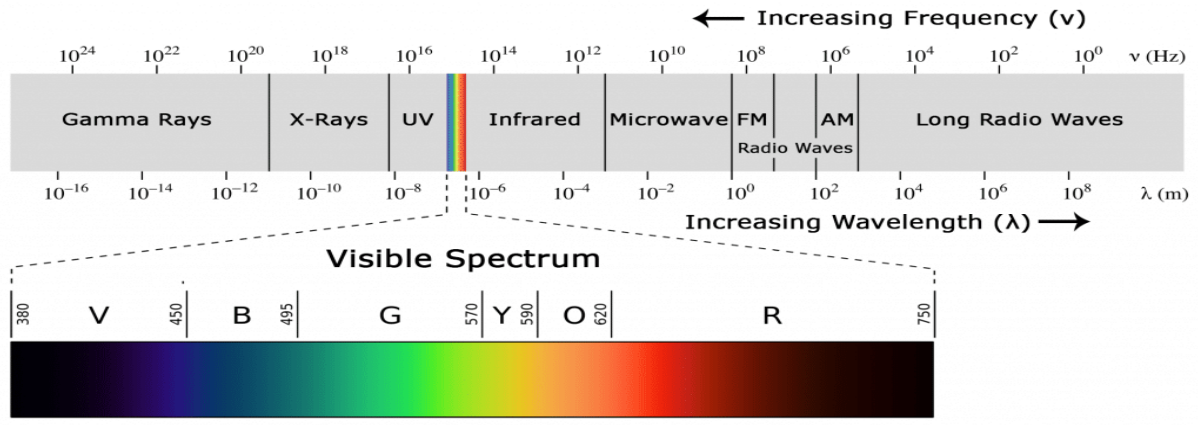

FIG 1.1 INFRARED RAYS

Because IR is a type of light, IR communication requires a direct line of sight from the receiver to the transmitter. It can't transmit through walls or other materials like Wi-Fi or Bluetooth.

2.LITERATURE SURVEY:

It is a survey of existing work which can be taken as a reference for RC- automation. We surveyed around 5 different articles which can be explained as:

[1] Microcontroller Based Remote Control of Home Appliances: It focuses on development of microcontroller based IR remote control signal decoder and used Sony IR remote as transmitter. But the output of the IR receiver is not very high.

[2] Home Appliances Controlled by Infrared Remote Control System: It tells how the receiver uses an infrared sensors module for sensing the IR signals from the transmitter section, it fails when IR beams modulated at the same frequency needs a line of sight for control.

[3] Home Automation Using Remote Control System: Here the home appliances are switched on/off using IR without actually going near to the switch boards or regulators, , it fails when IR beams modulated at the same frequency needs a line of sight for control.

[4] Home Automation Using IR (Infrared) Sensor & Arduino-UNO Single Board Microcontroller: Home automation provides a wireless communication link of the home appliances to the remote user and provides convenience and ease of work with more cost, complex circuit, not user friendly

[5] IR Based Home Appliances Control System: Here the micro controller stores the bit pattern of IR receiver and compares with the predefined bit pattern matches act as a switch to turn on/off any appliance. The major drawback is that the IR remote works on different protocol. Micro - controller stores the bit patterns for specific buttons of remote.

3.METHODOLOGY AND BLOCK DIAGRAM:

3.1 Working Explanation:

Working of this project is easily understandable. When we press any button of **IR Remote** then remote sends a code in form of train of encoded pulses using 38Khz modulating frequency. These pulses are received by **TSOP1738** sensor and read by Arduino and then Arduino decodes received train of pulse into a hex value and compares that decoded value with the predefined hex value of the pressed button. Here in this project, we have used 2 bulbs of different colors, for demonstration which indicates Fan, Light and TV.

There are many types of IR Remote are available for different device but most of them are worked on around 38KHz Frequency signal. Here in this project we control home appliances using IR TV remote. For detecting IR remote signal, we use TSOP1738 IR Receiver. This TSOP1738 sensor can sense 38Khz Frequency signal. The working of IR remote and the TSOP1738 can be covered in detail in this article: IR Transmitter and Receiver

3.2 Download the IR Remote Library:

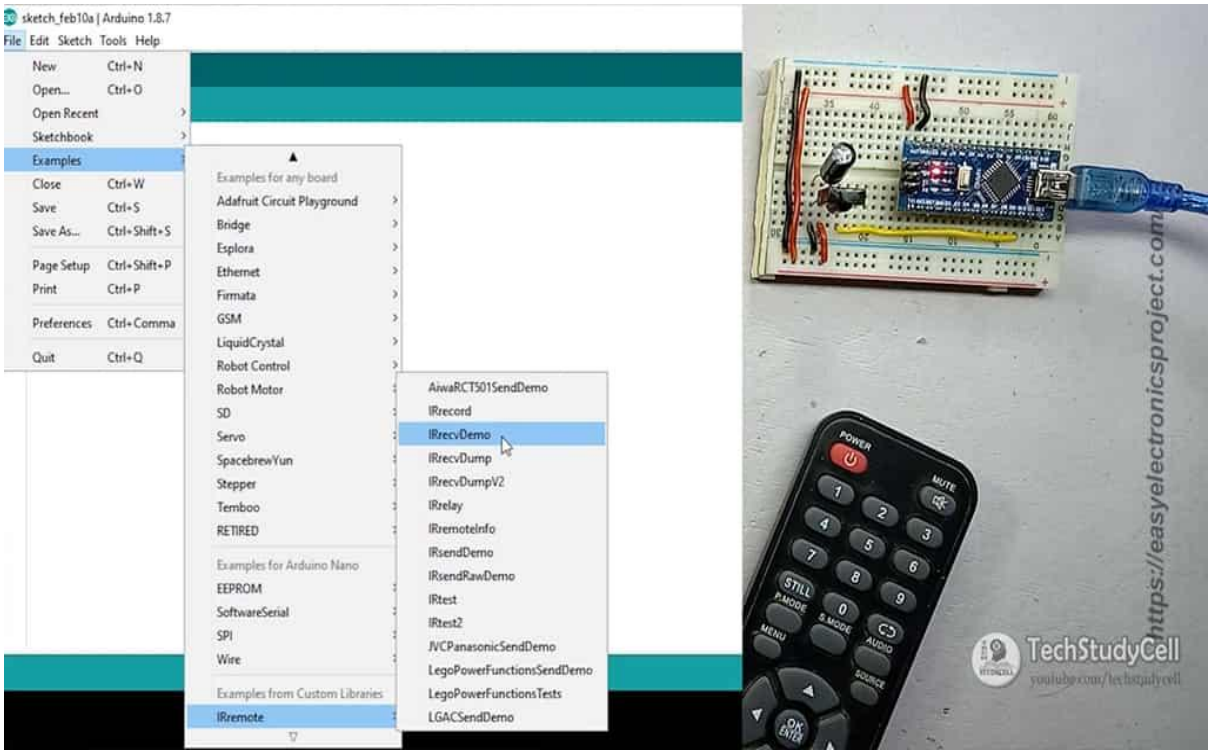

FIG 1.2 SERIAL WINDOW

First, connect the 1738 IR Receiver with Arduino Nano (pin **D11**) as per the circuit diagram. Then connect the Arduino with the laptop and open Arduino IDE. Download and install the **IRremote** (by shirriff) library from Manage Library or Click here to Download the library. Then go to **File –> Examples –> IRremote –> IRrecvDemo** and open the sketch. Now, upload the sketch to Arduino.

Here we have used toggle [EVEN ODD] method for ON and OFF the single home appliance. **Toggle method** is nothing but to get that whether the button is pressed even no of times or the odd no of times. This is found by getting the reminder after dividing it by 2 (i%2), if there is some reminder then device will be turned ON and if reminder is 0 then it will be turned OFF. Suppose Key 7 is pressed on the remote then remote sends a signal to Arduino through TSOP IR Receiver. Then Arduino decode it and store the decoded value into the results variable. Now results variable has a hex value 0x1FE00FF, after matching it with the predefined hex value of key 7 (see above image), Arduino turns ON the Fan.

3.3 IR REMOTE CONTROL PROGRAMING:

```
* IRremote: IRrecvDemo - demonstrates receiving IR codes with IRrecv
 * An IR detector/demodulator must be connected to the input RECV_PIN.
 * Version 0.1 July, 2009
 * Copyright 2009 Ken Shirriff
 * http://arcfn.com
 */


#include <IRremote.h>
int RECV_PIN = 11;
IRrecv irrecv(RECV_PIN);
decode_results results;
void setup()
{
  Serial.begin(9600);
  irrecv.enableIRIn(); // Start the receiver
}
void loop() {
  if (irrecv.decode(&results)) {
    Serial.println(results.value, HEX);
    irrecv.resume(); // Receive the next value
  }
  delay(100);
```

FIG 1.3 IR REMOTE

Decimal	Hex	Key
33425968	1FEA28F	1
33123458	1FE00FF	2
33987651	1FE48D7	3
33987414	1FEE01F	4
33468495	1FEB04F	5
33423615	1FE708F	6
33452175	1FE00FF	7
33484815	1FEF00F	8
33462375	1FC9867	9
33431775	1FE20DF	*
33480735	1FEE01F	0
33472575	1FEC03F	#
33441975	1FE48D7	Left Arrow
33446055	1FE58A7	Right Arrow
33456255	1FE807F	Down Arrow
33425998	1FE608F	Down Arrow

If you don’t know the Decoded output for your IR remote, it can be easily found, just follow these steps:

1. Download the IR remote library from here https://github.com/z3t0/Arduino-IRremote.
2. Unzip it, and place it in your Arduino ‘Libraries’ folder. Then rename the extracted folder to IR remote
3. Run the below program from your Arduino and open the Serial Monitor window in Arduino IDE. Now press any IR Remote button and see the corresponding decoded hex

3.4 RELAY MODULE CONTROLING PROGRAM:

The following is used to control the given appliances by toggling switches. As remote buttons

```
#include <IRremote.h>
//Define PIN constant
const int switch_1 = 7;
const int switch_2 = 8;
const int switch_3 = 9;
const int switch_4 = 10;
int RECV_PIN = 11;

int toggleState_1 = 0; //Define integer to remember the toggle state for switch 1
int toggleState_2 = 0; //Define integer to remember the toggle state for switch 2
int toggleState_3 = 0; //Define integer to remember the toggle state for switch 3
int toggleState_4 = 0; //Define integer to remember the toggle state for switch 4


//Define IR receiver and Result Objects
IRrecv irrecv(RECV_PIN);
decode_results results;

void setup()
{
  Serial.begin(9600);
  irrecv.enableIRIn(); // Enable the IR receiver
   pinMode(switch_1, OUTPUT);
   pinMode(switch_2, OUTPUT);
   pinMode(switch_3, OUTPUT);
   pinMode(switch_4, OUTPUT);
}

void loop() {
  if (irrecv.decode(&results)) {

    switch(results.value){
      case 0x10EFA956:        // 10EFA956 = Hex code for TV remote button 1
                if(toggleState_1 == 0){
                  digitalWrite(switch_1, HIGH); // turn on switch 1
                  toggleState_1 = 1;
                  }
                else{
                  digitalWrite(switch_1, LOW); // turn off switch 1
                  toggleState_1 = 0;
                  }
```

```
      break;
      case 0x10EF9966:          // 10EF9966 = Hex code for TV remote
button 2
                if(toggleState_2 == 0){
                  digitalWrite(switch_2, HIGH); // turn on switch 2
                  toggleState_2 = 1;
                  }
                else{
                  digitalWrite(switch_2, LOW); // turn off switch 2
                  toggleState_2 = 0;
                  }
                  delay(100);
      break;
      case 0x10EFB946:
                if(toggleState_3 == 0){
                  digitalWrite(switch_3, HIGH); // turn on switch 3
                  toggleState_3 = 1;
                  }
                else{
                  digitalWrite(switch_3, LOW); // turn off switch 3
                  toggleState_3 = 0;
                  }
                  delay(100);
      break;
      case 0x10EF6B94:
                if(toggleState_4 == 0){
                  digitalWrite(switch_4, HIGH); // turn on switch 4
                  toggleState_4 = 1;
                  }
                else{
                  digitalWrite(switch_4, LOW); // turn off switch 4
                  toggleState_4 = 0;
                  }
                  delay(100);
      break;
      default : break;
      }

    irrecv.resume(); // Receive the next value
  }

}
```

3.5 BLOCK DIAGRAM:

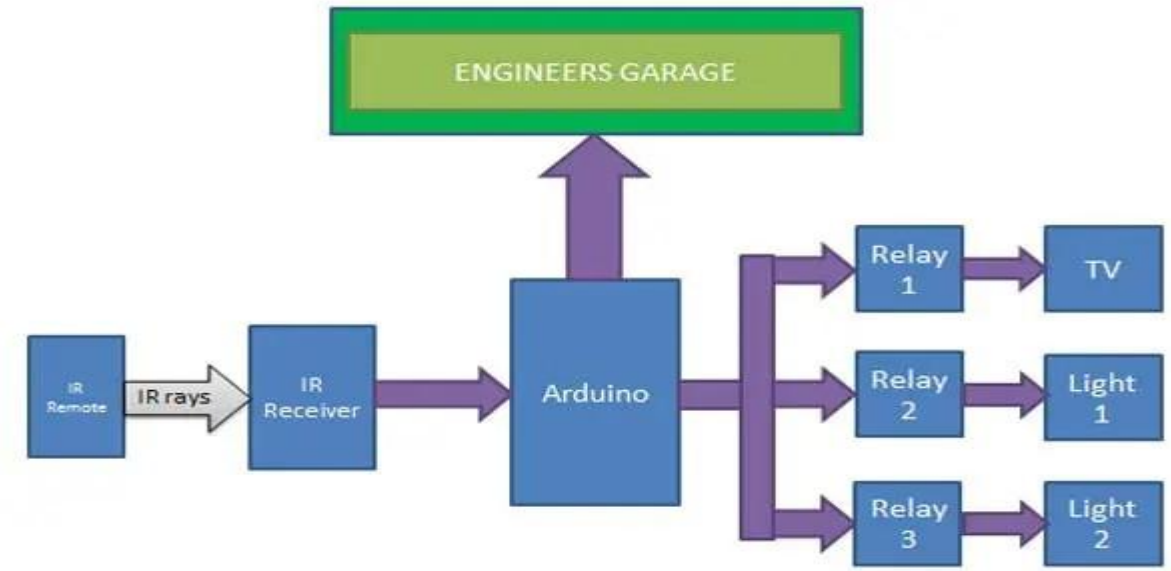

FIG 1.4 BLOCK DIAGRAM

4.PROJECT DESIGN AND COMPONENTS DESCRIPTION:

4.1 Description:

In this Arduino project, we will make a circuit that can control room light, fan from IR remote. Here I have explained how to make the remote control light circuit with details. So if you follow all the steps you can design this home automation project easily.

4.2 Arduino IR Remote Circuit:

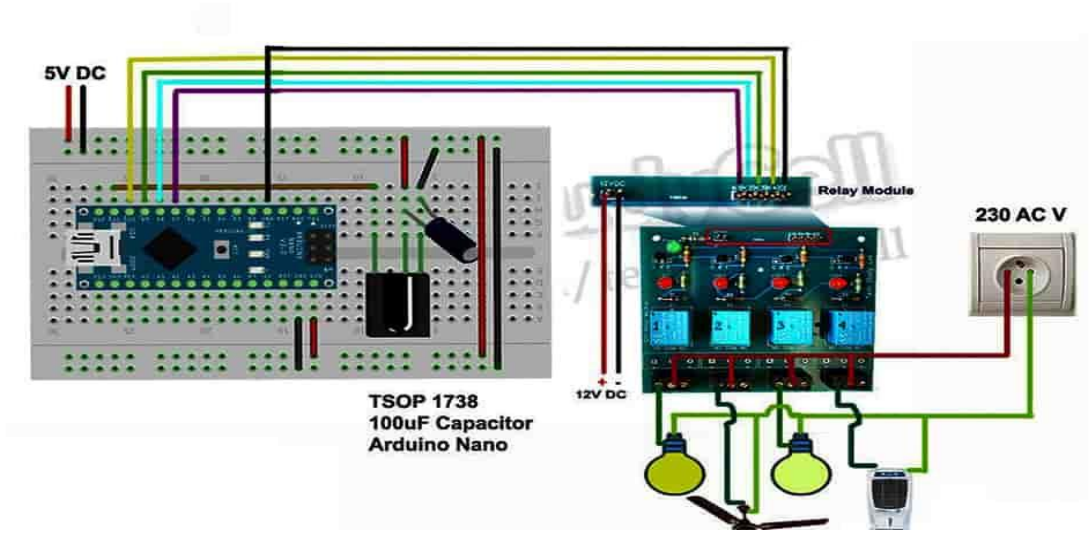

FIG 1.5 ARDUINO IR REMOTE CIRCUIT

In this circuit, I have used Arduino UNO, But you can also use Arduino NANO for this project

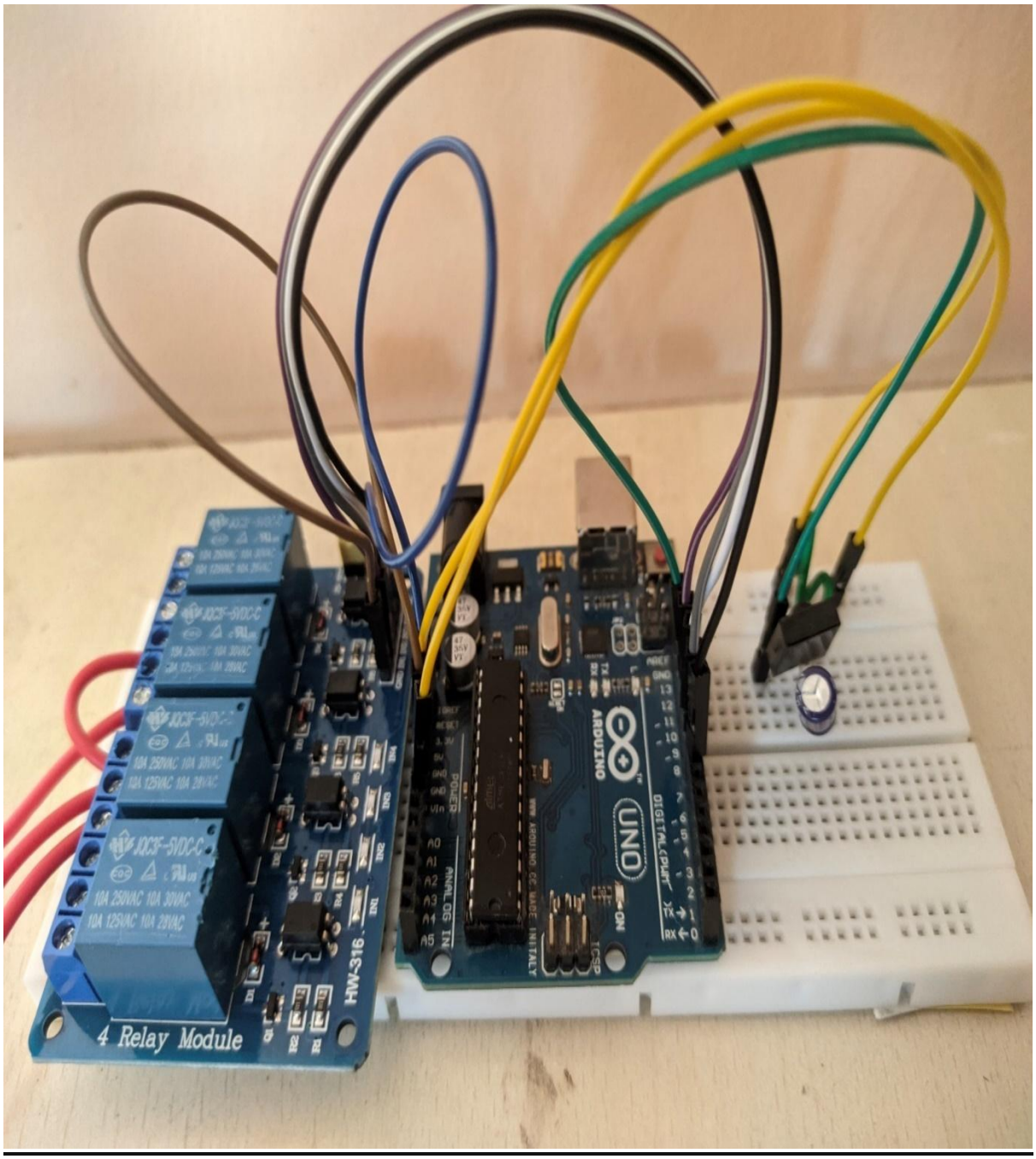

FIG 1.6 PICTURE OF CIRCUIT

FIG 1.7 USED IR REMOTE

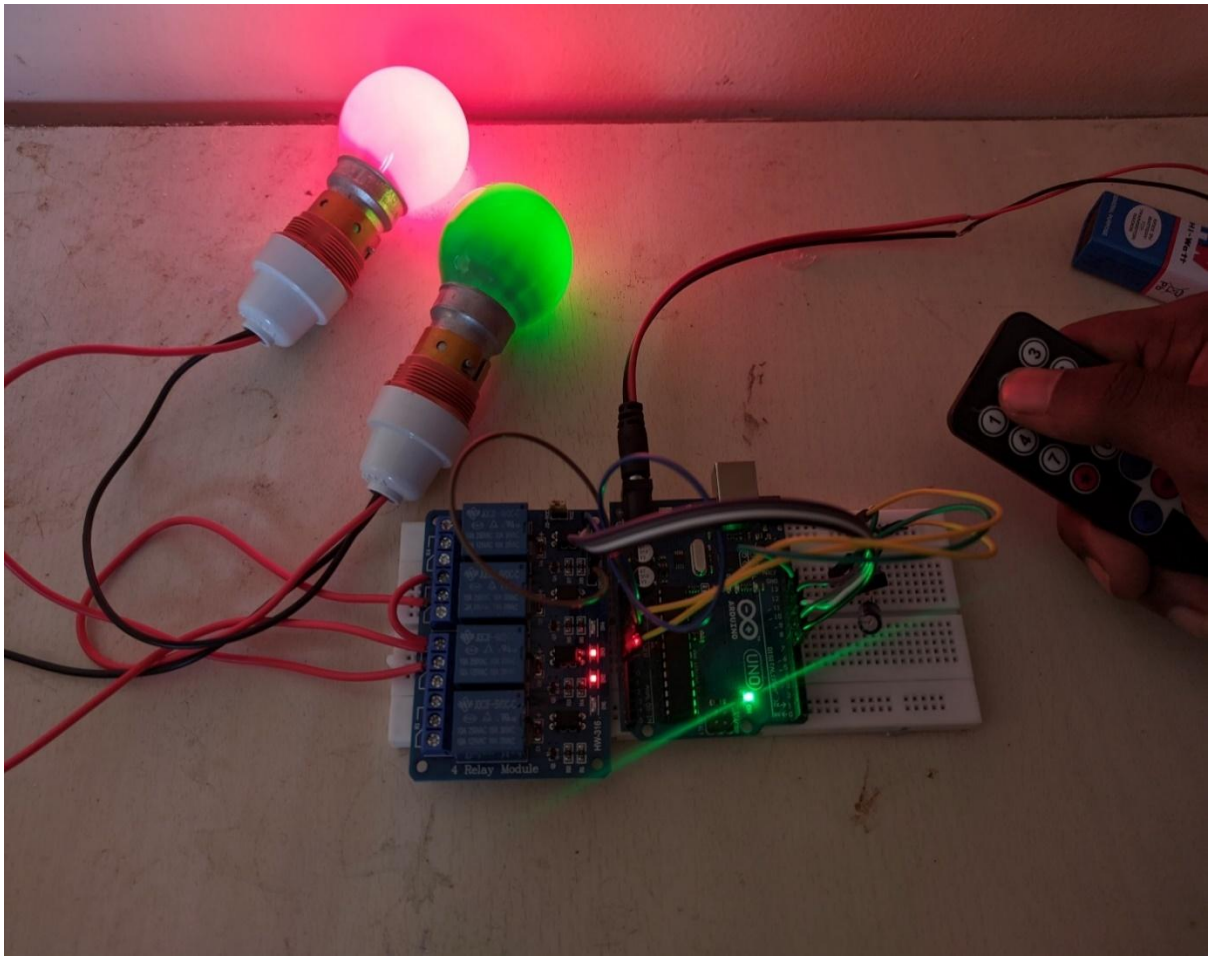

FIG 1.8 PICTURE OF DEMO

4.3 COMPONENTS REQUIRED:

- Arduino UNO

FIG 2.1 ARDUINO UNO

- RELAY MODULE

FIG 2.2 RELAY MODULE

- IR RECCIVER TSOP1738

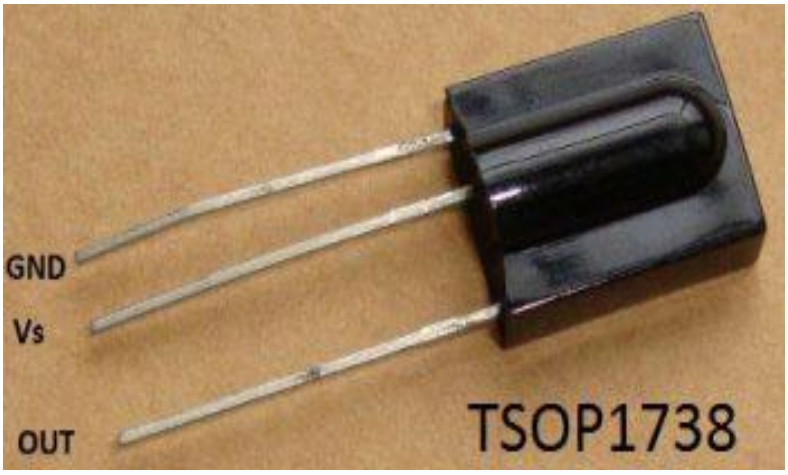

FIG 2.3 IR RECCIVER TSOP1738

- CAPACITOR 100nF

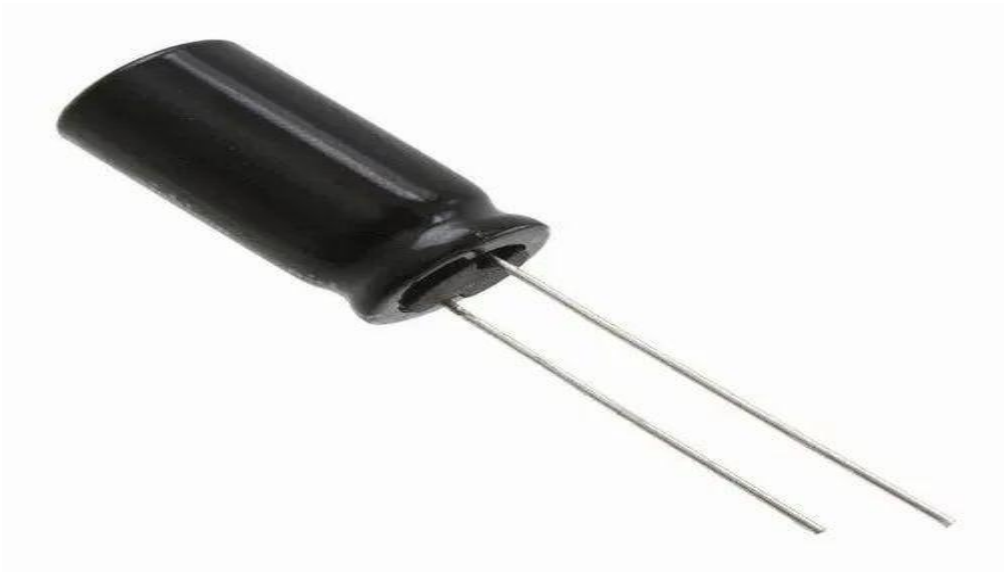

FIG 2.4 CAPACITOR 100nF

- BREAD BOARD

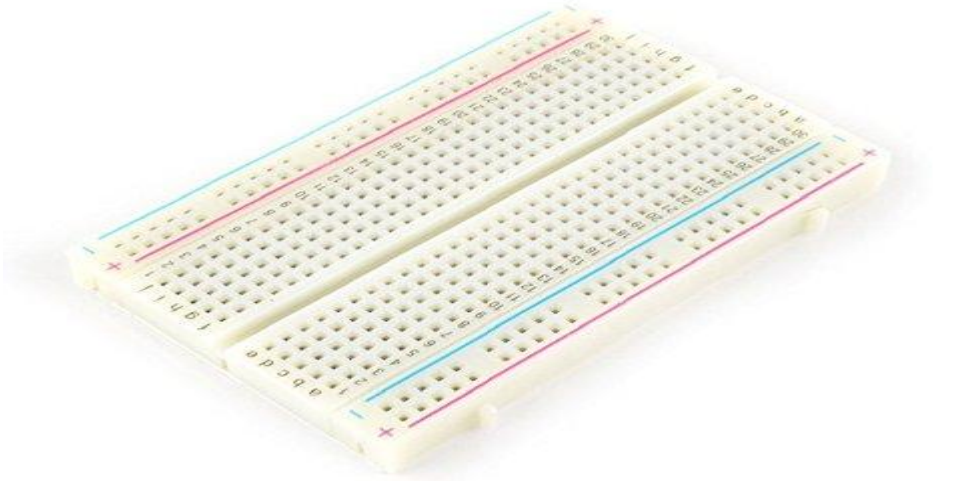

FIG. 2.5 BREAD BOARD

- BULB WITH HOLDER

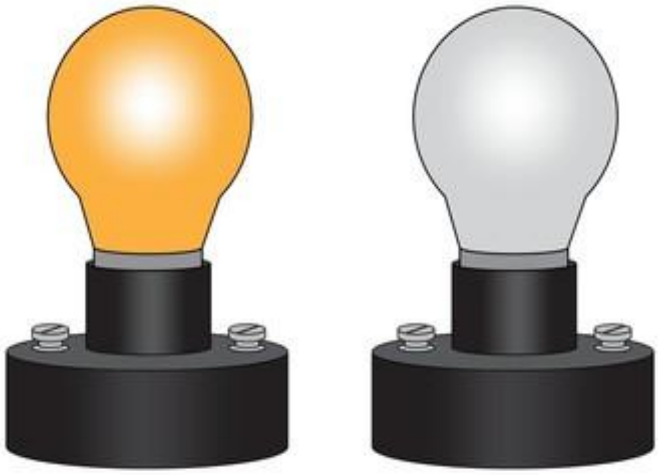

FIG 2.6 BULB WITH HOLDER

5 APPLICATIONS:

- Infrared remote control switches are used to control multiple things like, thyristor power control, TVs, video games, Space related equipments (NASA), etc.
- IR Remote Control Switch can also be used to switch on or off the electronic appliances like washing machines, radio, TVs, etc.
- By using the comparative relays we can switch ON or OFF the motor appliances also.
- Therefore, for controlling multiple devices like, TV, radio, CD/DVD players and IR obstacle detection etc., it is always better to use this type of IR remote switches.

6. CONCLUSION:

Home- automation for the "Home Automation" has a vast and great scope with limitless applications in this technology driven world. The system can be made more and more efficient and handy by make it applicable for varied range of devices. The basic motive of the system is to access the home appliances smartly and to reduce human efforts. Few suggestions for future research work on the paper can be like the user to set an on/off timer for home appliances, automatic lighting etc.

7. REFRENCES:

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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)
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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.

We express our sincere thanks to our Principal **Dr. H RAMAKRISHNA** for providing us with adequate facilities to undertake this project.

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.

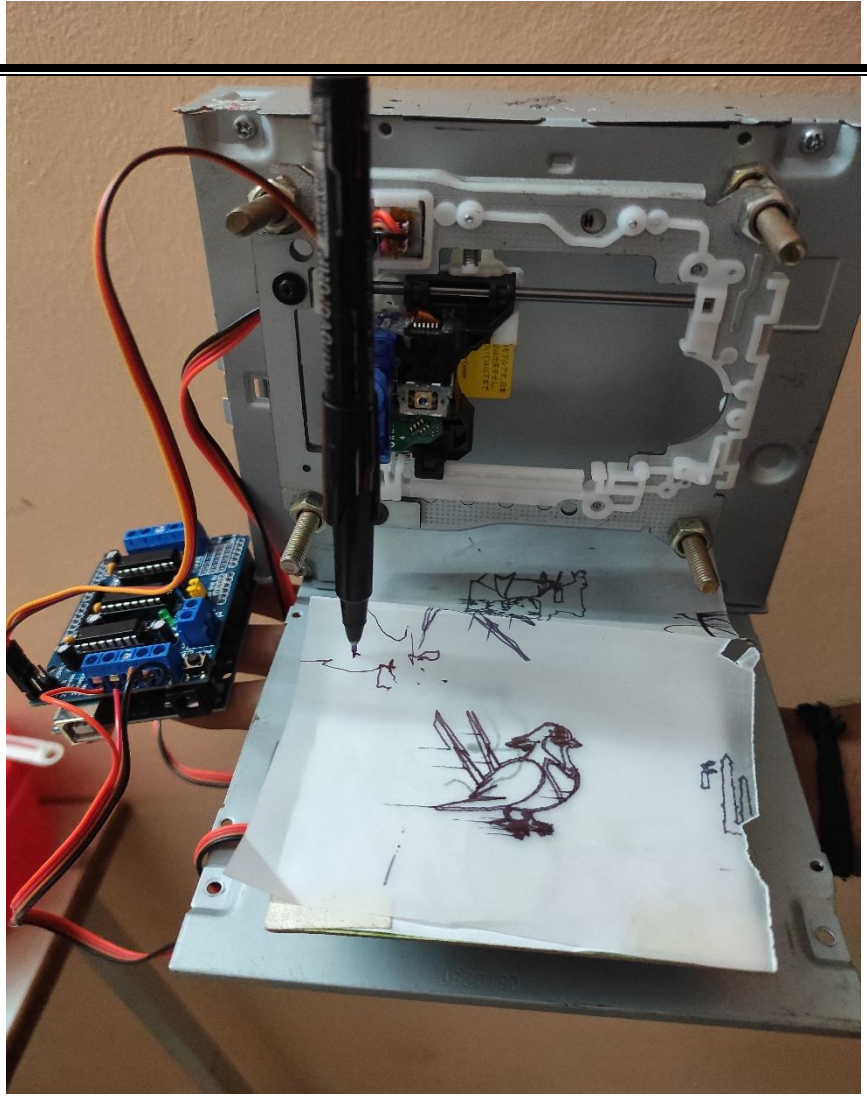
This drastically reduces human error during the controlled machining process and allows for high accuracy manufacture of the different parts. Another benefit of CNC machining is consistent and accurate workpieces.

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.

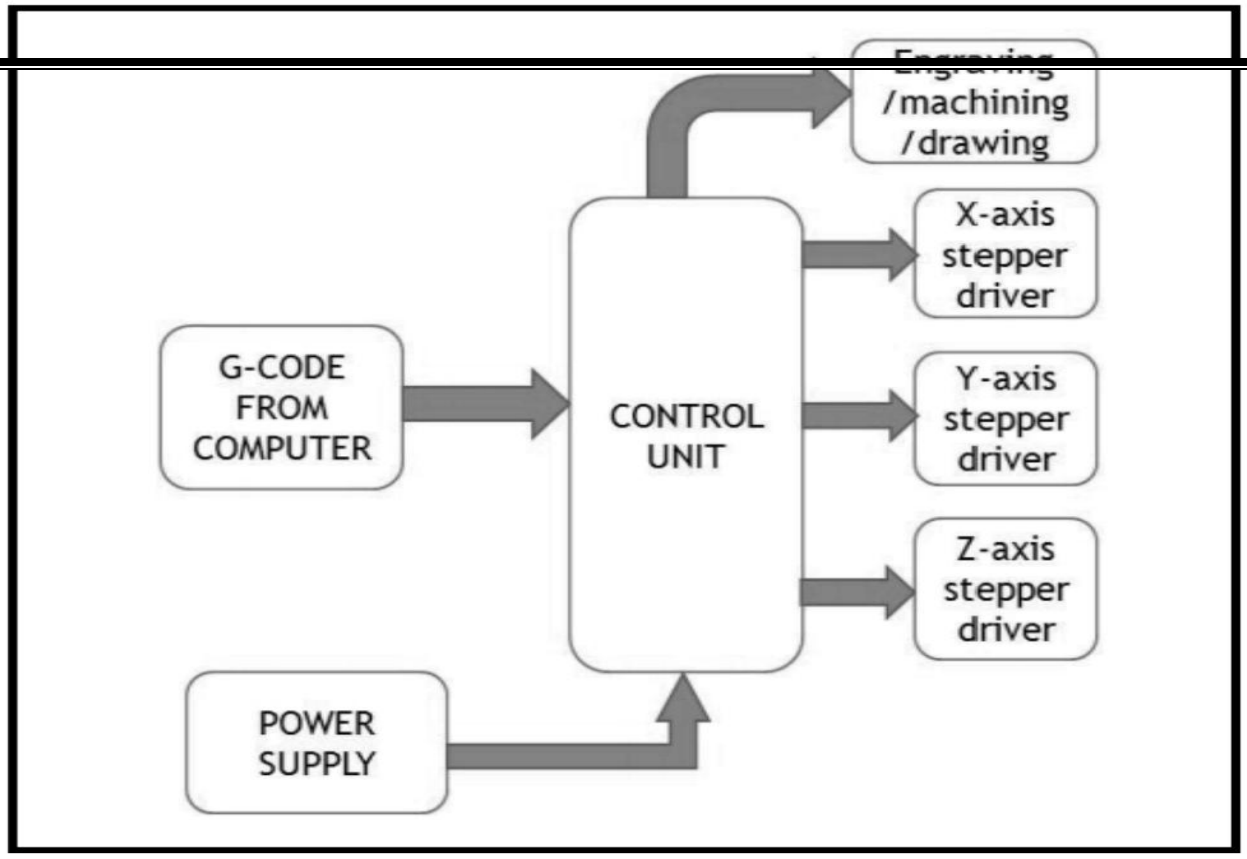
- **Venkata Krishna pabolu et al (2010)** discuss the design and implementation of low cost three dimensional computerised numerical control system (CNC) for industrial application.

  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

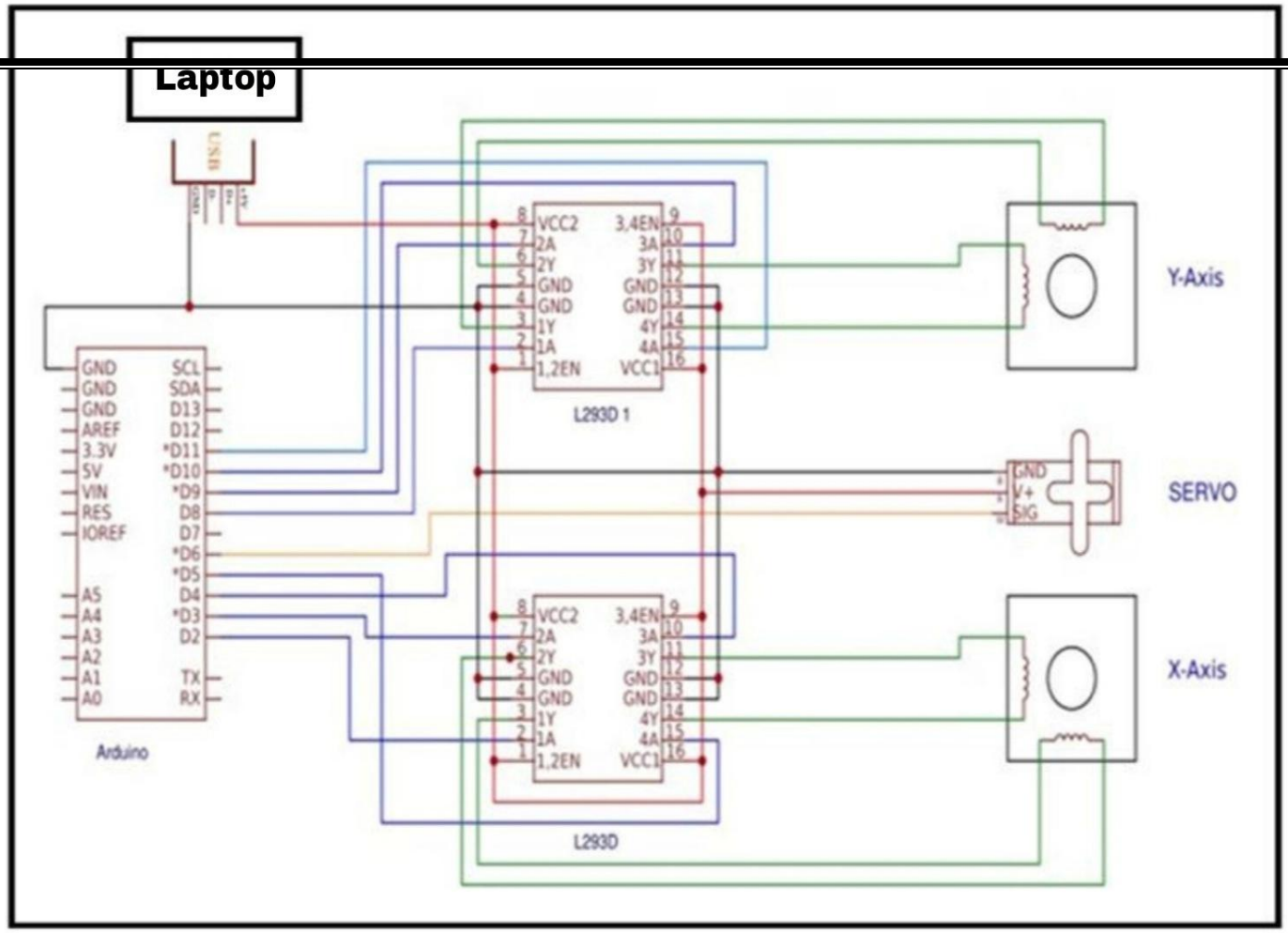


3.1 BLOCK DIAGRAM

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

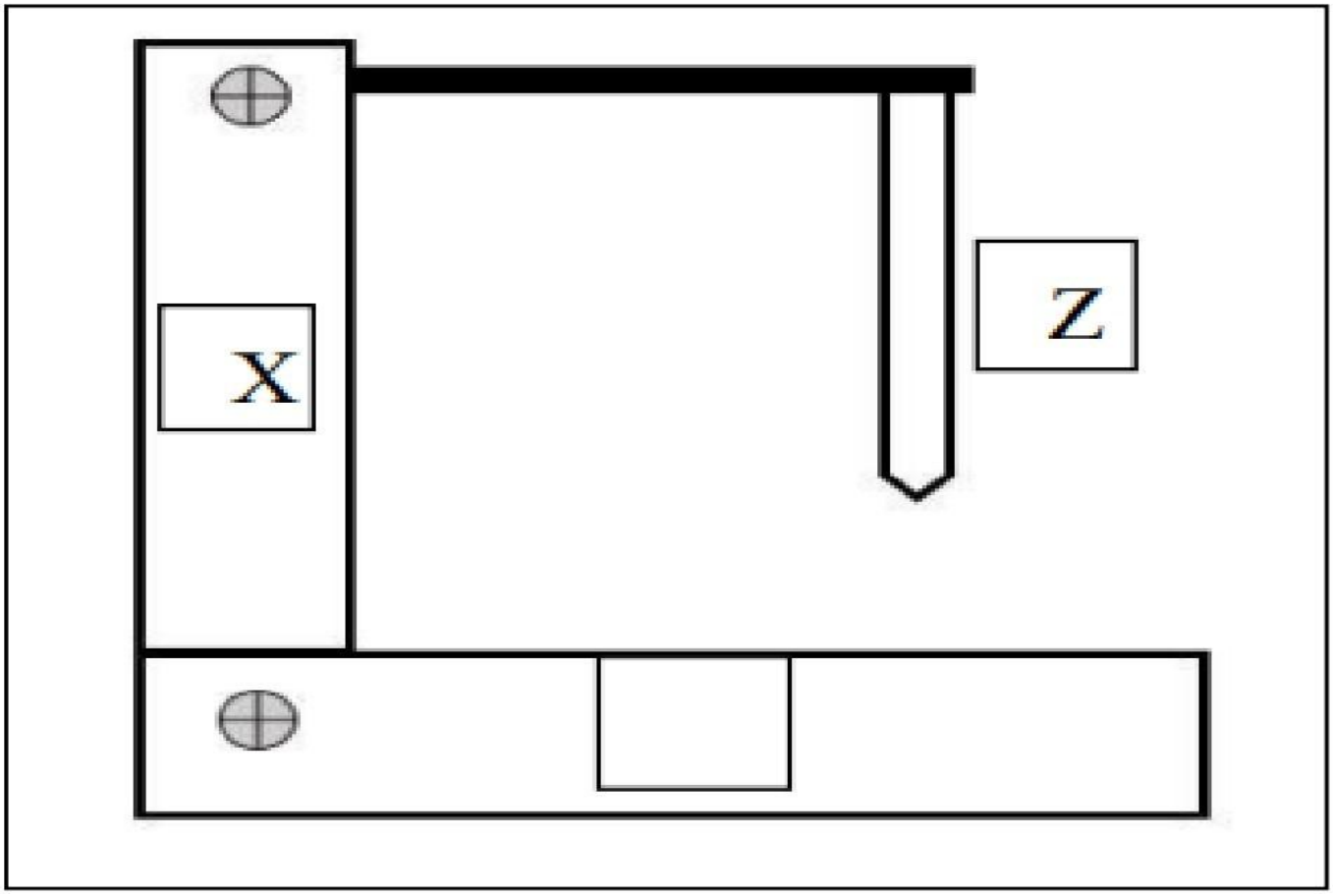
METHODOLOGY:

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

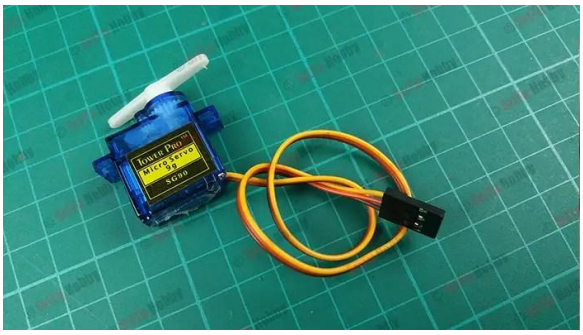
6.2 L293D MOTOR DRIVER:

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:

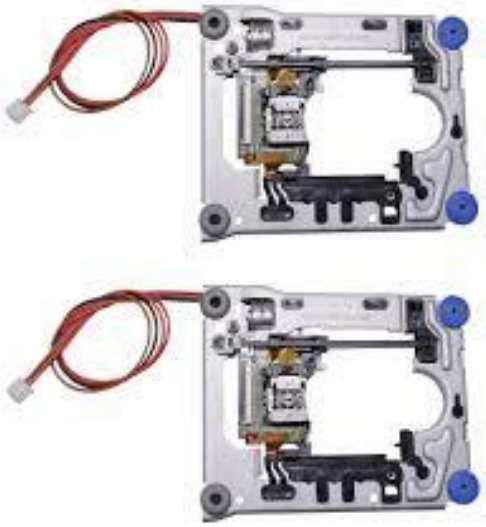
A servo motor is an entirely different story the function of the servo is to receive a control signal that represents a desired output position of the servo shift and apply power to its Dc motor until its shaft turns to that position.



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.



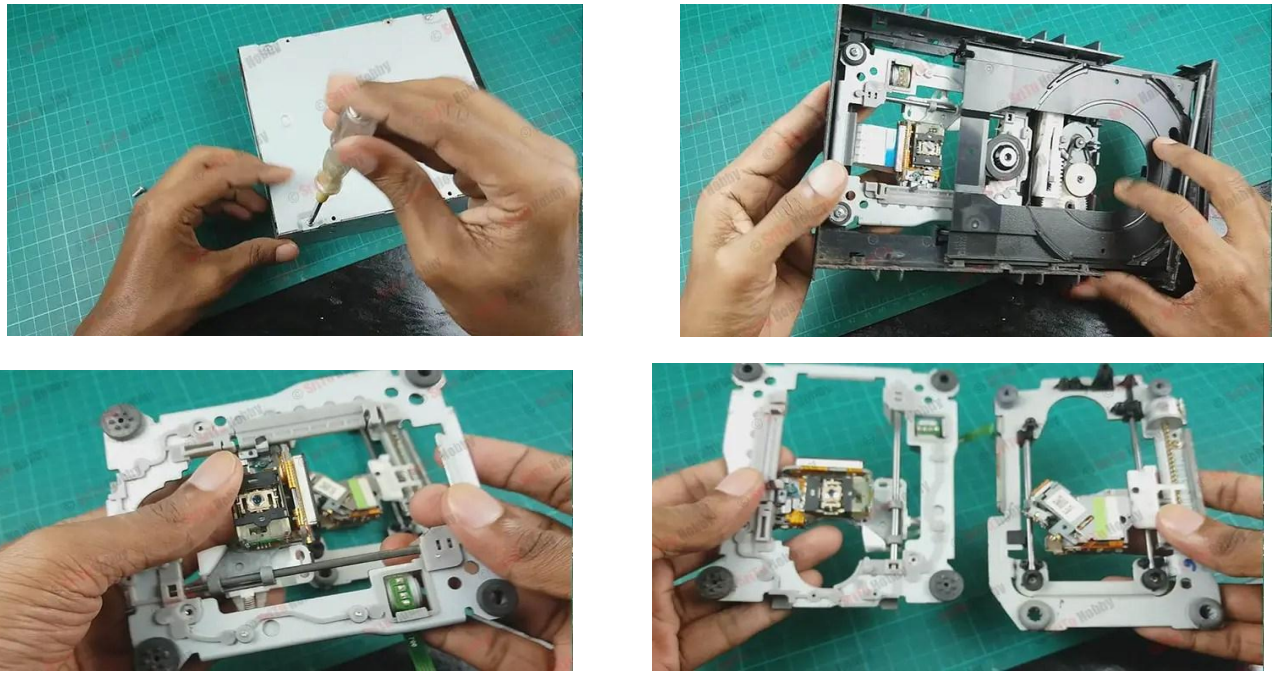
6.4 STEPPER MOTOR

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.

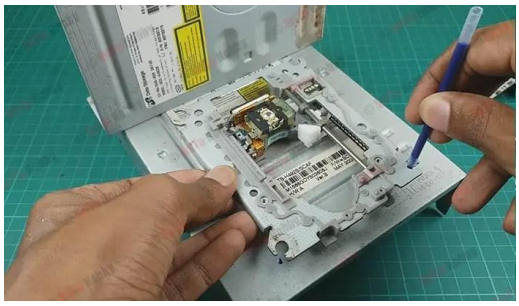


7.1 Step 1

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

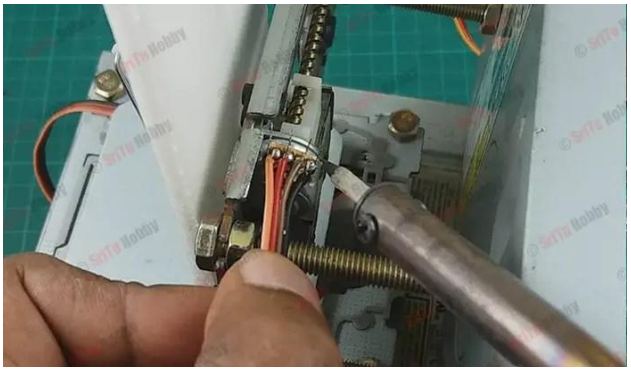
cut it to fit the construction. This is an easy procedure. Just make sure to put the Y axis straight to CNC base and the X axis vertically in this (90 degrees)



7.2 Step 2

STEP 3:

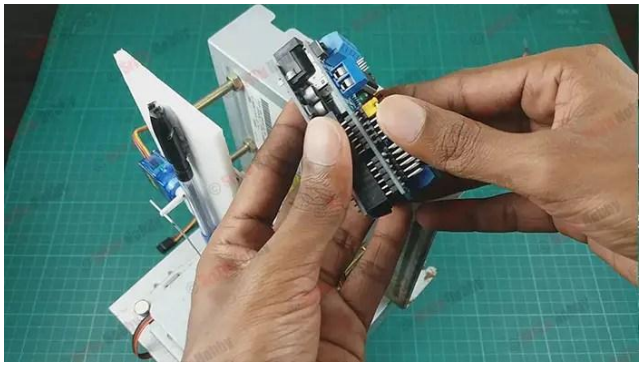
Soldering the stepper motors

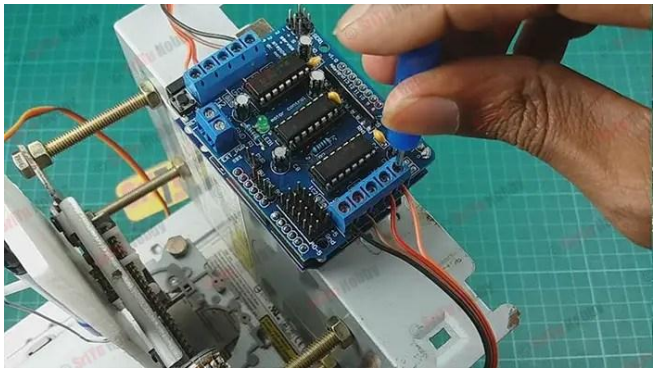


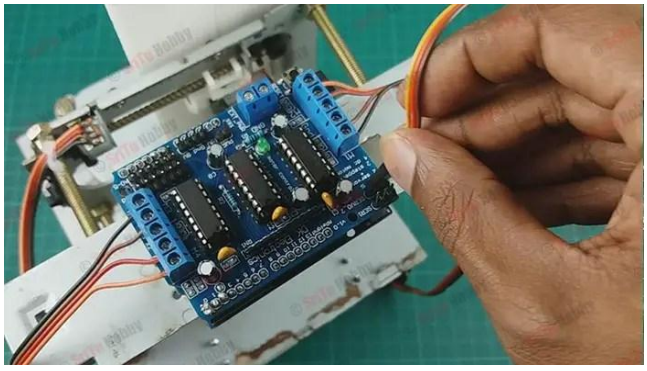
7.3 Step 3

Step 4:

Assembling L239D stepper driver and connecting it to stepper motors.







7.4 Step 4

Step 3:

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.

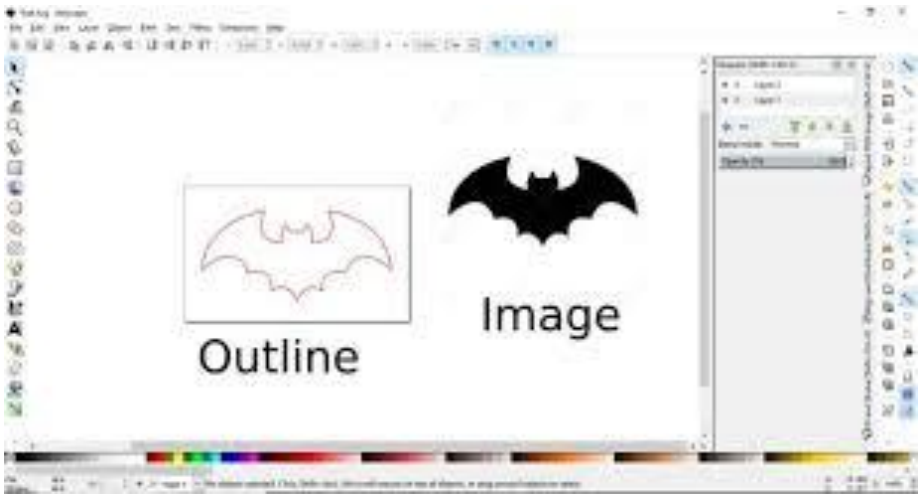


Fig No 9.1 INKSPACE 0.48.5

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.

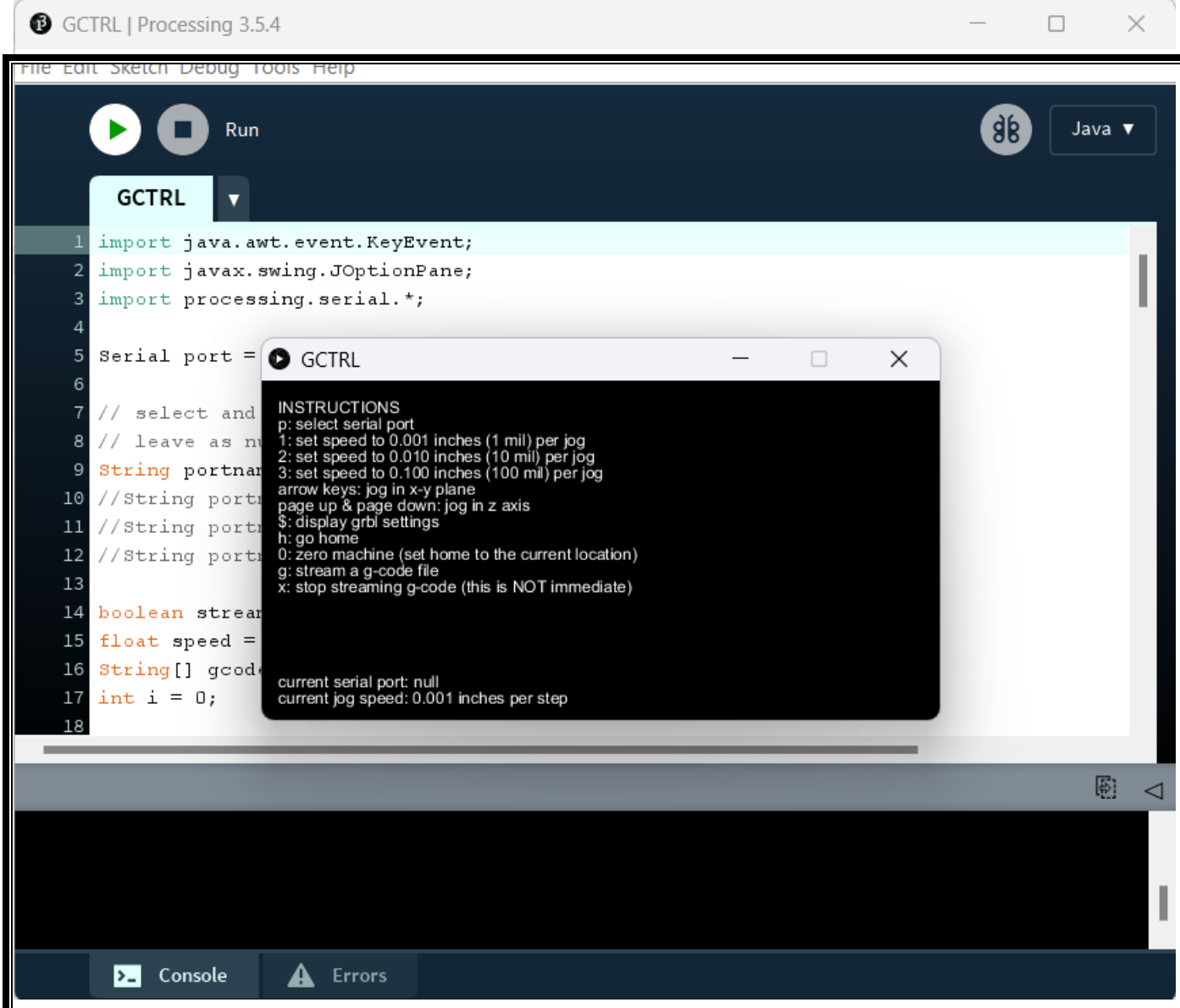


Fig No 9.2 PROCESSING

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 or 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:

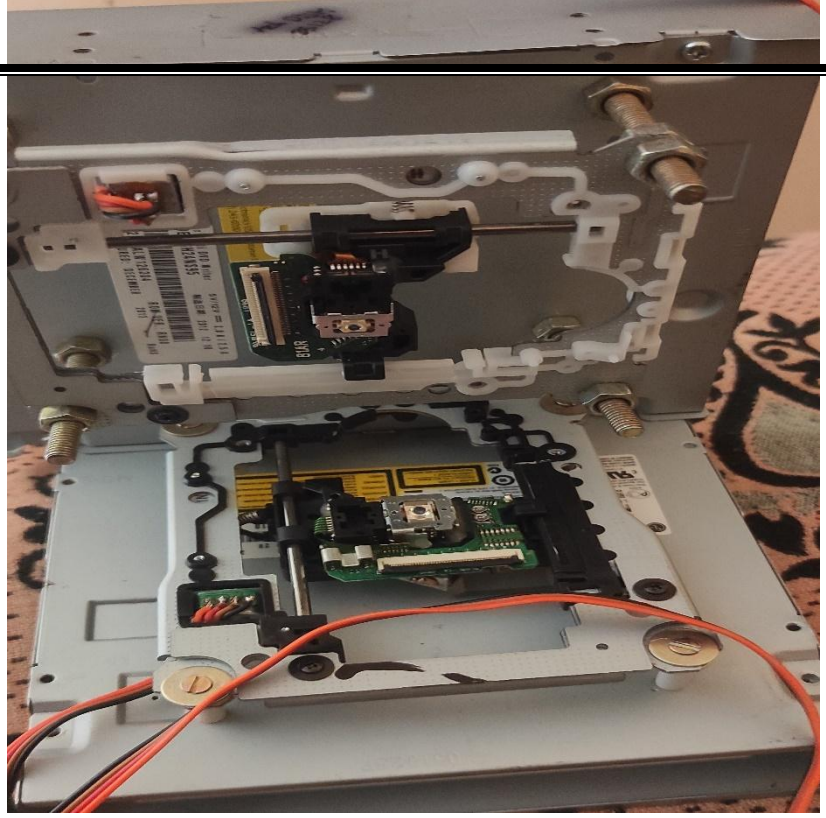
- Signage.
- Cabinets and furniture.
- Aluminum and brass machining.
- Prototyping and 3D modeling.
- Musical instruments.

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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[2] I. Nae and T. Andrei, "Designing and building a CNC router using stepper motors", Serial Technical, vo. LXII, pp. 55-62, 2010

[3] I. Pahole, L. Rataj, M. Ficko, S. Klancnik, S.Brezovnik, M.Brezocnik, and J. Balic, "Construction and evaluation of low cost table CNC milling machine", Scientific Bulletin, Series C: Mehcanics, Tribology, Machine Manufacturing Technology, vol. XXIII, pp. 1-7, 2009.

[4] Venkata Krishna pabolu et al discuss the design and implementation of low cost three dimensional computerized

[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.