CHAPTER 1: INTRODUCTION

1.1 Introduction

Working with automatic mechanical equipment demands precise, accuracy, speed, consistency and flexibility. In this case, it takes the help of embedded computer applications to do the job. One of the mechanical equipment combined with the microcomputer that has been widely used is a Computer Numerically Controlled. Robotic Arms are used for mechanical work such as cutting, engraving, drilling, and others. The computer technology used to control, parse and execute certain objects based on user command. In the manufacturing industry, the use of Robotic Arm greatly affects the increased production.

In Indonesia, Robotic Arm has not been developed so that they are imported directly from another country. This has an impact on the industry that is difficult to develop because of the price of Robotic Arm still expensive. The challenge is how to make Robotic Arm with good performance but low cost so that it can contribute to the acceleration of domestic manufacture industry.

Robotic Arm is popular and widely used in the industry is a Robotic Arm that can form objects on acrylic, glass, wood, and plate, mostly using laser, knife, or drill as cutting media. Research on the manufacture of Robotic Arm and fundamentals of embedded algorithms with the aim of producing high-performance Robotic Arm with low cost has been widely practiced. Research about the realization of low-cost Robotic Arm discusses the development of a low-cost 3-Axis Robotic Arm (B. Jayachandraiah, and R. A. Reddy, 2014). This research is main literature review on hardware dan mechanic design. A 3 axis Robotic as well as a LabVIEW-based application program as an instruction giver (Paulo, Rogério, and Maria, 2010). The paper does not specifically specify the use of the Robotic Arm. Robotic Arm, present a controlling system for Robotic Arms to mill and drill PCB board (M.A.A. Ali, A.M.A. ELShaikh, and S.F. Babiker, 2016). An object of PCB result of milling and drill and detail of test results not shown in the paper. Research on the development of algorithms for Robotic Arm control, in his paper, discussed the development of algorithms for interpreters and interpolators and then tested on Robotic Arms for linear as well as a circular interpolation (D.P. Desai and D.M. Patel., 2015).

This Computer Numerically Controlled router machine can be used as a tool to form 3-dimensional objects such as cutting, engraving, marking on wooden, acrylic and PCB objects. This paper also discussed in detail the results of testing the Computer Numerically Controlled performance parameters.

While most of the manufacturing activities have shifted to developing countries such as China and Brazil, the traditional machine tool manufacturing companies in western countries are all challenged to use their core competencies in a manner that produces highly differentiated and recognizable products. They are focused on innovative designs and using high precision components to make high-quality machine tools. The costs of these machine tools are much higher than the “Made-in-China” machines. A small company called “Computer Numerical Controlled Masters” in California is selling a small-scale Computer Numerical Controlled milling machine called Computer Numerical Controlled Baron Milling Machine for 6,575USD. This machine claims to have 0.001’’ (25.4μm) resolution and 0.00025’’ (6.35μm) repeatability, which is significantly better than “Made-in-China” machines. It also combines the interpolator and the driver into a control unit and integrates the unit onto the machine body, making the control much easier than “Made-in-China” machines.

A similar product called “PCNC 770 Computer Numerical Controlled Mill” sold by its competitor company “TORMACH” has relatively similar machine size and structure. The price is slightly higher (6,850USD) while all specifications are about the same. Both companies have many accessories available to upgrade the machine such as 4th rotational axis, coolant kit, and machine stands tools. The costs of these machine tools are much higher than the “Made-in-China” machines. A small company called “Computer Numerical Controlled Masters” in California is selling a small-scale Computer Numerical Controlled Milling Machine Called Computer Numerical Controlled Baron Milling Machine for 6,575USD. This machine claims to have 0.001’’ (25.4μm) resolution and 0.00025’’ (6.35μm) repeatability, which is significantly better than “Made-in-China” machines. It also combines the interpolator and the driver into a control unit and integrates the unit onto the machine body, making the control much easier than “Made-in-China” machines. A similar product called “PCNC 770 Computer Numerical Controlled Mill” sold by its competitor company “TORMACH” has relatively similar machine size and structure.

1.2 Objectives

- To develop a low-cost automatic computer numerical controlled Robotic Aram.
- To draw Printed Circuit Board (PCB) with point detection.
- To reduce the cost of the machine and increasing the flexibility.

1.3 Scope of Study

Our main goal was to develop and Design a Robotic Arm for point detection to print objects. This machine can be used for Cutting, Engraving, and Mark on wood, acrylic and PCB objects. It uses three stepper motors as linear actuators on each axis X, Y & Z. While printing/drawing, the proper synchronization of all thus three axis i.e. stepper motors, is a most challenging task. Finally, we make a Robotic Arm which to reduce the cost of the machine and increase the flexibility.

1.4 Problem Statement

The available Arduino controlled Computer Numerical Controlled Robotic Arms are having only2 axis movement. The structure is weak and can machine foam only. The fact that many devices whose are high machine cost. Their many devices work only print or only engraving, but not both in one device.

CHAPTER 2: LITERATURE REVIEW

2.1 Related Works

The first numerical control (NC) milling machine was conceived by Mr. John T. Parsons around 1940s-1950s. Parsons worked to attach servomotors to the x and y-axis of a manually operated machine tool to control them with a computer that read punches cards to give it positioning instructions. The reason for devising such a system was to machine complex shapes like arcs that can be made into airfoils for airplanes. This was not a trivial task to attempt with a manual milling machine, so the NC milling machine was born. (Mr. John T, 1940)

Today’s modern machinery is Computer Numeric Control milling machines and lathes. A microprocessor in each machine reads the G-Code program that the user creates and performs the programmed operations. Personal computers are used to design the parts and are also used to write programs by either manual typing of G-Code or using CAM (Computer Aided Manufacturing) software that outputs G-Code from the user's input of cutters and tool path.

2.2 Computer Numerical Control Robotic Arm concepts

An important advance in the philosophy of NC machine tools was the shift toward the use of computers instead of proprietary controller units in the NC system of the early 1970s. This gave rise to the computer numerical control. Robotic Arm is a self-contained NC system for a single machine tool including a dedicated minicomputer controlled by stored instructions to perform some or all of the basic NC functions. It has become widely used for manufacturing systems mainly because of its flexibility and less investment required.

Replacing conventional NC hardware with software as much as possible and simplifying the remaining hardware is one of the objectives of Computer Numerical Controlled systems. While most interpretation and interpolation functions can be replaced by proper software, the remaining hardware must contain at least servo amplifiers, transducer circuits, and an interface component.

The software portion of a computer numerical control system must consist of at least of three major programs: a part program, a service program, and a control program. The part program contains the geometry description of the part being produced and the cutting conditions such as spindle speed and federate. Computer Aided Manufacturing (CAM) software can be used to generate this part program.

It usually has a user interface that allows the user to operate the machine easily. The control program accepts the part program as input data and produces signals to drive the axes of motion. It performs interpolation, federate control, acceleration, and deceleration, and position counters showing the current axes position.

Most closed-loop computer numerical control Robotic Arm systems include both velocity and position control loops. The velocity feedback is usually provided by a tachometer and the position feedback is usually provided by an encoder or resolver. Computer numerical control software can also retrieve velocity feedback from encoder by differentiating the input signal.

The computer output in computer numerical control systems can be transmitted either as a sequence of reference pulses or as a binary word. If the reference pulse sequence is generated, each pulse generates a motion of 1 BLU of axis travel. The number of pulses represents the position and the pulse frequency represents axis velocity. In an open-loop system, these pulses are the control signal of a stepper motor. In a closed-loop system, these pulses can be fed as a reference signal.

2.3 Design consideration of Robotic Arm tools

Robotic Arm tools must be better designed and constructed and must be more accurate than conventional machine tools. It is necessary to minimize all non-cutting machine time, by fast tool changing methods, and minimize idle motions by increasing the rapid traverse velocities to make the use of the machine tool more efficient.

Digital control techniques and computers have undoubtedly contributed to better accuracy and higher productivity. However, it should be noted that it is the combined characteristics of the electric control as well as the mechanical design of the machine tool itself that determine the final accuracy and productivity of the machine tool system.

High productivity and accuracy might be contradictory. Because high productivity requires higher feed, speed, and depth of cut, which increases the heat and cutting forces in the system. This will lead to higher deflections, thermal deformations, and vibration of the machine, which results in accuracy deterioration. Therefore, to achieve high operating bandwidth while maintaining relatively high accuracy, the structure of computer numerical control tool must be more rigid and stiff than its conventional counterpart.

To achieve better stiffness and rigidity of structure, several factors should be considered in the design. The first concern is the material. Conventional machine tools are made of cast iron. However, the structures of Robotic Arm are usually all-steel-welded, constructed to achieve greater strength and rigidity for a given weight. In addition, better accuracy is obtained in Robotic Arms by using low-friction moving parts, avoiding lost motions and isolating thermal sources.

CHAPTER 3: METHODOLOGY

3.1 Introduction

A methodology is a set of ideas or guidelines about how to proceed in collecting and validating knowledge of a subject matter. Different areas of science have developed very different bodies of methodology on the basis of which to conduct their research. We can say that a methodology provides a guide for carrying out some or all of the following activities:

- Probing the empirical details of the domain of phenomena.
- Discovering explanations of surprising outcomes or patterns.
- Identifying entities or forces.
- Establishing patterns.
- Providing predictions.
- Separating noise from the signal.
- Using empirical reasoning to assess hypotheses and assertions.

3.2 Methodology

In this model, typically, the outcome of one phase acts as the Input for the next phase sequentially. Following is a diagrammatic representation of different phases of the model. The model has the five phases or steps of designing a network and these design phases are as follows:

- Problem Define,
- Study of Analysis,
- Design and Development,
- Testing
- Result.

Block Diagram of Methodology

This is the full steps to solve our problem

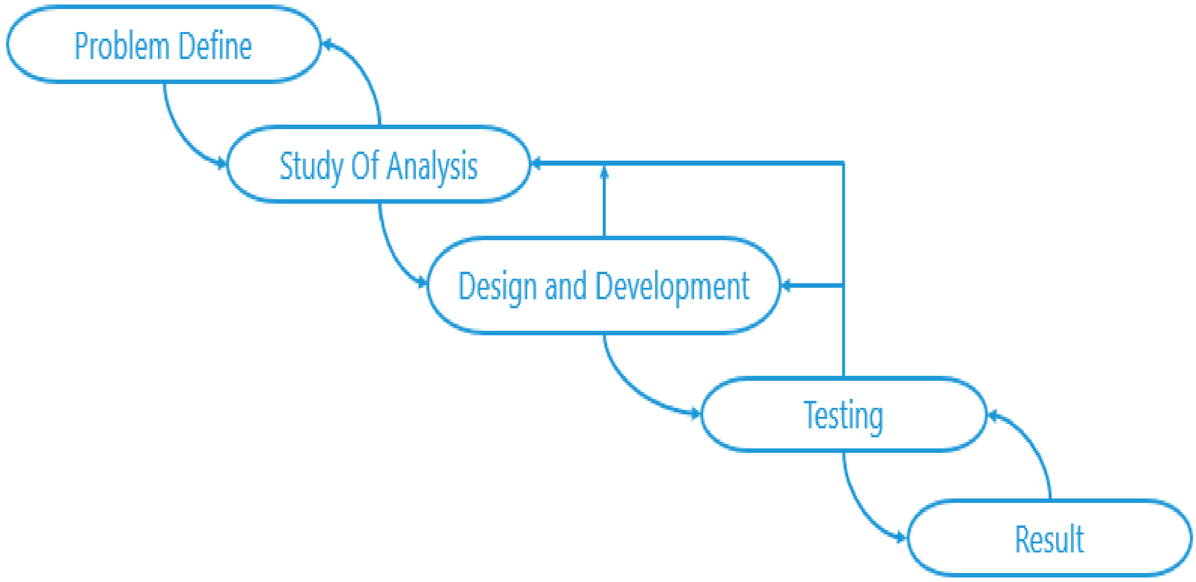


Figure 3.1: Block diagram of a methodology

3.2.1 Problem Define Phase

Problem define is made of whether the identified user needs may be the satisfied problem. Computer Numerical Controlled Robotic Arm is a process used in the manufacturing sector that involves the use of computers to control machine tools. A computer program is customized for an object and the machines are programmed with Computer Numerical Controlled machining language (called G-code) that essentially controls all features like feed rate, coordination, location, and speeds. With Computer Numerical Controlled Robotic Arm, the computer can control exact positioning and velocity. Computer Numerical Controlled machining is used in manufacturing both metal and plastic parts. The work includes design & development of prototype modeling of Computer Numerical Controlled machine tool controller unit. In modern Computer Numerical Controlled systems, the end-to-end component design is highly automated using a computer- programs produce a computer file that is interpreted to extract the commands needed to operate an aided design (CAD) and computer-aided manufacturing (CAM) programs.

Robotic Arms are having only 2 axis movement. The structure is weak and can machine foam only. The fact that many devices whose are high machine cost. Their many devices work only print or only engraving, but not both in one device. So, it is our big challenge to design this Robotic Arm.

3.2.2 Study of Analysis phase

Requirements analysis is critical to the success or failure of a systems or software project. The requirements should be documented, actionable, measurable, testable, traceable, related to identified business needs or opportunities, and defined to a level of detail sufficient for system design. Study of Analysis give the requirement specification, a search is made for analysis to implement the specification.

Computer Numerical Controlled Robotic Arm is worked on input as a G code of Design and converting it via the use of Arduino, Stepper Drivers, Computer Numerical Controlled Shield, and Stepper Motor into a Rotation of Leadscrew. We have work on to maintain the lowest cost of our project. We have designed a simple construction of our project. This is an easier way to use the stepper motor with the lead screw, Robotic Arm shield, Stepper drivers, Arduino Board, etc.

3.2.3 Design and Development Phase

The initial requirements determined in the Plan phase drive the software design specialists' activities. These specialists design the software according to those initial requirements, incorporating any additional data gathered during software analysis and software audit (when upgrading existing software) and through discussion with managers and software users. The software design specification that is produced is a comprehensive detailed design that meets current business and technical requirements and incorporates specifications to support availability, reliability, security, scalability, and performance. This design specification provides the basis for the implementation activities.

3.2.4 Testing Phase

In this phase, the testing this stage, software design is realized as a set of programs or program. Unit meets its specification. All the units developed in the implementation phase are integrated into a system after testing of each unit. Post-integration the entire system is tested for any faults and failures.

Testing Individual program unit s or programs are integrated and tested as a complete system to ensure that the machine requirements have been met. After testing, the machine system is delivered to the customer.

3.2.5 Result Phase

The finding can only confirm or project the hypothesis underpinning your study. However, the act of articulating the results helps you to understand the problem from within, to break it into pieces, and to view the research problem from various perspectives.

We first select port, then send instruction or G-Code from the computer or mobile then all instruction is received by Control unit. Control unit convert instruction and control X, Y & Z axis. Finally, Stepper Motors will work or be drilling, engraving and object print.

3.3. Working Flowchart of the System

This the full flowchart of our problem

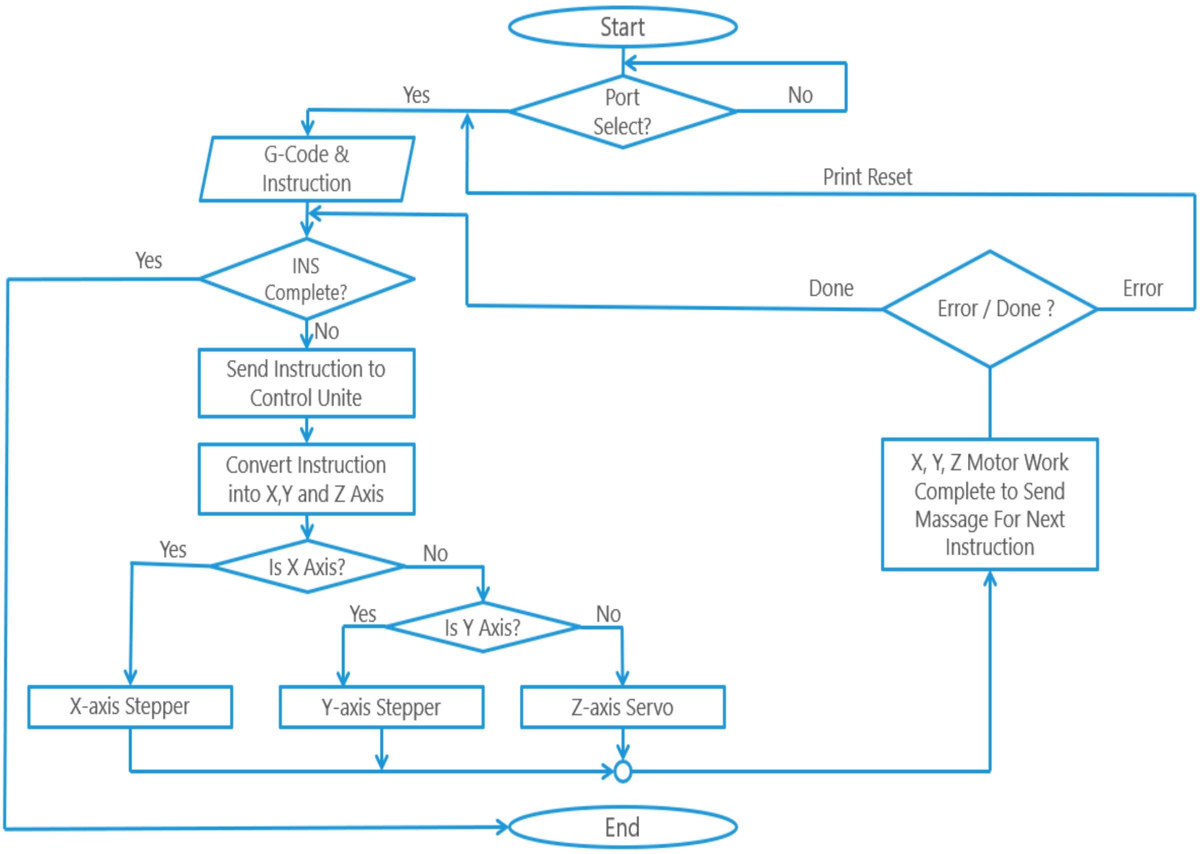


Figure 3.2: Working flowchart

3.4 Project Algorithm

Step 1: Start

Step 2: Port selection Yes or not?

If yes to Step 3 go to G-Code Instruction.

Else Step 1 again port selection.

Step 3: Send G-Code Instruction.

Step 4: Instruction complete or not?

If yes Printing End.

Else go to next Step 4 send the instruction to control Unite.

Step 5: Convert Instruction into X, Y, and Z-Axis.

If yes Printing End.

Else go to next Step 4 send the instruction to control Unite.

Step 6: Is X axis?

If Yes Send Instruction Step 8 X-axis Stepper Motor.

Else to send Step 7 Is Y-Axis?

Step 7: Is Y-Axis?

If Yes Send Instruction Step 9 Y-axis Stepper Motor.

Else to Send Instruction Step 10 Z-axis Stepper Motor.

Step 8: X-axis Stepper motor work complete.

Step 9: Y-axis Stepper motor work complete.

Step 10: Z-axis Servo motor work complete.

Step 11: X, Y, Z Motor Work Complete to Send Massage for Next Instruction.

Step 12: Checking Instruction Error or Done?

If Done to request Next Instruction.

Else Error to Print Reset.

Step 13: When the All Instruction is complete?

Yes, to Step 14 Print End.

Step 14: Print End.

CHAPTER 4: DESIGN, DEVELOPMENT, AND ANALYSIS

4.1 Tools and Techniques

Processing is an open-source computer programming language and integrated development environment (IDE) built for the electronic arts, new media art, and visual design communities with the purpose of teaching non-programmers the fundamentals of computer programming in a visual context. The Processing language builds on the Java language but uses a simplified syntax and a graphics user interface.

The project was initiated in 2001 by Ryan Hopkins and Casey Reas and Ben Fry, both formerly of the Aesthetics and Computation Group at the MIT Media Lab. In 2012, they started the Processing Foundation along with Daniel Shiffman, who joined as a third project lead. Johanna Hedva joined the Foundation in 2014 as Director of Advocacy.

4.1.2 Mobile Platform (Android Studio)

Android Studio is the officially integrated development environment (IDE) for Google's Android operating system, built on JetBrains' IntelliJ IDEA software and designed specifically for Android development. It is available for download on Windows, macOS and Linux based operating systems. It is a replacement for the Eclipse Android Development Tools (ADT) as primary IDE for native Android application development.

Android Studio was announced on May 16, 2013, at the Google I/O conference. It was in early access preview stage starting from version 0.1 in May 2013, then entered beta stage starting from version 0.8 which was released in June 2014. The first stable build was released in December 2014, starting from version 1.0. The current stable version is 3.1 released in March 2018.

4.1.3 UI G4P GUI builder

A graphical user interface builder (or GUI builder), also known as GUI designer, is a software development tool that simplifies the creation of GUIs by allowing the designer to arrange graphical control elements (often called widgets) using a drag-and-drop WYSIWYG editor. Without a GUI builder, a GUI must be built by manually specifying each widget's parameters in source-code, with no visual feedback until the program is run.

User interfaces are commonly programmed using an event-driven architecture, so GUI builders also simplify creating event-driven code. This supporting code connects widgets with the outgoing and incoming events that trigger the functions providing the application logic.

Some graphical user interface builders, such as e.g. Glade Interface Designer, automatically generate all the source code for a graphical control element. Others, like Interface Builder, generate serialized object instances that are then loaded by the application.

4.1.4 Arduino IDE v1.8.5

Arduino is an open-source computer hardware and software company, project, and user community that designs and manufactures single-board microcontrollers and microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical and digital world. The project's products are distributed as open-source hardware and software, which are licensed under the GNU Lesser General Public License (LGPL) or the GNU General Public License (GPL), permitting the manufacture of Arduino boards and software distribution by anyone. Arduino boards are available commercially in preassembled form, or as do-it-yourself (DIY) kits.

Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards or Breadboards(shields) and other circuits. The boards feature serial communications interfaces, including Universal Serial Bus (USB) on some models, which are also used for loading programs from personal computers. The microcontrollers are typically programmed using a dialect of features from the programming languages C and C++. In addition to using traditional compiler toolchains, the Arduino project provides an integrated development environment (IDE) based on the Processing language project.

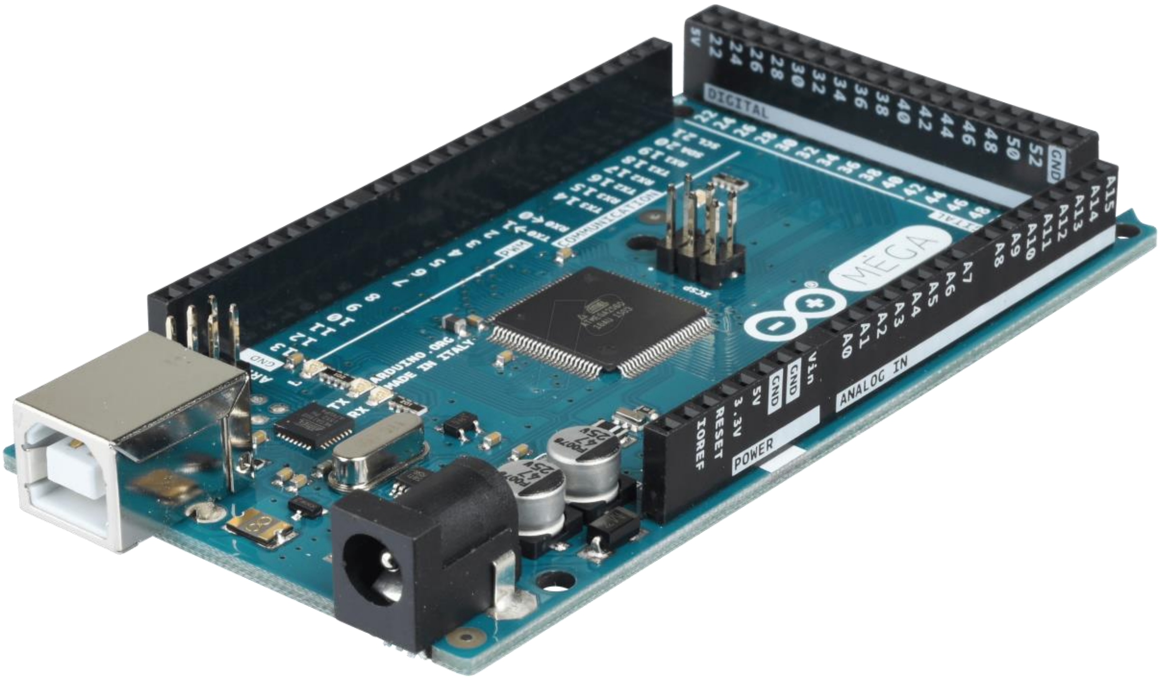


Figure 4.1: Arduino Mega

The Arduino project started in 2003 as a program for students at the Interaction Design Institute Ivrea in Ivrea, Italy, aiming to provide a low-cost and easy way for novices and professionals to create devices that interact with their environment using sensors and actuators. Common examples of such devices intended for beginner hobbyists include simple robots, thermostats, and motion detectors.

The name Arduino comes from a bar in Ivrea, Italy, where some of the founders of the project used to meet. The bar was named after Arduino of Ivrea, who was the margrave of the March of Ivrea and King of Italy from 1002 to 1014.

4.1.5 G-Code

G-code (also RS-274), which has many variants, is the common name for the most widely used numerical control (NC) programming language. It is used mainly in computer-aided manufacturing to control automated machine tools. G-code is sometimes called G programming language, not to be confused with LabVIEW's G programming language.

G-code is a language in which people tell computerized machine tools how to make something. The "how" is defined by g-code instructions provided to a machine controller (industrial computer) that tells the motors where to move, how fast to move, and what path to follow. The most common situation is that, within a machine tool, a cutting tool is moved according to these instructions through a toolpath and cuts away material to leave only the finished workpiece. The same concept also extends to noncutting tools such as forming or burnishing tools, photo plotting, additive methods such as 3D printing, and measuring instruments.

4.1.6 Java (SE) Language 10

The latest version is Java 10, released on March 20, 2018, which follows Java 9 after only six months in line with the new release schedule. Java 8 is still supported but there will be no more security updates for Java 9. Versions earlier than Java 8 are supported by companies on a commercial basis; e.g. by Oracle back to Java 6 as of October 2017 (while they still "highly recommend that you uninstall" pre-Java 8 from at least Windows computers).

4.1.7 System Requirement

Hardware Requirements

For Implementation purpose minimum configuration is needed.

- Processing Speed- 1.6 GHz dual-core or machine
- Random Access Memory (RAM)- 2 GB or higher
- 5GB Disk Space
- Windows 7, Windows 8, Windows 10 or Android
- LED or LCD Monitor
- USB cable
- Android phone or Tablet
- Stepper Motor two Piece
- Arduino Mega 2560
- Breadboard
- Veroboard
- Male to Male Connector
- Male to Female Connector

Software Requirements

- Processing v3.0
- G4P GUI Builder
- Arduino IDE v1.8.5
- Mobile Platform (Android Studio)
- jViewer.

4.2 Components Used

4.2.1 Stepper Motor

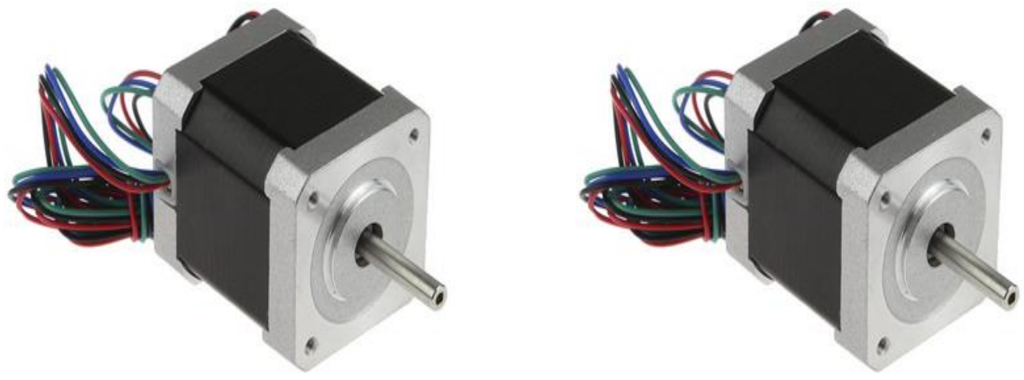


Figure 4.2: X& Y-Axis Stepper Motor

A stepper motor or step motor or stepping motor is a brushless DC electric motor that divides a full rotation into a number of equal steps. The motor's position can then be commanded to move and hold at one of these steps without any position sensor for feedback (an open-loop controller), as long as the motor is carefully sized to the application in respect to torque and speed.

Switched reluctance motors are very large stepping motors with a reduced pole count, and generally are closed-loop commutated.

4.2.2 Servo Motor

Figure 4.3: Z-axis servo Motor

A servomotor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity, and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors.

Servomotors are not a specific class of motor although the term servomotor is often used to refer to a motor suitable for use in a closed-loop control system.

Servomotors are used in applications such as robotics, CNC machinery or automated manufacturing.

4.2.3 L293D Motor Driver

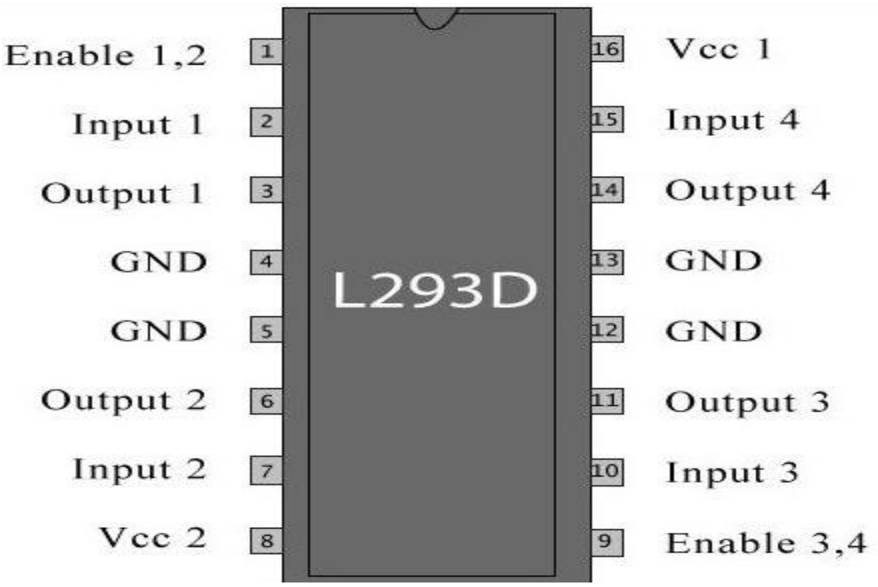


Figure 4.4: L293D Motor Driver

The L293D is a 16 pin IC, with eight pins, on each side, dedicated to the controlling of a motor. There are 2 INPUT pins, 2 OUTPUT pins and 1 ENABLE pin for each motor. L293D consist of two H-bridge. H-bridge is the simplest circuit for controlling a low current rated motor.

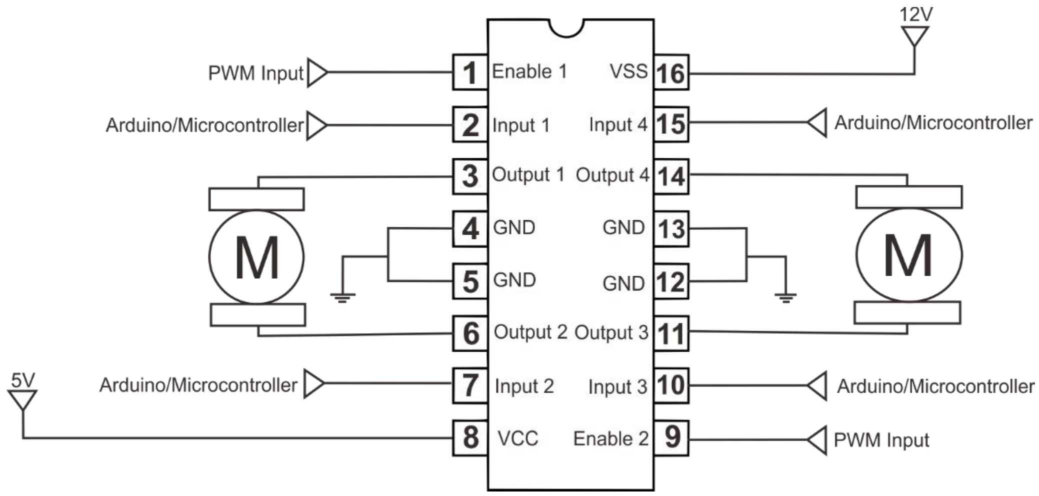


Figure 4.5: Working Procedure L293D Motor Driver

4.2.3.1 L293D Pin No. - Pin Characteristics

- 1 - Enable 1-2, when this is HIGH the left part of the IC will work and when it is low the left part won't work.
- 2 - INPUT 1, when this pin is HIGH the current will flow through output 1.
- 3 - OUTPUT 1, this pin should be connected to one of the terminals of the motor.
- 4 - GND, ground pins.
- 5 - GND, ground pins.
- 6 - OUTPUT 2, this pin should be connected to one of the terminals of the motor.
- 7 - INPUT 2, when this pin is HIGH the current will flow through output 2.
- 8 - VCC2, this is the voltage which will be supplied to the motor.
- 9 - Enable 3-4, when this is HIGH the right part of the IC will work and when it is low the right part won't work.
- 10 - INPUT 3, when this pin is HIGH the current will flow through output 3.
- 11 - OUTPUT 3, this pin should be connected to one of the terminals of the motor.
- 13 - GND, ground pins.
- 12 - GND, ground pins.
- 14 - OUTPUT 4, this pin should be connected to one of the terminals of the motor.
- 15 - INPUT 4, when this pin is HIGH the current will flow through output 4.
- 16 - VCC1, this is the power source to the IC. So, this pin should be supplied with 5V.

4.2.4 Breadboard

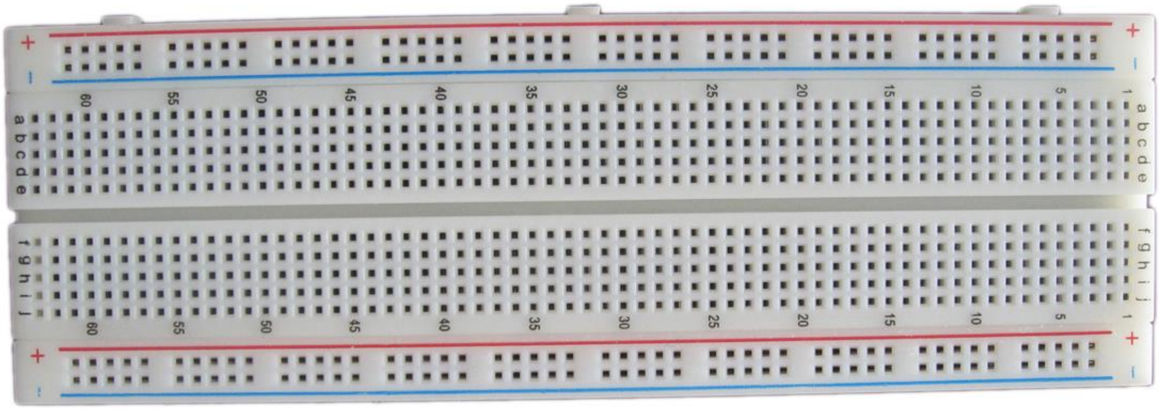


Figure 4.6: Breadboard

A breadboard is a solderless device for a temporary prototype with electronics and test circuit designs. Most electronic components in electronic circuits can be interconnected by inserting their leads or terminals into the holes and then making connections through wires where appropriate. The breadboard has strips of metal underneath the board and connects the holes on the top of the board. The metal strips are laid out as shown below. Note that the top and bottom rows of holes are connected horizontally and split in the middle while the remaining holes are connected vertically.

4.2.5 Voltage Adaptor

Figure 4.7: Voltage Adaptor

A small adapter allows American-style plugs (two flat prongs) to fit into British or Irish outlets (which take three rectangular prongs) or continental European outlets (which take two round prongs). Unless my trip is UK-only I bring a handful of the continental adapters - and even on a continent-only trip, I always have at least one British adapter on hand for London layovers. Secure your adapter to your device's plug with electrical or duct tape; otherwise, it can easily get left behind in the outlet (hotels and B&Bs sometimes have a box of abandoned adapters - ask). Many sockets in Europe are recessed into the wall; your adapter should be small enough so that the prongs seat properly in the socket. Although you can get universal adapters that work Europe-wide (or even worldwide), these tend to be large, heavy, and more expensive.

4.2.6 Cost summary

The costs of everything required to make a mini Robotic Arm until now are listed in the table 4.2.6.1. For now, the total cost is well below our budget Robotic Arm.

4.2.6.1 Table: Cost summary for Robotic Arm prototype

Item	Description	Price
01	Arduino Mega 2560	1000
02	Stepper Motor 2 pitch	3000
03	Servomotor	450
04	IC L293D 3 pitch	400
05	IC Base 16pin 3pitch	50
06	Solid steel 0.5mm 5’fit	250
07	Adaptor 12v	200
08	PCB board	250
09	Teeth belt 5’fit	450
10	DC Socket	50
11	Vero Board	70
12	Pulley 2 pitch	300
13	Drill bit 0.5mm	140
14	Glue Gun 80W	150
15	Glue Gun Sticks 8pitch	120
16	Multimeter	500
17	Plastic Board	350

18	**Male Female Connector**	**100**
19	**Male to Male Connector**	**100**
20	**Single Wire**	**30**
21	**Soldering Iron**	**360**
22	**Soldering Lead**	**40**
	Total amount of cost = 8,360 Taka	

Table 4.2.6.1: Cost summary for Robotic Arm

4.3 System Design

The main aim of this is to control our control unit that will be created by this Control Unit. Control Unit, step by step work which is provided by a user. This system module is supported by a computer or smart phone’s OS.

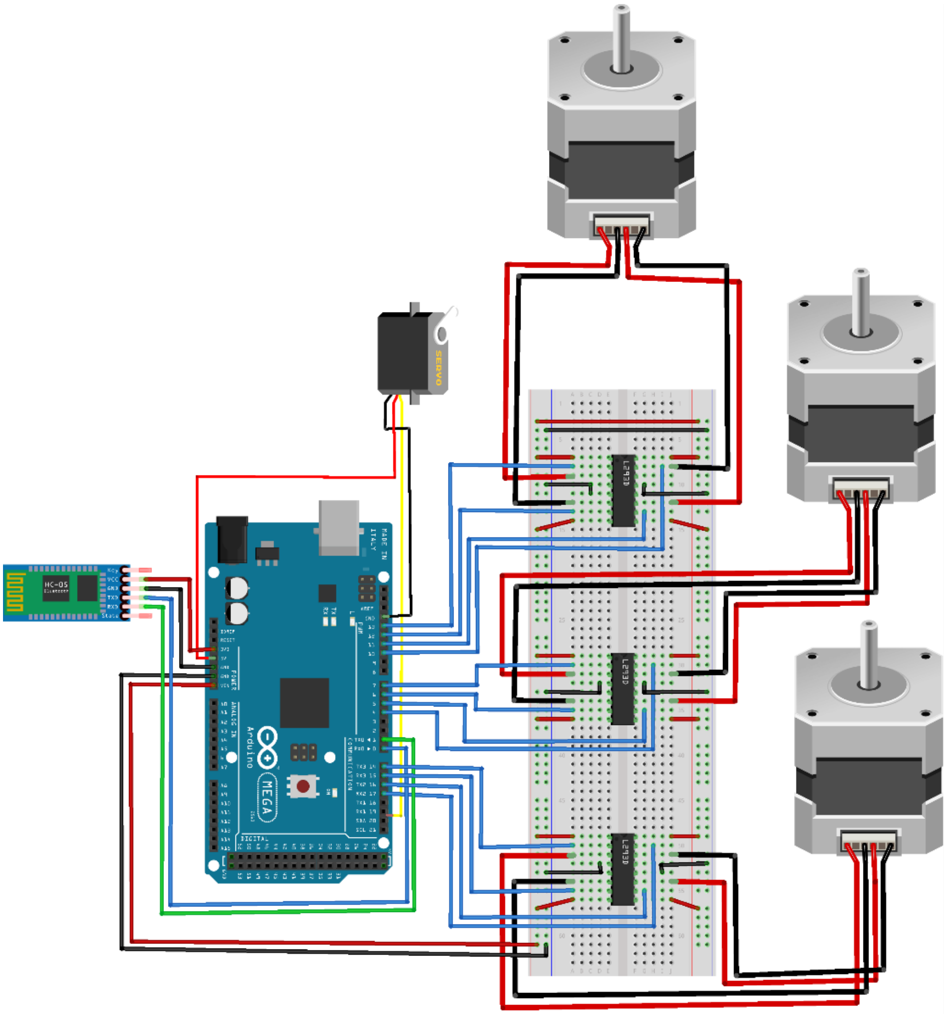


Figure 4.8: System Design for Robotic Arm

4.3.1 Block Diagram (Windows)

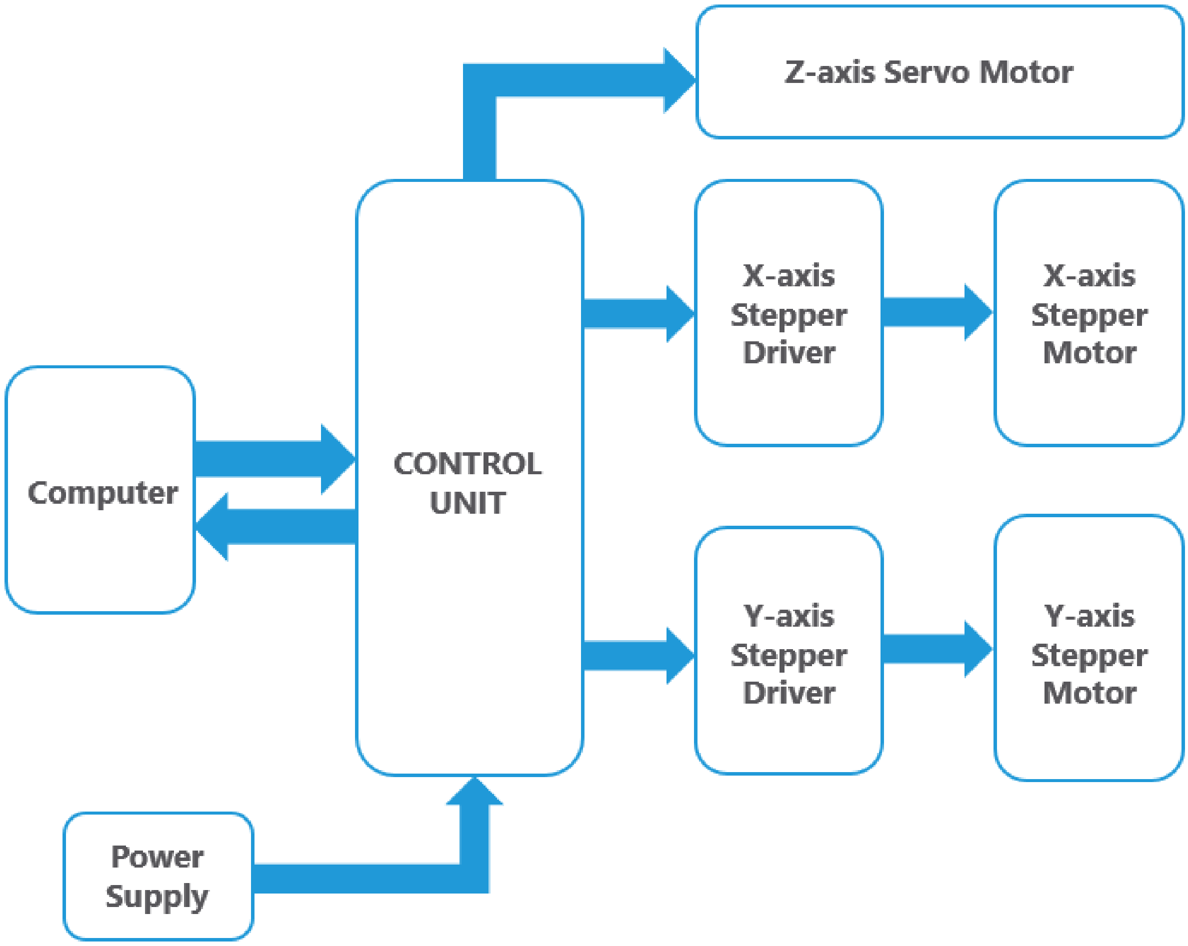


Figure 4.9: Magnetization as a block diagram of Robotic Arm (Windows)

In this module, Computer creates a G-Code from a source and its send to Control Unit by Computer, Control Unit send instruction or Data to X, Y, and Z-Axis Stepper Driver which provide to move the Stepper Motors. When the computer gets a notification, the job is done or error then user given another instruction.

4.3.2 Block Diagram (Android)

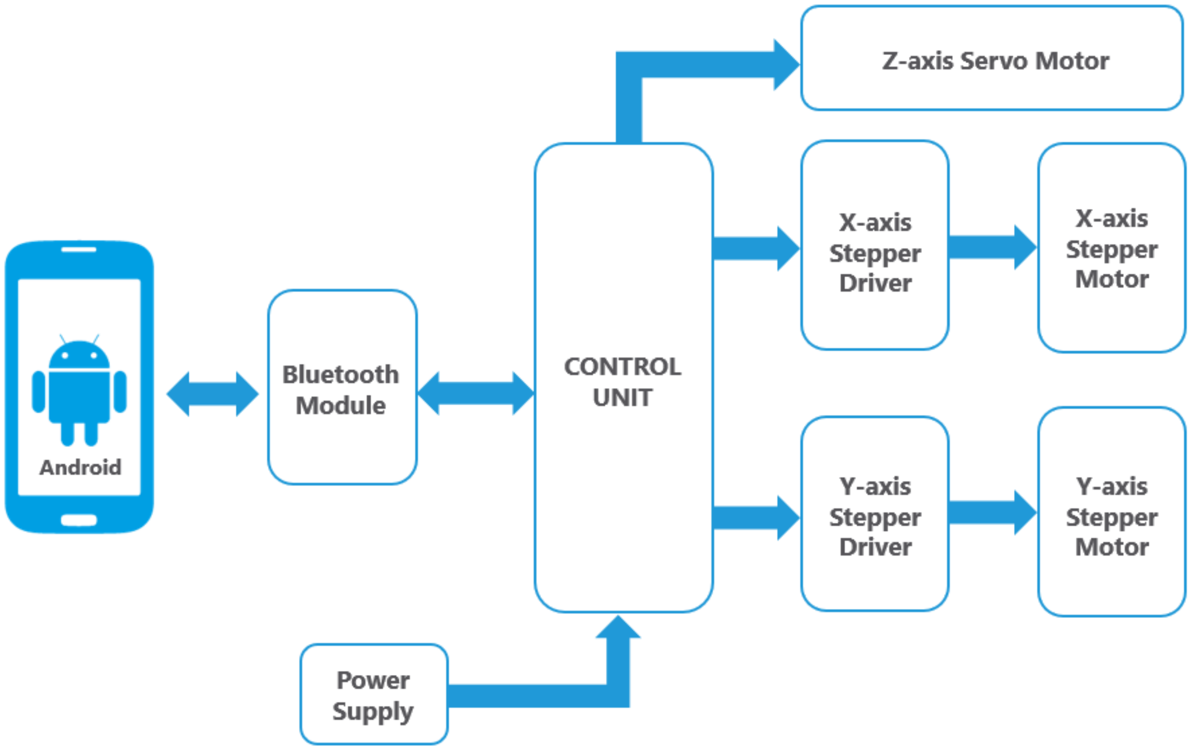


Figure 4.10: Magnetization as a block diagram of Robotic Arm (Android)

In this module, Mobile or Smartphone create a G-Code from a source and its send to Control Unit by Mobile, Control Unit send instruction or Data to X, Y, and Z-Axis Stepper Driver which provide to move the Stepper Motors. When Mobile Display will get a notification, the job is done or error then user given another instruction.

4.4.1 System Development

4.4.1.1 G Code from PC

G-Code is one of a number of computer code languages that are used to instruct CNC machining devices what motions they need to perform such as work coordinates, canned cycles, and multiple repetitive cycles.

4.4.1.2 Control Unit

This system uses Arduino controller platform with Arduino Mega This board is the brain of our CNC machine and serves as the main interface to the Computer. The Arduino board is programmed with a modified Riprap G-Code interpreter and the 3 axes motion.

4.4.1.3 Stepper Motor

A stepper motor is a brushless, synchronous electric motor that converts digital pulses into mechanical shaft rotation in a number of equal steps. Used to control the movement of the work table in X, Y& Z axes.

4.4.1.4 Process Description

Main blocks of this system consist of the power supply, drivers each connected to stepper motors X, Y, Z. From power supply, we get two voltages i.e. +5volt and +12 volt. 5volt which is required to Arduino Mega, drivers whereas +12volt supply is required to stepper motors. The job is fed through the computer software to the Arduino. With this data, the stepper motor starts with the driver circuitry and horizontal and vertical movement of work table is obtained. The spindle fastened to the vertical axis can remove material with proper feed and depth of cut.

4.5 Mechanical Design

The main tools in mechanical design consist of a multiplex board, stepper motor, linear bearing, ball bearing, linear shaft, leadscrew and nut, coupling beam, power supply and spindle drill. 3D design of Robotic Arms made using AutoCAD software. The electronic system used in microcontroller based Robotic Arm was the power supply which used as a voltage source on personal computers and Robotic Arms. The personal computer was used as a device to run some software such as Xloader, Universal Gcode Sender, and Arduino IDE, also to send design file to Arduino Mega microcontroller using serial communication. 12V 10A power supply was used as a voltage source for A4988 driver motor to run the 3 Nema 17 stepper motors which controlled by Arduino Mega microcontroller and 12V fan voltage source was used as a drive motor and Arduino Mega cooler to avoid overheating that could damage the component. 48V 10A power supply was used as a voltage source for spindle drill, the voltage that goes into the spindle drill was set using a motor controller. The 3 Nema 17 stepper motors will move the spindle drill in the direction of the X, Y and Z axes so that the object can be formed in the wood board according to the design. Display of microcontroller based Robotic Arms that has been built.

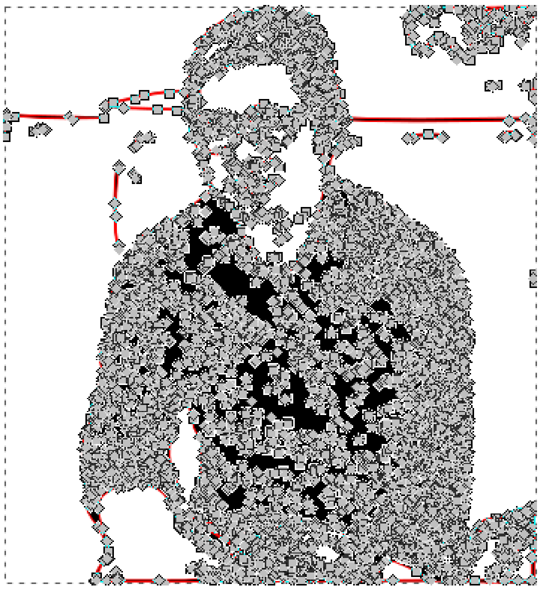
CHAPTER 5: DESCRIPTION AND SIMULATION

5.1 Startup Description and Screenshot

Here is the entry point of our system looks like as below screenshot. First, we have to select a picture second it converts Sketch image and finally converts to Line code that is prepared to prints.

Step 1: Original Image

Step 2: Sketch Image



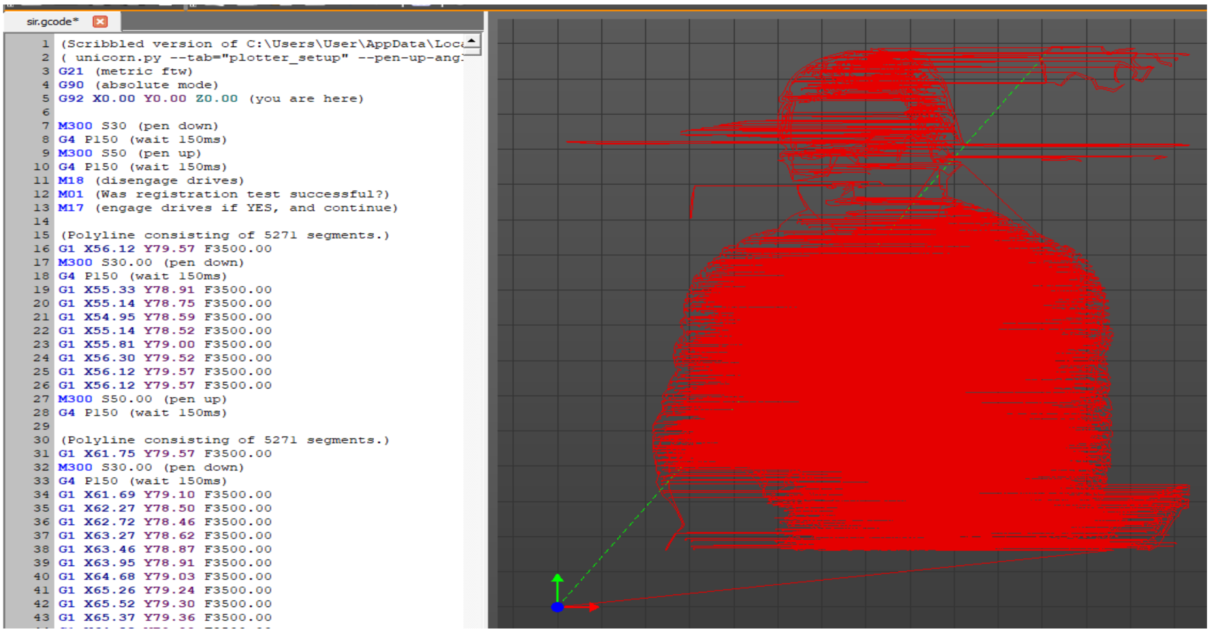
Step 3: Line Coding Image

Step 4: Printed View Image

Figure 5.1: System Entry point

5.2 Convert to G-Code & prepare to print and Screenshot

While the line code is ready then creates G-code that is the set of instruction, and its send this instruction in devices (stepper and servo motors). Finally, we browse this G-code in our system Driver. Then select a port and finally pressed a print bottom and it starts to prints.



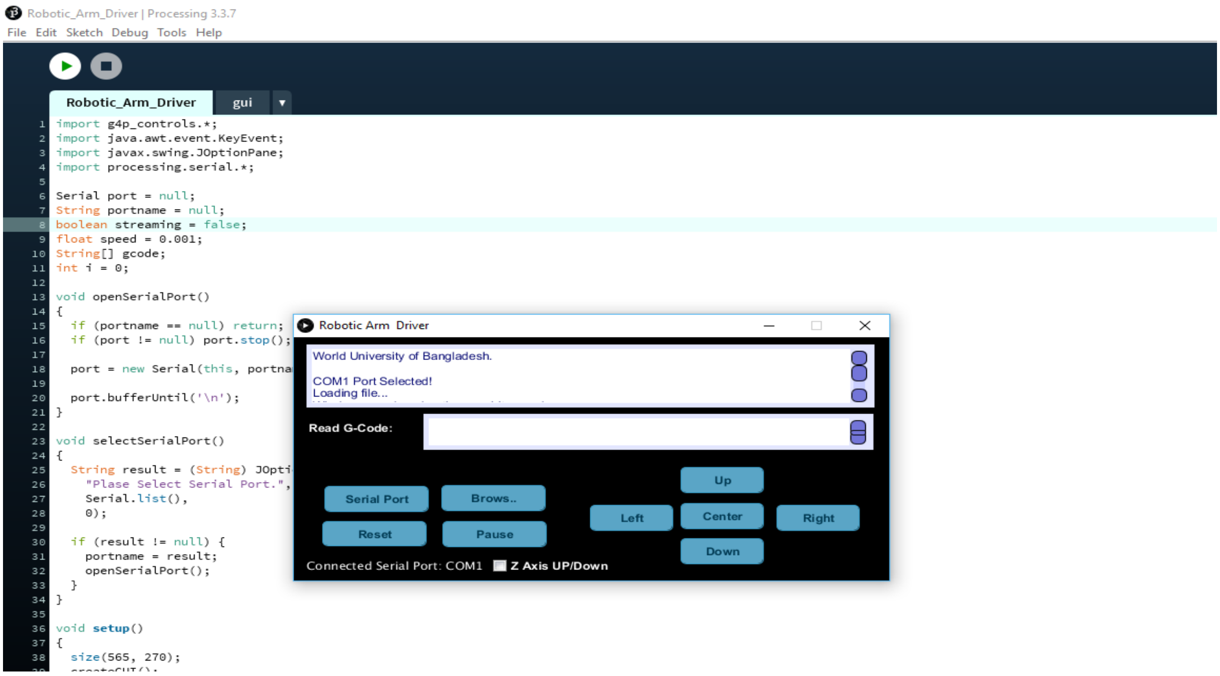


Figure 5.2: Select Axis and Driver view

The Robotic Arm driver, at first, we select a port. Then we will check the Robotic Arm by press bottom Up and Down or Right and Left when our Robotic Arm prepares to work. And then select or browse a G-Code that will be printed. The driver will send interaction to devices (stepper motor or servo motor) and execute these instructions.

5.3 Results

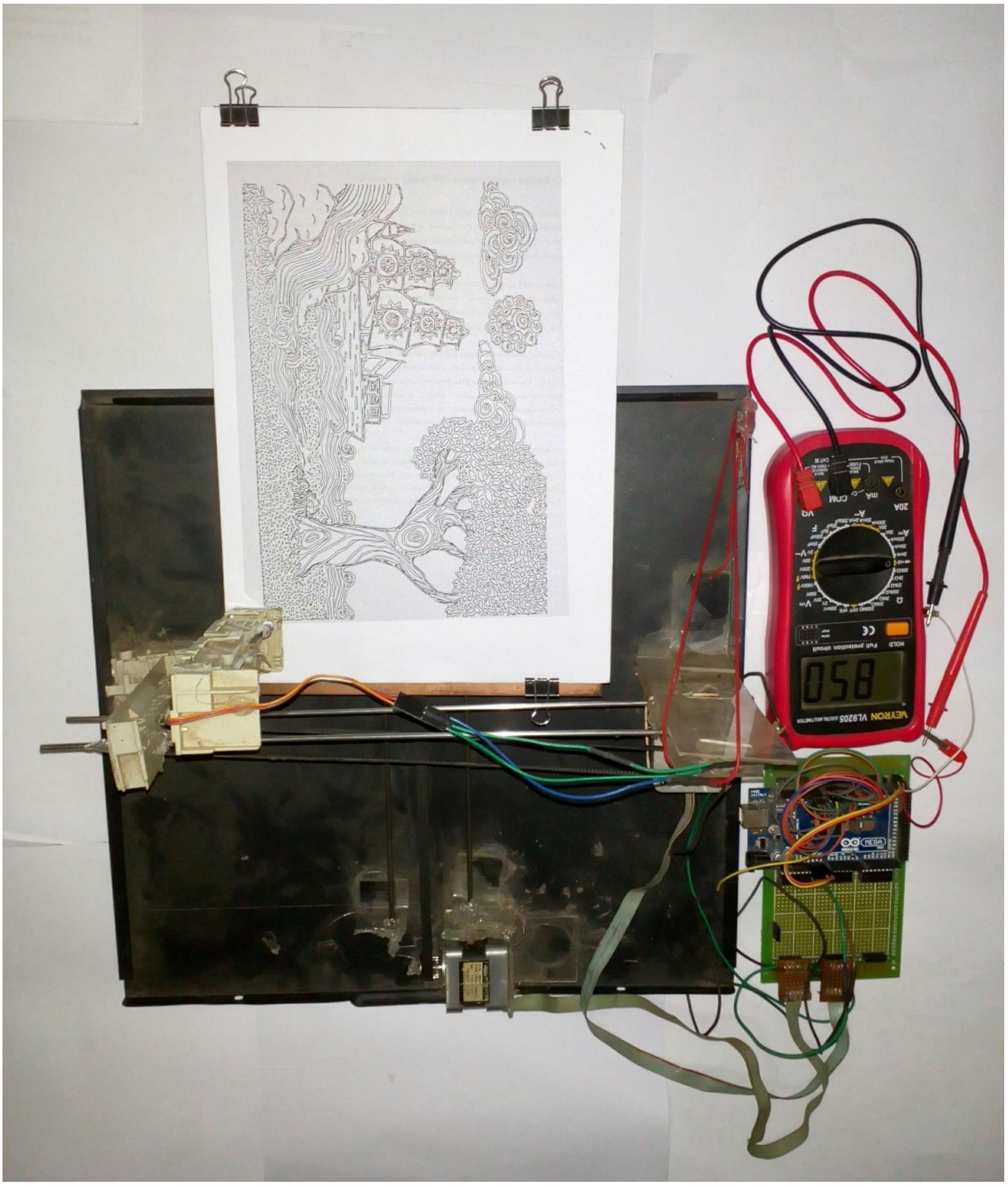


Figure 5.3: Page select and printing

5.3.1 Final Results

		
Original Image		Printed View Image

Figure 5.4: Final printed images

In this resultant printed image, we have to see that the printed image has accuracy level is 75% because of pixel overlap. When a pixel set on another pixel then it will happen. We have to increase this accuracy level up to 100% and develop our project.

History Of World University of Bangladesh World University of Bangladesh (WUB) established under the private University Act, 1992 (amended in 1998), approved and recognized by the Ministry of Education, Government of the People's Republic of Bangladesh and the University Grants Commission (UGC) of Bangladesh is a leading university for utilitarian education. The University is governed by a board of trustees constituted as per private universities Act 2010 which is a non-profit making concern. The university is a member of the Association of Private Universities in Bangladesh, Association of Common Wealth Universities and Quality Assurance & Improvement Council and appears in the worldwide listing of universities by the UNESCO.		History Of World University of Bangladesh World University of Bangladesh (WUB) established under the private University Act, 1992 (amended in 1998), approved and recognized by the Ministry of Education, Government of the People's Republic of Bangladesh and the University Grants Commission (UGC) of Bangladesh is a leading university for utilitarian education. The University is governed by a board of trustees constituted as per private universities Act 2010 which is a non-profit making concern. The university is a member of the Association of Private Universities in Bangladesh, Association of Common Wealth Universities and Quality Assurance & Improvement Council and appears in the worldwide listing of universities by the UNESCO.
Original Text English		Printed View Text English

Figure 5.5: Final Printed Text Bangla

The National Anthem of Bangladesh আমার সোনার বাংলা, আমি তোমায় ভালবাসি। চিরদিন তোমার আকাশ, তোমার বাতাস আমার প্রাণে বাজায় বাঁশি। ও মা, ফাগুনে তোর আমের বনে ঘ্রাণে পাগল করে মরি হায়, হায় রে ও মা, অঘ্রানে তোর ভরা ক্ষেতে, আমি কী দেখেছি মধুর হাসি।। কী শোভা, কী ছায়া গো, কী স্নেহ, কী মায়া গো, কী আঁচল বিছায়েছ বটের মূলে, নদীর কূলে কূলে। মা, তোর মুখের বাণী আমার কানে লাগে সুধার মতো- মা তোর বদন খানি মলিন হলে আমি নয়ন ও মা আমি নয়ন জলে ভাসি সোনার বাংলা,আমি তোমায় ভালবাসি।		The National Anthem of Bangladesh আমার সোনার বাংলা, আমি তোমায় ভালবাসি। চিরদিন তোমার আকাশ, তোমার বাতাস আমার প্রাণে বাজায় বাঁশি। ও মা, ফাগুনে তোর আমের বনে ঘ্রাণে পাগল করে মরি হায়, হায় রে ও মা, অঘ্রানে তোর ভরা ক্ষেতে, আমি কী দেখেছি মধুর হাসি।। কী শোভা, কী ছায়া গো, কী স্নেহ, কী মায়া গো, কী আঁচল বিছায়েছ বটের মূলে, নদীর কূলে কূলে। মা, তোর মুখের বাণী আমার কানে লাগে সুধার মতো- মা তোর বদন খানি মলিন হলে আমি নয়ন ও মা আমি নয়ন জলে ভাসি সোনার বাংলা,আমি তোমায় ভালবাসি।
Original Text Bangla		Printed View Text Bangla

Figure 5.6: Final Printed Text Bangla

In this resultant printed text, we have to see that the printed text has accuracy level is 50 % because of Machine noise. The machine does not fix the problem due to text images are always mixed in the small and capital letter. We have to increase this accuracy level up to 100% and develop our project.

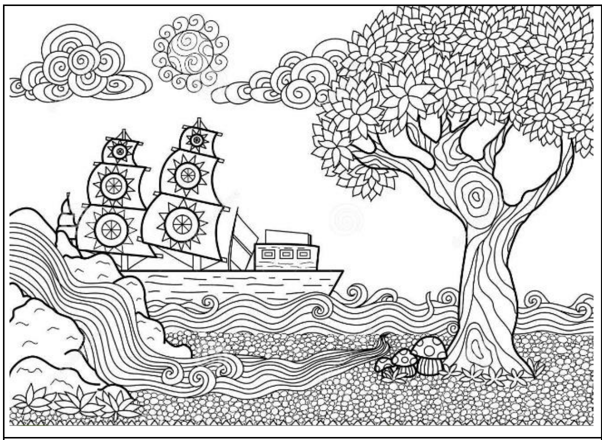
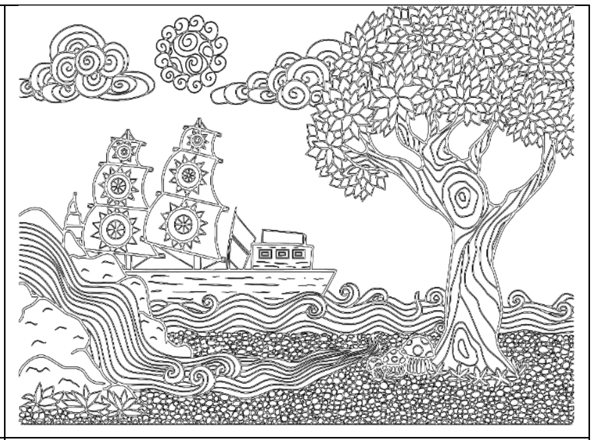
		
Original Sketch Image		Printed View Sketch Image

Figure 5.7: Final Printed Sketch Images

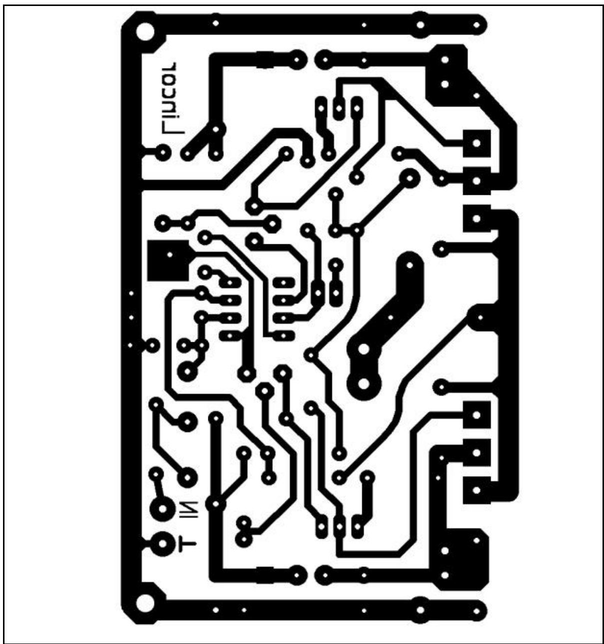
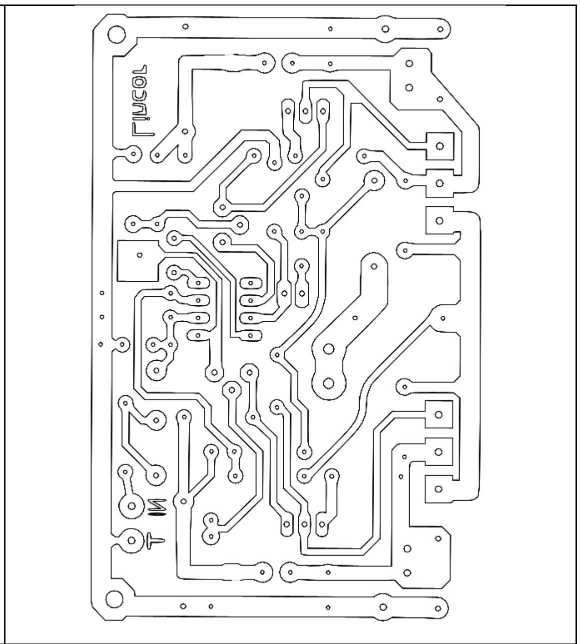
		
Original PCB Circuit		Printed View PCB Circuit

Figure 5.8: Final printed PCB Object

In this resultant printed PCB image, we have to see that the printed PCB image has accuracy level is 95 %. We have to increase this accuracy level up to 100% and develop our project.

5.4 Result Analysis

Type of Image	Number of Images	Number of Correctly Draw	Number of Incorrectly draw	Success Rate (%)	Failure Rate (%)
Human	**20**	**18**	**2**	**90%**	**10%**
Natural	**15**	**10**	**5**	**67%**	**33%**
Text	**10**	**6**	**4**	**60%**	**40%**
PCB	**25**	**24**	**1**	**96%**	**4%**

Averages Result:

$$= \frac{\sum Success\ Rate}{Total\ \ type\ of\ image}(\%)$$

$$= \frac{(90+67+60+96)\%}{4} = 78.25\%$$

=78.25% (Averages Result)

CHAPTER 6: CONCLUSION

6.1 Conclusion

This setup of hardware with a combination of G-code gives better accuracy and reduces the workload. G code make easy to find the information of locations of all stepper motor moving, as the status of our moving motor is directly seen on computer hence we can start or stop the machine whenever we are needed. Making a small machine brings a flexibility to do work.

The Robotic Arm router machine was successfully built using ATmega328p and IC4988 microcontrollers combined with stepper motors, with the 20x20cm cross-sectional area and using 500-Watt Spindle Air Cooled drill type. The Robotic Arm can be used for cutting, engraving and marking on wood to form 2D or 3D objects with 98.5% carving accuracy and 100% depth accuracy. The process of synchronizing the stepper motors was controlled using GRBL library and Universal G-code Sender Software.

6.2 Limitations

Our project has some limitations that we have faced this are-

- This Machine cannot print 3D objects.
- Our project printed image-Accuracy Level average 75% because of time limits.
- Cannot Engraving or mailing due to the time limit and high-cost devices that we cannot set these facilities.

6.3 Future Works

Although our Robotic Arm can print to 2D objects, we will develop a Robotic Arm that can print 3D or 4D objects. In future, we have an innovative idea that is Robotic Arms detect an image and it automatic prints this image.

We have implemented this idea, and also low-cost machine and mini Robotic Arm. To make 100% accuracy this Robotic Arm we will work and development and analysis our project.

References

A.S. Pawar, M.J. Halunde, S.M. Nayakawadi, and Ms. P. P. Mirajkar., 2017, “3 AXIS DRAWING MACHINE,”International Research Journal of Engineering and Technology (IRJET), vol. 04 Issue: 03, pp. 693-697.

B. Jayachandraiah, O. V. Krishna, P. A. Khan, and R. A. Reddy., 2014, “Fabrication of Low-Cost 3-AxisComputer Numerical Controlled. Router,” Int. J. Eng. Sci. Invent., vol. 3, no. 6, pp. 1–10.D.

Awari, M. Bhamare, A. Ghanwat, K. Jadhav, J.Chahande.,2017, “Methodology for Selecting Components for Fabricating COMPUTER NUMERICAL CONTROLLED Milling Machine for Small Scale Industry,” International Journal for Scientific Research & Development, Vol. 4, Issue: 11,pp.168-171.

M.A.A. Ali, A.M.A. ELShaikh, and S.F. Babiker., 2016, “Controlling the COMPUTER NUMERICAL CONTROLLED Machine using Microcontroller to Manufacture PCB,” Conference of Basic Sciences and Engineering Studies (SGCAC), pp. 116-120.

Paulo, Rogério, and Maria., 2010, “Prototype COMPUTER NUMERICAL CONTROLLED Machine Design,” International Conference on Industry Applications.