CHAPTER 1
INTRODUCTION

1.1 3D Printing

3D Printing is an additive manufacturing process that creates a physical object from a digital design. There are different 3D printing technologies and materials that one can print with, but all are based on the same principle: a digital model is turned into a solid three-dimensional physical object by adding material layer by layer.

Fused Deposition Modeling (FDM) process comes under additive process. Additive Manufacturing follows building components by addition of material. In order to visualize the approach used, stacking a pack of cards can be considered as an example FDM, the name itself gives the idea that the parts are formed by deposition of the fused material in layers. This RP technique is used in modeling, prototyping and production applications. FDM was developed by S. Scott Crump in the late 1980s and was commercialized in 1990 by Stratasys.

FDM is a great choice for quick and low-cost prototyping and can be used for a wide variety of applications. More recent innovations in FDM 3D printing include the ability to manufacture functional end products with embedded electronics and mechanical parts such as drones. Due to some design and material limitations, fused deposition modeling 3D printing is not recommended for more intricate designs.

The materials used are thermoplastic polymers and come in a filament form. FDM is the most widely used 3D Printing technology: it represents the largest installed base of 3D printers globally and is often the first technology people are exposed to as the cheapest 3D printing technology on the market, FDM also offers a wide variety of plastic-based materials in a rainbow of colors including ABS, PLA, nylon and even more exotic material blends including carbon or wood. 3D printing is a process of making three dimensional solid objects from a digital file. The object is created by laying down successive layers of material until the object is created.
Previous 3D printing model which is available in our college have many problems and issues .So we try to overcome this problems by optimizing the previous model.

1.2 History

Charles W. (Chuck) Hull is generally credited with developing the first working robotic 3D printer in 1984, 3D printing has been changing the manufacturing and prototyping industries since the late 1980's, but it wasn't until 2009 that "desktop" 3D printers were readily available to the public.

A desktop 3D printer is industry jargon for a smaller, less expensive 3D printer that a typical consumer can buy. S. Scott and Lisa Crump patented fused deposition modeling (FDM) in 1989 and co founded the printer manufacturer Stratasys, Ltd. This technology (more generically called FFF, for fused filament fabrication) feeds a plastic filament into a heated extruder and then precisely lays down the material. When key patents expired in 2005, this technology became the basis of the RepRap movement. Bowyer published the designs for the parts for his 3D printers and encouraged others to improve them and in-turn post to improve versions. He called this source concept, the RepRap project and obtained some initial funding from the UK's Engineering and Physical Sciences Research Council (EPSRC). Bowyer's team called their first printer as Darwin (released in March 2007) and the next as Mendel (released in 2009). Since 2010, 3D printer technology has shown explosive growth with the help of the open source and DIY communities. It was superseded by the Maker Bot Thing-O-Metric in 2010.

First Robotics-controlled airplane was printed in 2011, university of South amp ton. These were mostly made of laser cut wooden parts with some 3D-printed parts (plus, of course, motors and electronics). Eventually, Maker Bot became one of the earlier commercial consumer printer companies and was purchased by Stratasys in 2013. The Fused Deposition Manufacturing Technology is the mostly available and comparably less.

1.3 Problem definition

- Previous 3D printer model have metal body so because of this it goes through wear and tear .It is very noisy also.
- Also it don't have casing so it can not get handle easily and don't look manageable .Also due to environmental changes product get expand and shrink so we need casing to overcome this.

- Previous model has MDF body which can not tolerate the weight of the frame and got bend so we need strong base.
- Also in previous model zip ties are used to tie the parts.zip ties are not suitable so we use nut and bolt.

1.4 Objectives

• To be overcome this wear and tear we are using wooden body .So because of this wooden body it can get rid of noise also.

• Also we are going to give a case to the printer with handle. Because of casing it get constant environment and it gives constant product and accuracy. Also it looks premium and more manageable.

• This model has to be memory card slot so we can access this printer easily and don't need of laptop and it can transport anywhere easily.

• This model has to be base of 8mm thickness plywood to tolerate the weight of frame so it don't bend.

• In this model parts are to be fitted by using 3D printed parts to hold the printer parts and because of this it gives more accuracy.

• This model has to be screen to direct access of X-Y-Z axis.

• This model also have to be a cooling fan because of fan , out product accuracy increases.

CHAPTER 2

LITERATURE SURVEY

G. Gokhare, et.al., [1] This paper gives introduction about FDM. Fused deposition modelling (FDM) method was developed by S. Scott Crump in the late 1980s and was designed in 1990 by Stratasys. After the patent on this technology expired, a large open source development community developed and commercial variants utilizing this type of 3D printer appeared. As a result, the price of FDM technology has dropped by two orders magnitude since its creation. In this technique, the model is produced by extruding small beads of material which harden to form layers. A thermoplastic filament or wire that is wound into a coil is unwinding to supply material to an extrusion nozzle head. The nozzle head heats the material up to the certain temperature and turns the flow on and off. Typically, the stepper motors are employed to move the extrusion head in the z-direction and adjust the flow according to the requirements.

M. Kamran, et.al., [2] PLA (Poly-lactic acid or Poly-lactide): It is a biodegradable plastic typically made from corn or potatoes. When heated, PLA smells a bit like sweet, toasted corn. PLA is stiffer than ABS. While PLA does not require heating of a printed bed but warping of PLA during cooling will improve by heated bed only. Note that there is a “flexible PLA” variant generates a squishy object but it is complex to use.

P. Chennakesava, et.al., [3] Rapid-Prototyping (RP) is a group of techniques used to quickly fabricate a scale model of a physical part or assembly using three-dimensional Computer Aided Design (CAD) data. There are two phases in the birth of a product, first would be the design phase and second would be the manufacturing phase. Both the processes involve several steps as per design and manufacturing guidelines. In this competitive age any time reduction in these steps will help in profit maximization. Apart from the conventional manufacturing processes which are used for several years while manufacturing of a product, additive manufacturing processes have gained momentum in the recent years.

CHAPTER 3
COMPONENTS DESCRIPTION

3.1. Component Description

1. Hot end

Hot end is temperature sensor and an extrusion tip where plastic filament is fed through to deposit molten material. This where the plastic is melted and extruded in a little tiny layers. There are many different types of Hot Ends available on the market today. The V6 J-head Bowden Hot end is used for project.

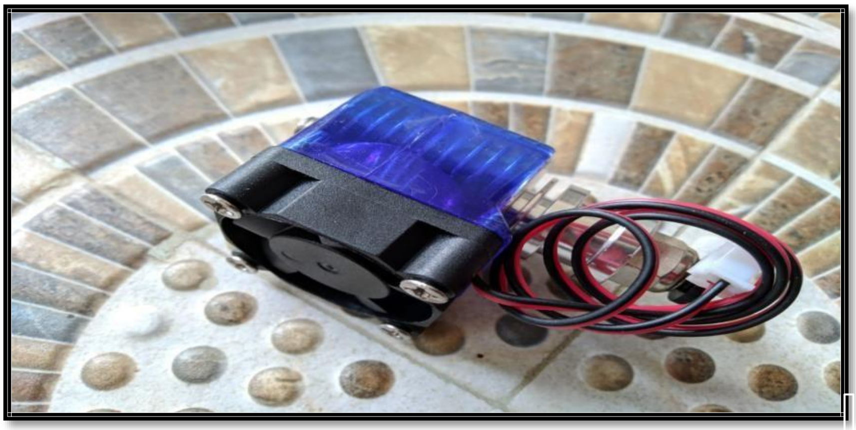

Figure 3.1: Hot end module

2. Nozzle

The Nozzle is the tip of the Hot End where the plastics comes out. It needs to be exchangeable when needed. The nozzle size is really important. It usually varies from 0.25mm to 0.75mm. For the project purpose nozzle of 0.4 mm is selected.

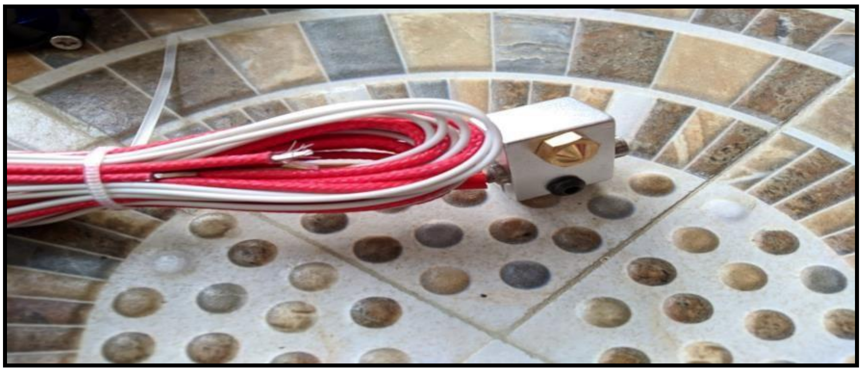

Figure 3.2: Nozzle

3. Extruder

The Extruder is the part that feeds the filament to the hot end. A MK8 extruder is used for the project.

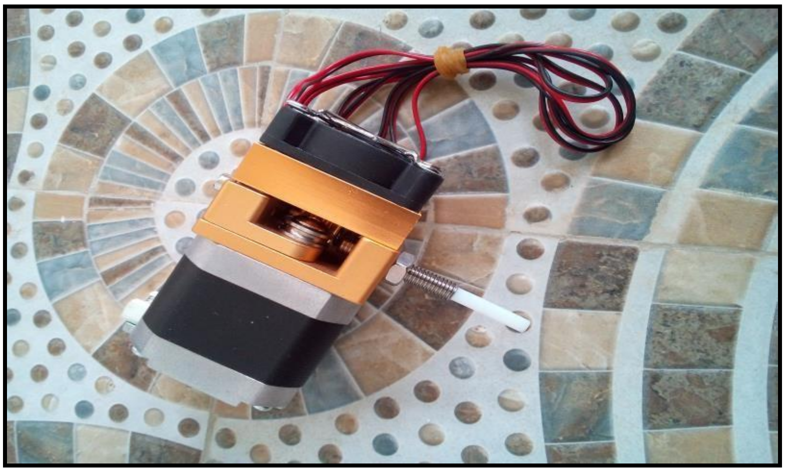

Figure 3.3: Extruder

4. Arduino mega

To move the extrusion head in both vertical and horizontal directions. And control of the mechanisms is done by CAM software packages which is running on this Microcontroller.

Figure3.4: Arduino mega microcontroller

5. Ramps 1.4 shield

A number of Arduino expansion boards can be added to the system as long as the main RAMPS Board is kept to the top of the stack. RAMPS Board is the heart of most DIY 3D printers on the markets and a clean compact way to integrate all the systems into a compact enclosure mountable format.

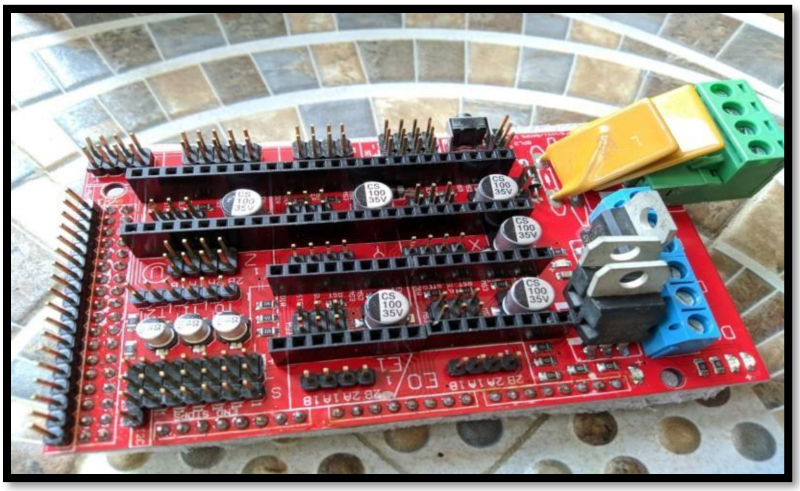

Figure 3.5: Ramps 1.4 shield

6. A49AA Stepper drive

The driver features adjustable current limiting, over current protection, and five different micro step resolutions. It operates from 8 – 35 V and can deliver up to 2 A per coil. Five drivers are used for running 5 motors. Heat sink is pasted on the ramp so that IC should not be burned out.

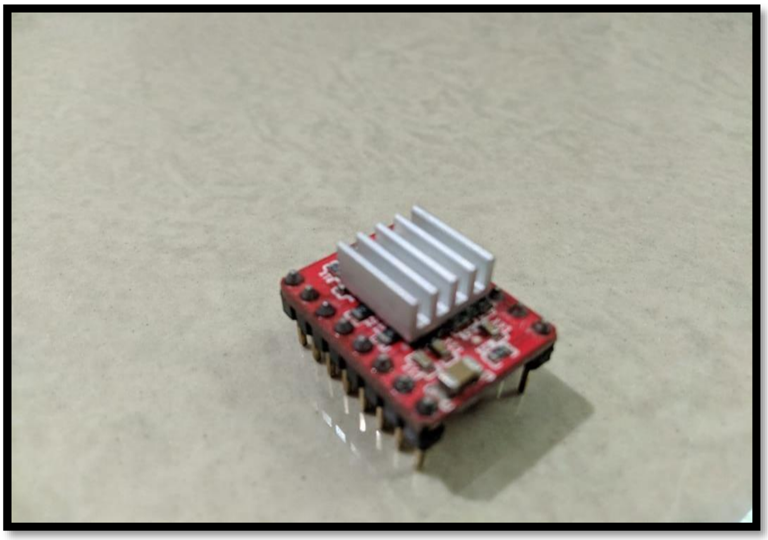

Figure3.6: A49AA Stepper drive

7. NEMA 17 Stepper motor

The stepper motor is an electromagnetic device that converts digital pulses into mechanical shaft rotation. Many advantages are achieved using this kind of motors, such as higher Simplicity, since no brushes or contacts are present, low cost, high reliability, high torque at low speeds, and high accuracy of motion.

This project involves the usage of at least five motors specifically five stepper motors. One motor to control the Y-axis, the other to control the X-axis, two to control Z-axis and one to control the extruder. The configuration of all the five motors is same and the driver is used to drive the motor.

Figure3.7: NEMA 17 Stepper motor

8. Bearings & couplers:

Ten Lm8uu bearings, two 5x8 mm couplers and two GT2 pulleys along with 2m of GT2 timing belt is used for providing support and movement.

Figure 3.8: Bearings & couplers

9. Plywood for casing

8mm thickness plywood is used for the casing of 3d printer.

Figure 3.9 Plywood for casing

10. Power Supply Adapter

A single motor requires 1.7 A, for five motors 8.5 A will be required. Hot end takes up to 3A or so. For a standard setup without the heated bed power supply of total 15-20A which is about a 180-240W at 12V is required. Switch mode power supplies have relatively complex circuits that are to convert mains AC electricity to DC voltages that required by the Steppers and the Electronics circuit. The main advantage is that of a Switch mode power supply is highly efficient in converting energy. Thus a SMPS of 240W (12V 20 A) is used as a power supply.

Figure 3.10: Power Supply Adapter (12V 240W)

11. PLA filament

PLA is a biodegradable plastic typically made from corn or potatoes (produced from plant starch). It has following pros and cons:

PROS: Bio-plastics therefore environmental friendly, good smell when heated, nontoxic, No heated print bed necessary, High print speed.

CONS: Slow cooling down, Low heat resistance, Easier to break.

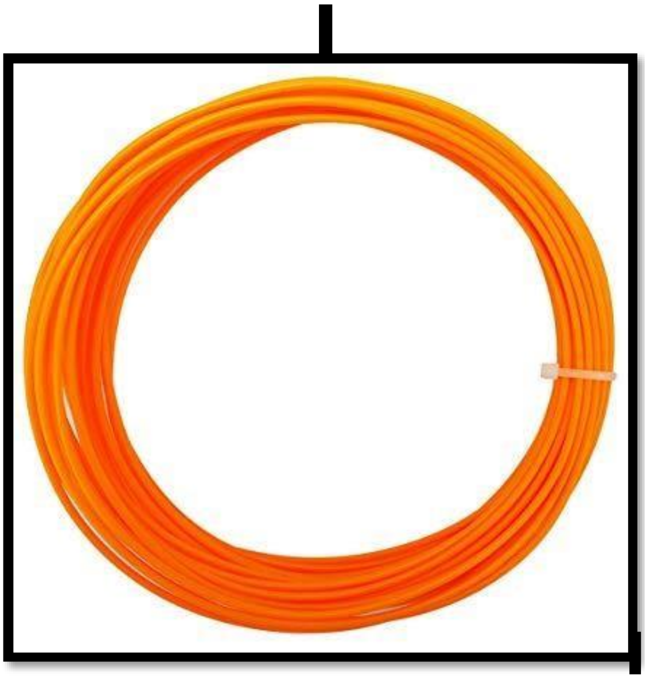

Figure 3.11 PLA filament 10m roll

12. Radial blow

It is the 12v, 50mm 3d printer fan which cools down the temperature inside the printer and increase the accuracy level of the product.

Figure 3.11 Radial blow

13. LCD smart controller

It is 120*60 mm 3d printer LCD smart controller. It controls the operation of 3d printer.

Figure. 13 LCD smart controller

CHAPTER 4

DESIGN AND FABRICATION OF 3D PRINTER

4.1. Design

After studying various 3D printers first, the required parts and components those are used to manufacture a 3D printer were ordered and purchased. It took a while to procure the all of them. In the meanwhile, a CAD model of a 3D printer has been created using CATIA V5. Design of all the parts required for the assembly and dimensions were strictly taken

. Then all the parts are assembled in the Assembly workbench of CATIA V5 to create the 3D printer assembly. Here are the rendered pictures designed model and the drafted views of frame structural members.

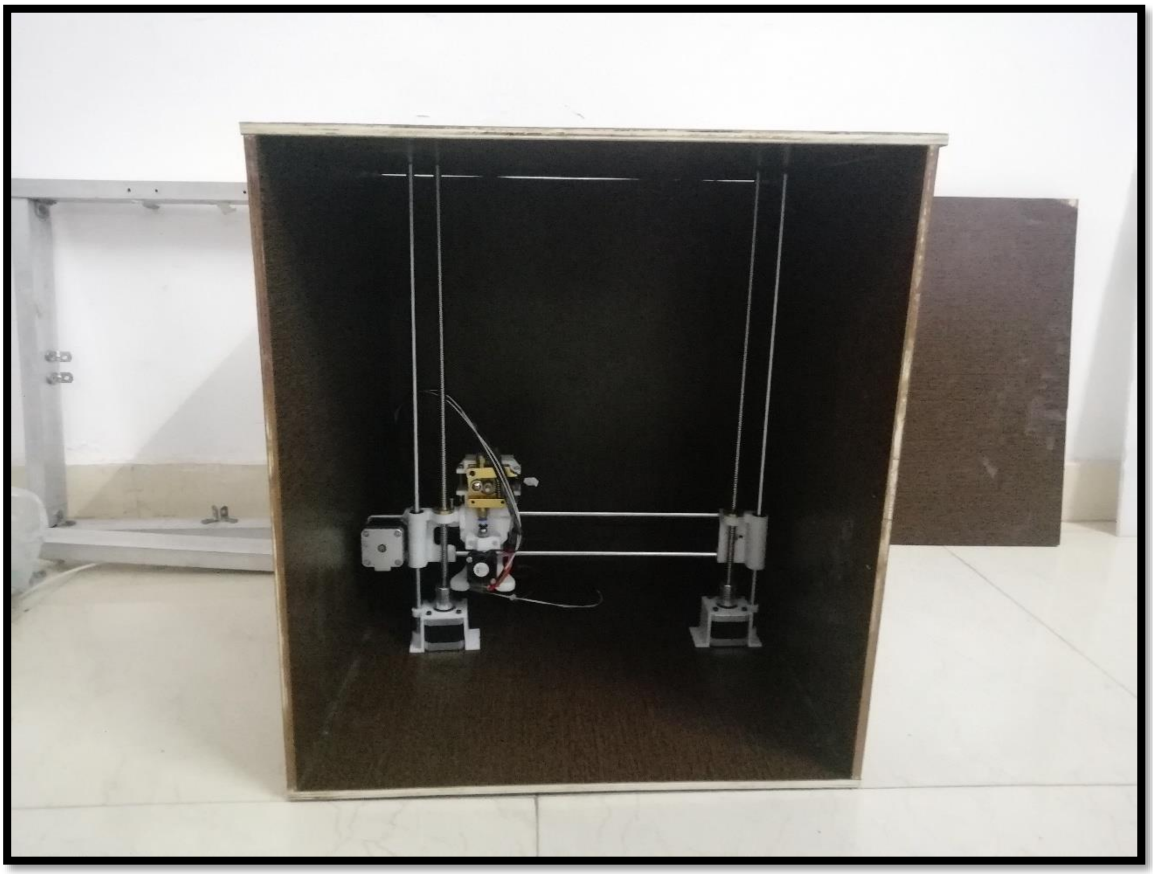

Figure 4.1 optimized parts with casing

4.2. Fabrication

As per the drafted model, first of all plywood is measured and cut into pieces for the outer cover and they fixed properly and made a casing. Then the 3d printed parts manufacturerd as per the measurements and place them on the smooth rod as per the drafting. The x-axis and z-axis mother’s are bolted as per the drafting on the base of the wooden casing. The y-axis lower bed was cut and properly bolted as per its drafting. Acrylic sheet cut outs are to encompass the y-axis arrengement. Now the threaded rods and smooth rods of z-axis are mounted on suitable distance along with x- axis arrengement mounted in between the two moters of z-axis. Later extruder and v6 hotend are come together and fixed on the smooth rod.

Fig4.2: Measuring and cutting of plywood

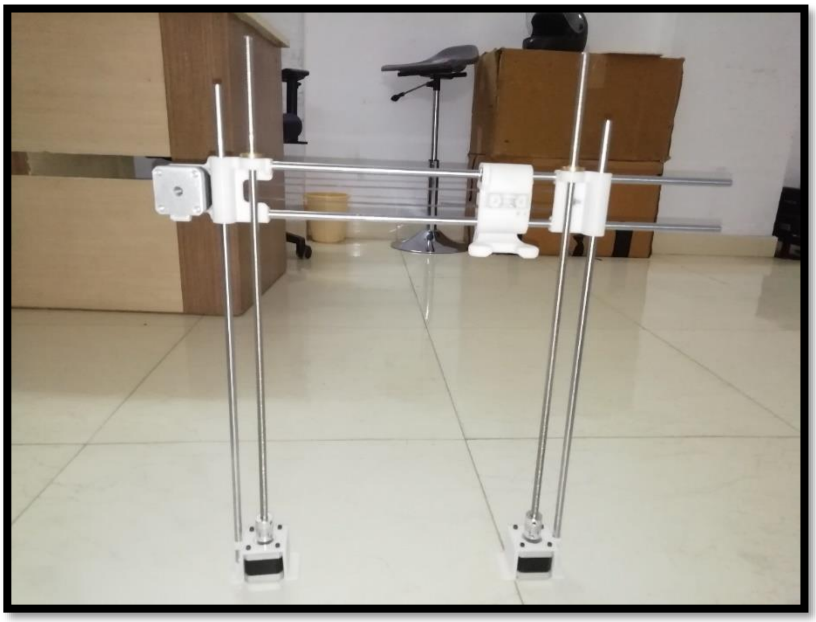

Figure 4.3: 3d printed parts fitted on rad and motors

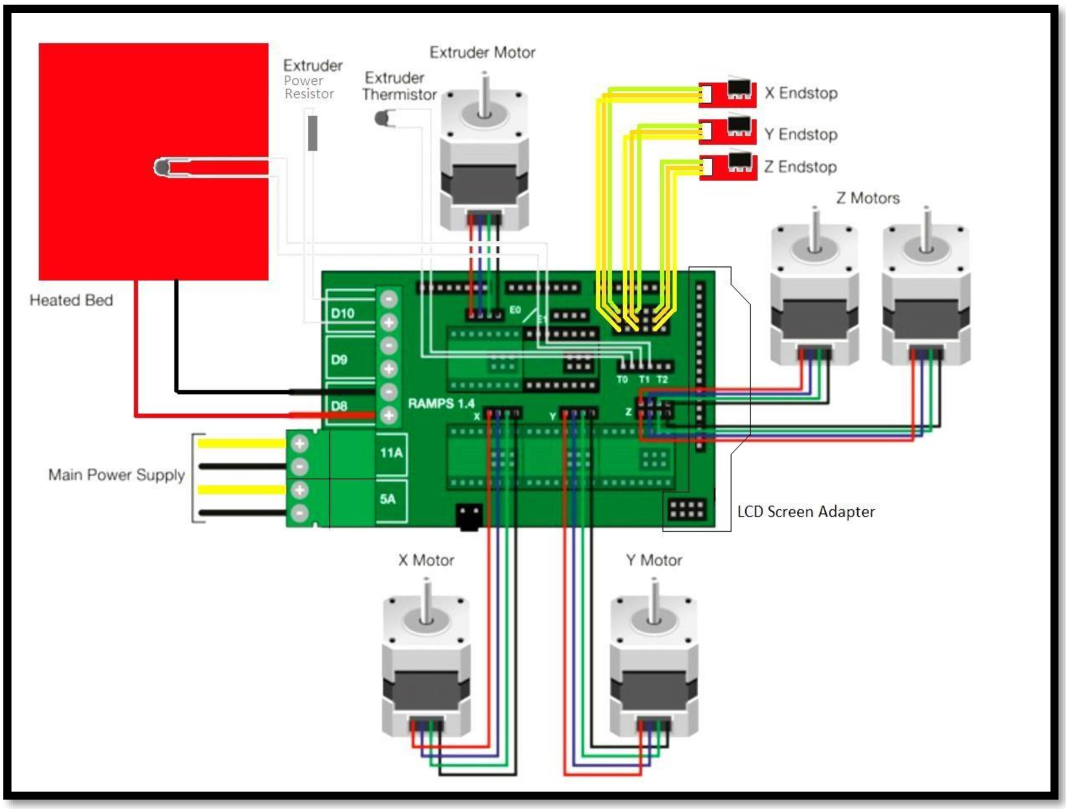

Figure 4.5: Wiring of the 3d printer components on the RAMPS 1.4 control board

CHAPTER 5
FIRMWARE INSTALLATION AND SOFTWARES USED

5.1. Introduction

Firmware is the permanent software used in read-only memory(ROM) in the form of nonvolatile memory in a computer program that provides to control the device in hardware. It can provide a standard operating environment to the devices to more complex software that allows hardware to run on the operating system (OS), to perform various devices to complete all monitoring and other manipulation functions. The firmware is used for different purposes like consumer appliances, computer peripherals etc. 3D printer electronic devices are controlled by CPU such as Intel processor and Based on Arduino microcontroller used in the 3D printer. These processors are used in the computer to run the primitive software. The firmware of entire software makes the 3D printer work, the firmware portion of it is the closest one can get to actual programming. Therefore, it is called as cross-compiling.

5.2. Marlin Firmware

Marlin is an open source firmware in which any of RepRap family to replicate in Rapid prototyping and it is popularly known as a 3D printer. It was obtained by GRBL and Sprinter and it became open source for all 3D printer. Marlin is used for a respected 3D printer like ultimate, Prusa, and Printrbot for just a few of the vendors who ship a variant of marlin. Marlin runs in 8-bit microcontrollers the chips are at the centre of open source reference platform for marlin Arduino Mega2560 with RAMPS
1.4.

Marlin is firmware can be used in any of single-processor electronics, like supporting for ultima Ker, ramps, and several other Arduino2570-based on 3D printers. It supports printing over USB or from SD cards with folders and uses lookahead trajectory planning. Marlin is licensed under the GNU GPL v3 or later. It is based on sprinter firmware, licensed under GPL v2 or later. Marlin Firmware runs through a 3D printer’s main board, to manage all the real-time activities on the machine. It coordinates the heaters, buttons, sensors, steppers, LCD display, lights and everything will be involved in the 3D printing operation. Marlin implies on additive manufacturing process called as fused deposition modelling. In this process a motor pushes the thermoplastic filament into a hot nozzle which melts and extrudes the material while the nozzle is moved under computer control. After several minutes it start laying layer by layer to form a physical object. The control-language for Marlin is used to derivative of G-code. G-code gives commands about machine to do simple things like to “set heater 1 to 210°,” or “move to XY at speed F.” To print a model through Marlin, it must be converted to G-code using a program called a “slicer.” Since every printer is different, G-code files aren’t available online for download, it is to be sliced according to the printer settings by oneself. As Marlin receives movement of all commands it allows themselves into a movement queue to be executed in the order received. The stepper will interrupt the processes for queue and they start converting linear movements into precisely-timed electronic pulses to the stepper motors. Even at modest speeds Marlin needs to generate thousands of stepper pulses every second. Since CPU speed limits how fast the machine can be moved, we’re always looking for new ways to optimize the stepper interrupt! Heaters and sensors are managed in a second interrupt that executes at much slower speed, while the main loop handles command processing, updating the display, and controller events. For safety purpose in Marlin firmware it will actually reboot the CPU gets too overloaded to read the sensors.

5.3 Steps to Install Firmware

Step 1: The first step in firmware is to be download the Arduino IDE from the Arduino website and install it following the usual procedure. Marlin can be compiled in Linux, Windows, and Unix.

Step 2: Download marlin firmware source code from website choose the proper version based on code bases from the given website.

Step 3: See Configuring Marlin for an explanation of the configuration file format and a synopsis of most of options in these files to specify which hardware is in use.

Step 4: Verify/Compile the firmware using Arduino IDE.

Step 5: Connect the controller to PC via USB cable.

Step 6: Upload the firmware program to controller CPU.

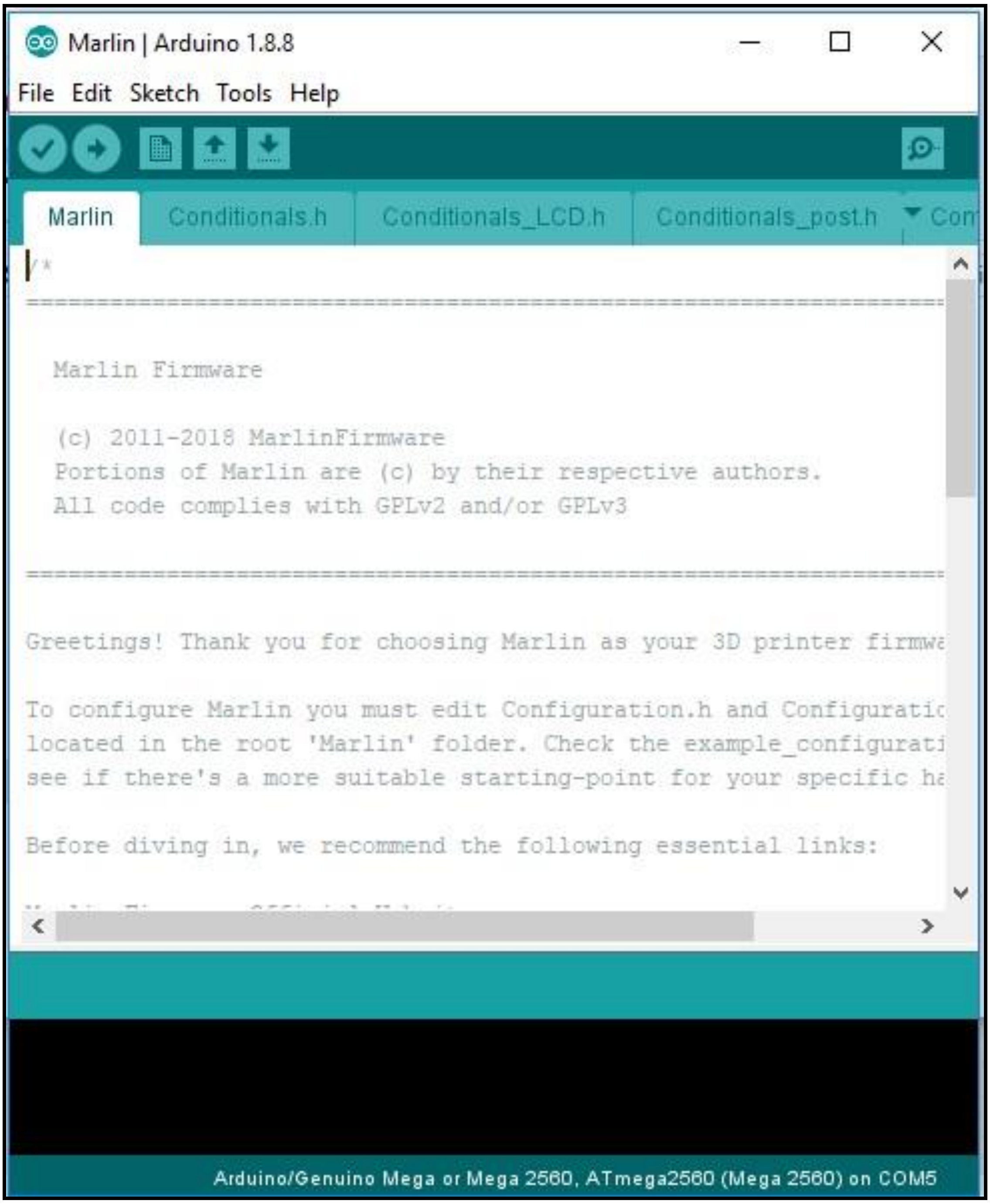

Figure 5.1: Program of Arduino

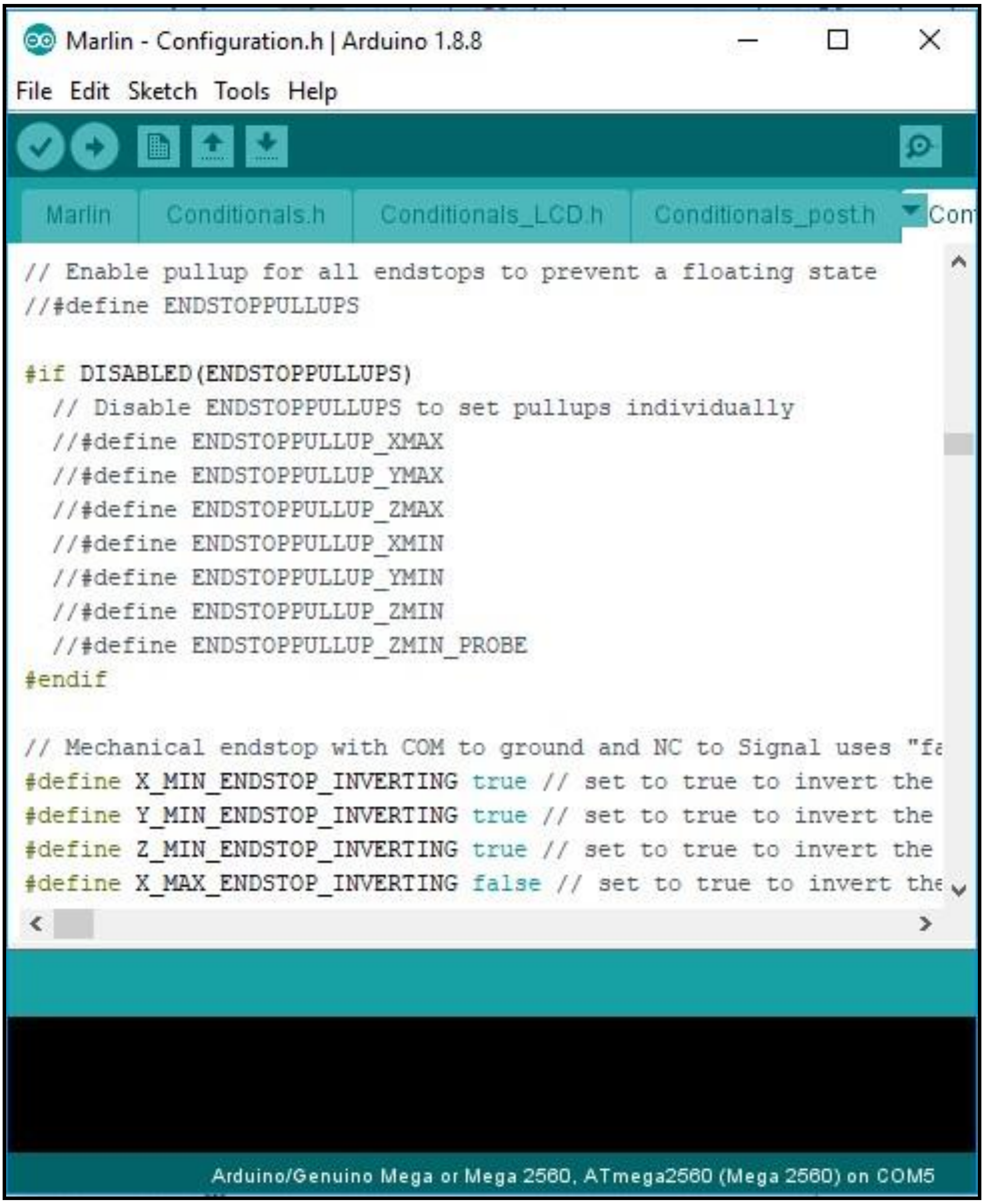

Figure 5.2. Marlin Firmware

5.4. Software used for designing

5.4.1. CATIA V5

It was published by Dassault system. The CATIA V5 is used for solid modeling computer-aided design (CAD). It runs on operating systems like windows7 and higher. The 3D printed parts were designed using CATIA V5 to develop an assembly of a 3D printer with complete design with CATIA, one can print directly to 3D printer, similar to how one would print a document to a normal printer. It can also give different types of output like STL, IGES, VRML and JPEG etc.

STL files are being used because it accepts the format of 3D printing and there are many formats provide more information about the model being printed. It does not require any post-processing to define data such as orientation, color, material etc. CATIA V5 support any slicing software to produce any G-code for printing the 3D models, so CATIA V5 R21 is preferred for designing complete mode.

5.5. Software's used for printing the 3d models

5.5.1. Slic3r

Slic3r is mainly a toolpath generator for 3D printers: it reads 3D models (STL, OBJ, AMF, 3MF) and it converts them into G-code instructions for 3D printers. But it does much more than that.

Slic3r is:

- Open: it is totally open source and it's independent from any commercial company or printer manufacturer.
- Compatible: it supports all the known G-code dialects (Marlin, Repetier, Mach3, Linux CNC, Machine kit, Smoothie, Maker ware, Sailfish).
- Advanced: many configuration options allow for fine-tuning and full control. While novice users often need just few options, Slic3r is mostly used by advanced users.
- Community-driven: new features or issues are discussed in the GitHub repository.
- Robust: the codebase includes more than 1,000 unit and regression tests, collected in 6 years of development.

- Modular: the core of Slic3r is libslic3r, a C++ library that provides a granular API and reusable components.
- Embeddable: a complete and powerful command line interface allows Slic3r to be used from the shell or integrated with server-side applications.

Steps for slicing:

- For Slicing the object, the first thing needed to do is add the. stl file into the Slic3r.
- Set the position of the object as per requirement by moving the object using curser.
- Set the Print Setting, Filament Setting and Printer Setting as per requirement.
- Now Click on Export G- code tab and export the file to desired location.

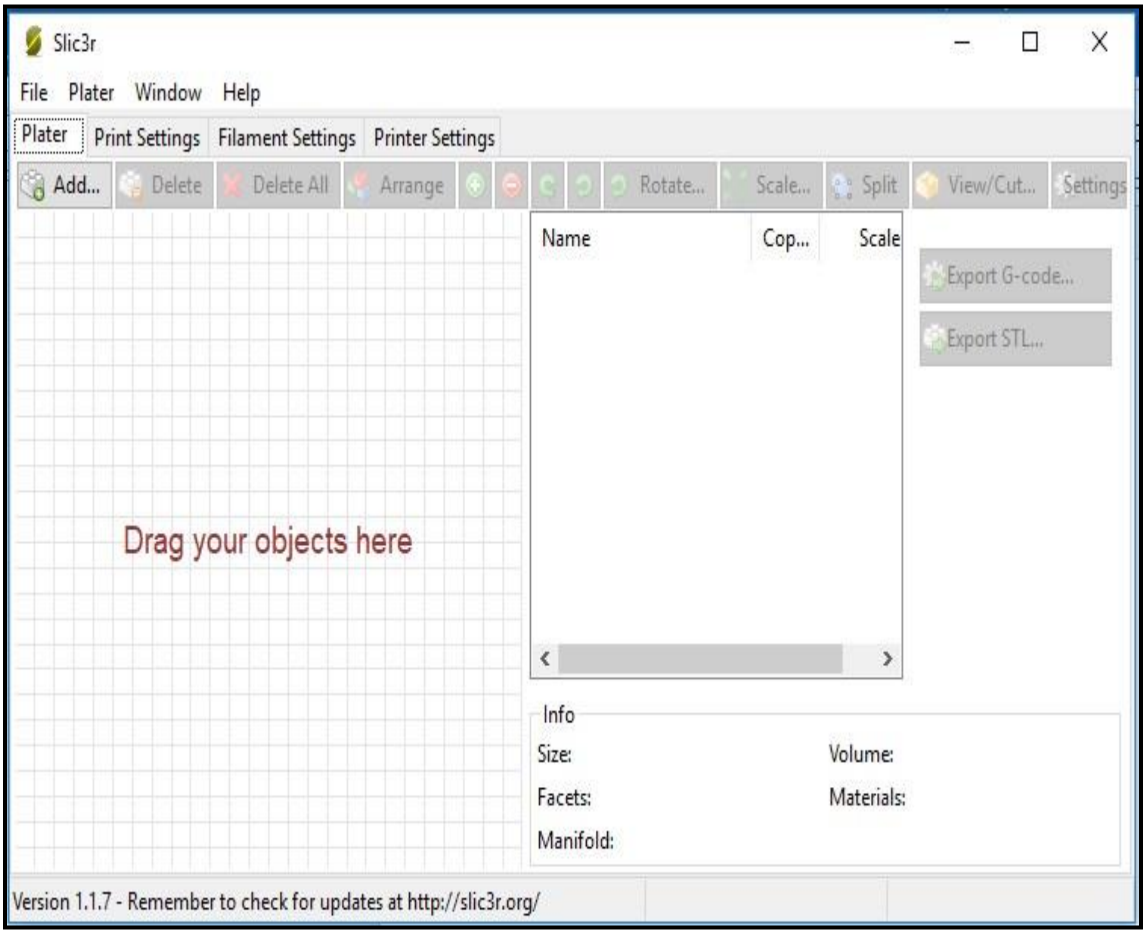

Figure 5.4: Slic3r

5.5.2. Pronterface

It creates communication between computer and 3D printer and sends the Gcodes file to printer. Generate the G-code from any slicing software and after generating the G-code from slicing software then load the file on a memory card if it can support or connect the USB connection via computer to 3D printer with help of microcontroller it can understand the G-code language and can connect program on the workstation. To print the object simply connect the printer, load the file into pronterface and press the Print button.

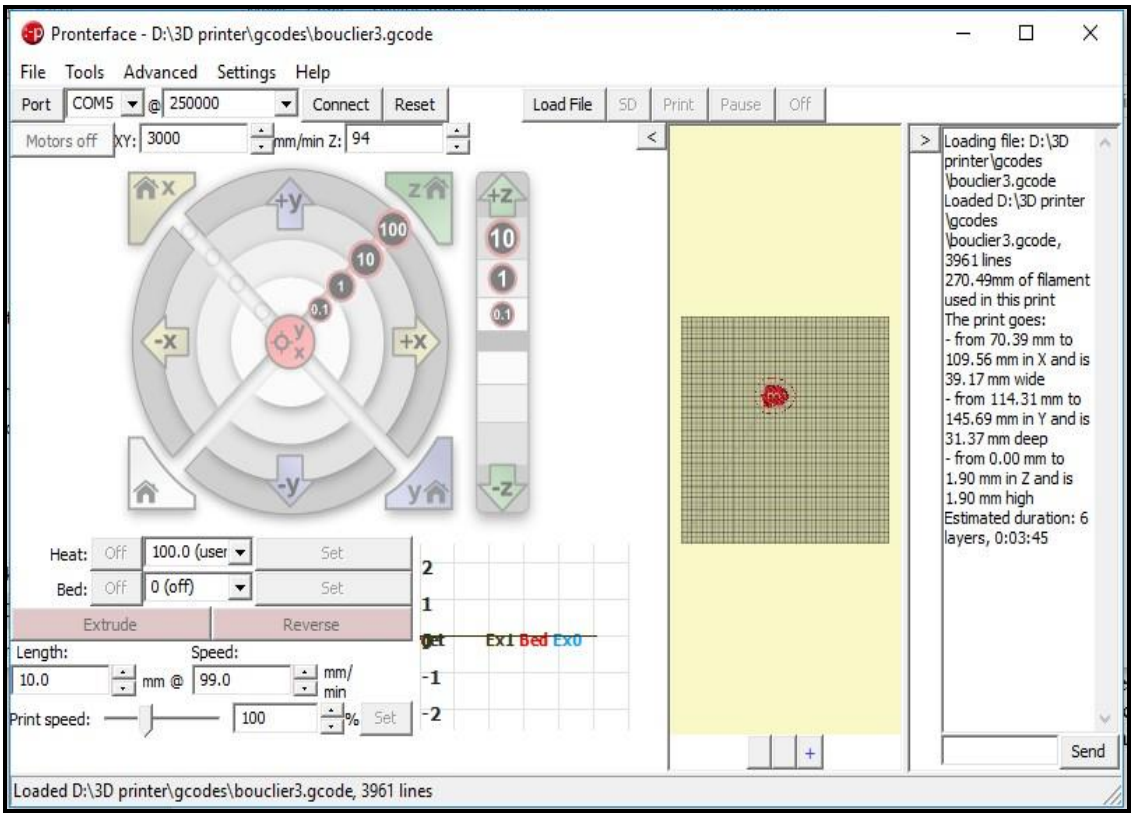

Figure 5.5: Pronterface

CHAPTER 6

WORKING PRINCIPLE & WORKING OPERATION

6.1. Working principle:

The modeling process includes building of object layer from the bottom by heating and extruding thermoplastic filament which is similar to previously defined stereo lithography technique. The process is simple as below:

1. Pre-processing: Pre-processing includes preparation of digital file of an object or CAD file and slicing of the file type required by the printer. The path to extrude thermoplastic material is calculated.

2. Production: The heater inside 3D printer melts the thermoplastic filament to semi liquid state and places along the extrusion path as per the object dimension. The resolution and precision if this printing process varies with the type of 3D printer and thermoplastic materials used. Scaffolding process occurs during production phase, the 3D printer adds material where support is needed and vice versa.

3. Post-processing: The final product is achieved in this state by removing away from the printer. Support structure are removed either by breaking or by dissolving in water for water soluble support structures.

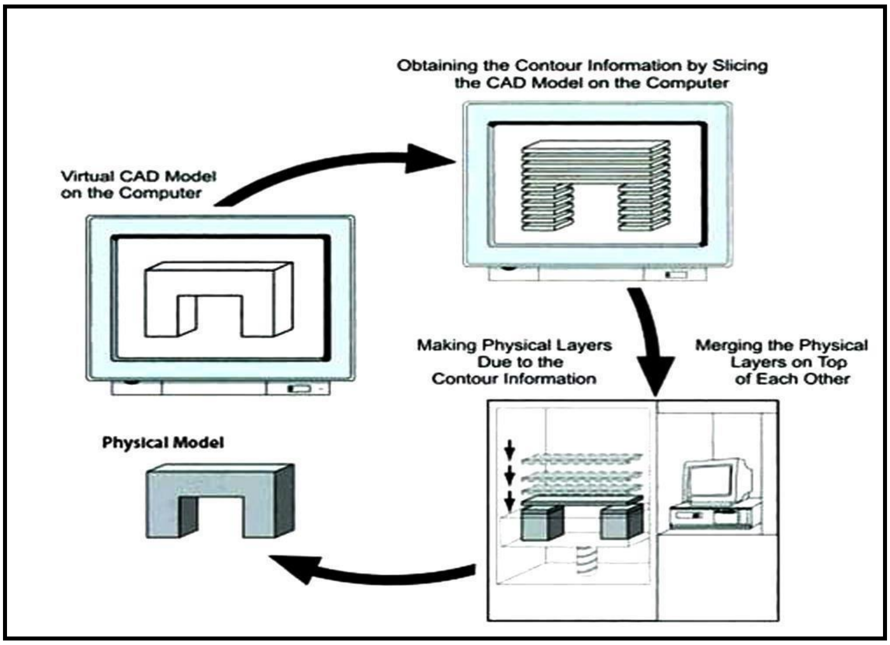

Figure 6.1. Working Principle of 3d printer

6.2 Working operation:

A spool of thermoplastic filament is first loaded into the printer. Once the nozzle has reached the desired temperature, the filament is fed to the extrusion head and in the nozzle where it melts. The extrusion head is attached to a 3-axis system that allows it to move in the X, Y and Z directions. The melted material is extruded in thin strands and is deposited layer-by-layer in predetermined locations, where it cools and solidifies.

To fill an area, multiple passes are required. When a layer is finished, the build platform moves down and a new layer is deposited. This process is repeated until the part is complete. FDM parts can be finished to a very high standard using various post-processing methods, such as sanding and polishing.

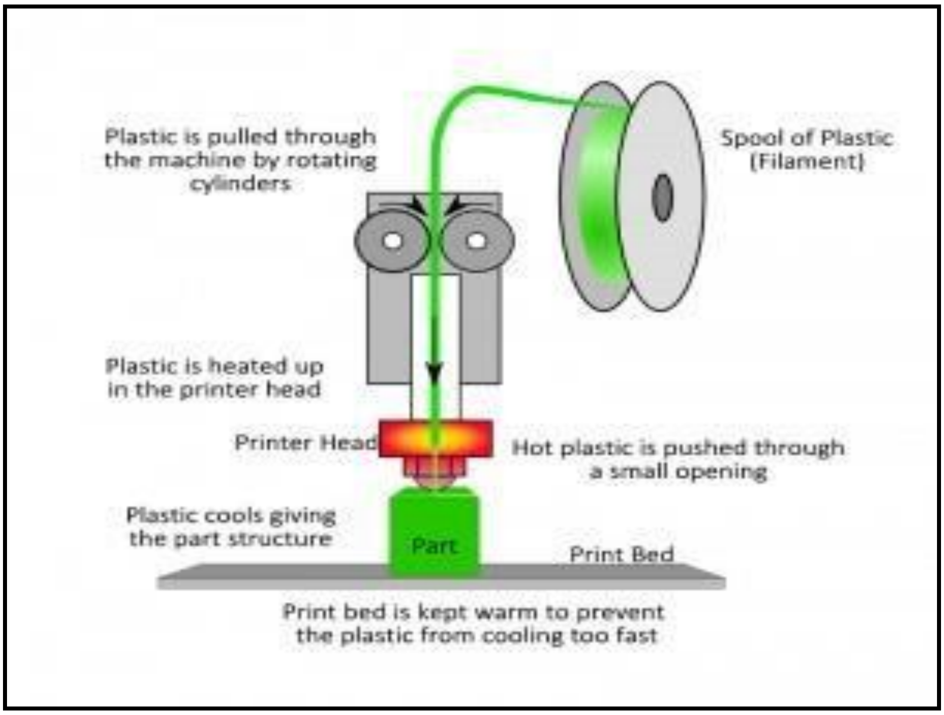

Figure 6.2 Working of FDM

CHAPTER 7
COST ESTIMATION

7.1 Cost Estimation

The total amount of money needed for making this demonstration project has its cot estimation as follows:

Table 7.1: Cost Estimation

SR.NO	NAME OF THE PARTS	QUANTITY	COST IN Rs.
1	Arduino mega	1	1359
2	Ramp 1.4 shield	1	
3	A49AA Stepper Drive	4	
4	NEMA 17 Stepper motor	5	2728
5	E3D hot ends	1	512
6	End stops	3	306
8	240W power supply	1	900
9	PLA Filament (10m)	2	600
10	MK8 Extruder	1	357
11	GT2 Timing belt	1	120
13	Blower	1	60
13	Lm8UU Bearings	10	520
14	LCD smart controller	1	800
15	8mm smooth rod 500 mm	6	2405
18	8mm Treaded rod 462mm	2	1198
19	3d printed parts	-	2000
20 21	M3 Screw M3 Nuts M5 Screw M3 Nuts	10 10	120 250
22	3mm Acrylic sheet	1	1015
23	Plywood sheet	1	1500
24	Miscellaneous charges	-	2000
	Total	-	18, 750

CHAPTER 8
APPLICATIONS AND FUTURE SCOPE

8.1 Applications

- Aerospace and Automotive sector: - With the help of 3-D-printed components which are used for aircrafts and parts are 70% less weighing but identically tough as conventional parts, indicating cost reduction and carbon reduction and emissions of unwanted particle.
- Rapid manufacturing: - Advancements in Rapid Prototyping have presented materials those are necessary for final manufacturing, leading to the possibility of manufactured finished components and parts.
- Mass customization: - Many industries have provided services where people can recreate their desirables implementing simple web-based customizing software. This now enables customers to replicate cases of their mobiles.
- NASA: - In July 2013, NASA designed, printed, and tested rocket engine injectors by exposing them to extreme pressures and temperatures of over 6,000-degree F. A key advantage of printing in 3-D is eliminating the need for welded seams in an object, and a great project direction would be to identify and print traditional objects or design components that would normally require welded seams.
- Replication: - A key idea in the growing field of 3-D printing is the ability for printers to replicate themselves, or to create as many essential components as possible that are necessary to build a machine. Many consumer 3-D printers now come assembled with parts that were themselves printed in 3D.
- Defense: - A company called EOIR Technologies developed a way to mass produce camera gun sights for M1 Abrams tanks and Bradley fighting vehicle using 3-D printing. According to CSC, that cut the cost of manufacturing the gear by 60%. The Air Force is also in the initial stages of pumping out components of otherwise highly sensitive and expensive systems, like drones, in order to use them in training exercises.

8.2 Future Scope

In future 3D printers would be available at a very low cost and can be even used in household applications as it would be affordable and also highly accurate and a multicolor extruder can be used and also the printers would be made portable

Faster Equipment Speed

The future is bright for 3D printing applications across the supply chain. In fact, the average 3D printer production speed is expected to increase by 88% by 2023. And, as printer speed increases, volume capabilities also are likely to increase.

New and Enhanced Materials

New combinations of 3D printing materials, as well as improvements to existing materials, will not only enable unprecedented 3D printing applications, but also will help reduce prices.

Advanced Printing Technology and Additional Capabilities

Advancements in printing technologies and capabilities also will spur the development of new equipment and applications, like 3D-printed electronics.

Areas of further development

- Printing large volumes economically
- Expanding the range of printable materials
- Reducing the cost of printable mater

REFERENCE

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