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Design and fabricate 3D printer for PCB engraving and prototype design.

Aditi Sharma, Rajnish Kumar, Yash Dhole, Shubham Kshirsagar
Prof.Shobha Nikam

aditisingh1263@gmail.com
rajnishkumar8083@gmail.com
yashdhole25@gmail.com
shubhamkshirsagarchb@gmail.com
shobhanikam@aissmsioit.org

Electronics and Telecommunication
AISSMS IOIT, Pune,India.

ABSTRACT

3D printer is a type of material design printer that designs and builds 3D models and products using an additive manufacturing process. 3D printer design three-dimensional prototypes and create the end product by directly building them using computer aided design(CAD) or software created 3D design diagram, figures and patterns. Its area of application is very wide as in rapid prototyping, production parts, manufacturing tooling, bio printings, art and jewelry, fashion designing etc..The main aim of this project is to build a device which will convert the 3D CAD model into original product and convert a copper plate into PCB board by engraving the copper from the board as per the PCB layout.

Keywords—3D Printer, CAD model, Slicer firmware, alluminium extrusion.

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I. INTRODUCTION

3D printing has evolved dramatically in the last few years. 3D printer should be affordable enough that anyone can buy it. Indeed 3D printer is extremely expensive. In industries 3D printer can be used to create prototypes for manufacturing, developing architectural and engineering models and figures for gaming characters or to fix things. By increasing the scale of manufacturing 3D printer and making the technology open source will make the 3D printer more affordable and accessible for all[1].

3D printing is a process of designing an object using material deposited layer by layer in three dimensions. The basic difference between the traditional manufacturing processes is that, it was completely based on the combination of grinding, forging, bending, cutting, molding, welding as well as assembling. At the beginning this technology was put into the used as a tool to shape and bring into the artistic, but in this last decade this technology is developing to that level where mechanical components and some required can be printed. Use of 3D printer has not only change the industrial world but also medical world as well.

There are two main techniques to print 3D object: Fused Deposition Modeling and Stereo Lithography. These two methods are nearly same. Both these process add material layer by layer to create 3D object.

FDM 3D printers build parts by melting and extruding thermoplastic filament, which a print nozzle deposite layer by layer in the build area. FDM works with a range of standard thermoplastics, such as ABS, PLA and their various blends. The technique is well-suited for basic proof of concept models, as well as quick and low cost prototyping of simple parts, such as parts that might typically be machined.

FDM has the lowest resolution and accuracy as compared to stereo-lithography and is not the best option for printing complex designs and parts with intricate features. In industries FDM 3D printers use soluble supports to mitigate some of the issues of stereo-lithography and offer a wide range of engineering thermoplastics. Hence FDM method is used in this project to overcome the issues and drawbacks and to get better accuracy.

This technology has been put into many useful tools in the field of research, designing, manufacturing, engineering and medical science, by making the processes which were not possible by conventional manufacturing process. 3D printing is the ability to produce very complex shapes or

geometries, and a prerequisite for producing any 3D printed part.

II. LITERATURE SURVEY

.[1] Madina Alimanova, Aslanbek Zholdygarayev etc. all"Overview of low cost self made 3D printer"IEEE
This paper conclude many problems in the design of 3D printer frame and seen the drawbacks of wooden frame which leads to the vibration in the frame which leads to the non precise output therefore it can be concluded that the use of use aluminium extrusion for the design of outer frame which will reduce the vibration to get more precise output.

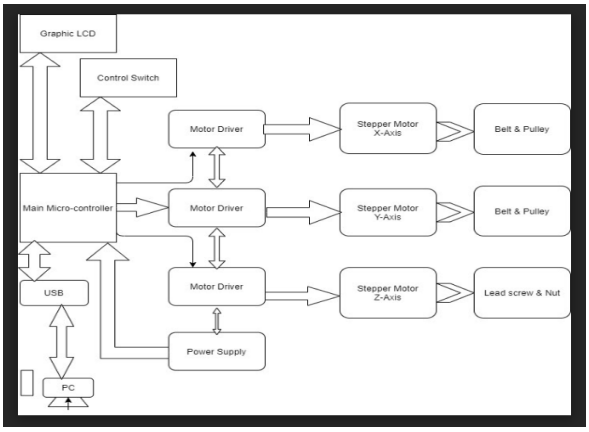
[2] Jong-uk-hou, Dongkyum kim etc all. "Copyright Protections of Digital Content in the Age of 3D Printer: Emerging Issues and Survey" IEEE DOI 10.1109/ACCESS.2018.2864331 VOLUME 4, 2016.
This paper proposed the copy right issues regarding the digital 3D objects and its design,the authority has complete rights to change the design both online and physical as well.

.[3] Gaziz Yerbolat, Amangeldi Shynggys, etc all,"Mechanical Propert prediction Method Based on Multi-material 3D Printer"978-1-5386-5163-6/18/$31.00 ©2018 IEEE.
There are different types of filament used in this papers such as PLA, ABS, Nylon, etc. PLA filament has very high tensile strength that's why to get better accuracy the PLA filament will be used in this project.

[4] Zbigniew Pilch,Jaroslaw Domin,"The impact of vibration of the 3D printer table on the quality of print "978-1-4673-9452-9/15/$31.00 ©2015 European Union".
This paper gives the brief information about the vibrations in the mechanical parts.Increasing printing speed over 160% may leads to the vibration.It can be concluded that the speed of printing should be less than the 160% to print effective and good quality objects.

III. METHODOLOGY

3D printing is a additive manufacturing method which converts the CAD model into the final product. The block diagram basically contains main controller, motor drivers, sensor, heat bed,heta end and power supply as well.



Firstly the CAD model is prepared for the object which is to be printed in various software such as Autocad, Catia and Fusion 360. The output of the software is in the .STL format.Slicing software is used to slice the CAD model into 2D layer and convert it into G-code.G-code generated by slicer software is given as input to the control board using USB port or memory card.

Now the control board preapare the 3D printer for printing by giving the instructions to the motor drivers which helps to adjust it to home position.Meanwhile the temperature of heat brick and heat bed is control by the control board and raise it to optimum temperature.After proper synchronization and optimum temperature, it starts the printing of the object. 3D printing or additive manufacturing is a process of making three dimensional solid objects from a digital file.The creation of a 3D printed object is achieved using additive processes. In an additive process an object is created by laying down successive layers of material until the object is created. Each of these layers can be seen as a thinly sliced horizontal cross-section of the eventual object.

3D printing is the opposite of subtractive manufacturing which is cutting out / hollowing out a piece of metal or plastic with for instance a milling machine.3D printing enables you to produce complex shapes using less material than traditional manufacturing methods. It all starts with a 3D model. You create a CAD model of selected application and then convert the CAD model into G-code using slicer software .Either when creating it you can choose to use a 3D code or 3D modeling software.

IV.HARDWARE AND SOFTWARE DESIGN

To design a 3D architecture of selected application using autocad software. Then a file is generated by auto cad having .STL extension. This file is then uploaded into the slicer software. The slicer software sliced the 3D architecture into 2D layers and generates the co-ordinates of the 3D architecture. This co-ordinates are provided to the controller which helps to print the 3D object.

A. Hardware Design

1. STEPPER MOTOR:

The result is theoretically right, but we might still need to calibrate our machine to get finest detail. For that we are using stepper motor which has an angle of 1.8 degree and micro stepping of 1/16 u steps. The belt is using with the stepper motor is of 2mm pitch.

2. EXTRUDER:

To calculate the Extruder Calibration steps per mm from the extrusion length we can use this equation;

- steps/mm × 100 mm = X then X / extruded distance = new steps/mm value.
- so in our example 104.40 x 100 = 10440 then 10440 / 95 = 109.89 <- new steps/mm value.

3. END STOP:

End stop or limit switch is used to define the origin and limits of each axis. It is usually placed at the minimum side of the axis and the maximum side of the axis is defined in the firmware.

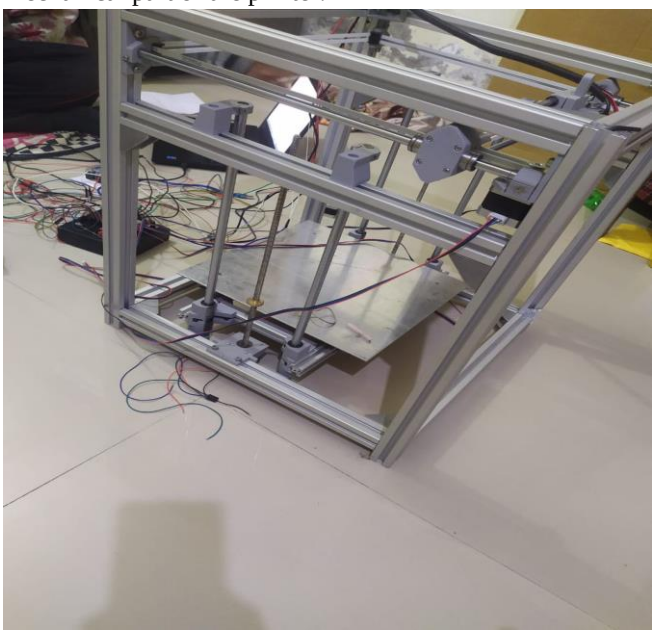
4.PROCESSOR:

It is a 32 bit processor based on harward architecture. There are 3 stages pipeline, fetch, decode and execute.The main control chip used in processor is LPC 1768, which supports G-code file format. This processor is cost effective which is use to reduce the processor area and has extensive improving interrupt handling and system debug capabilities.

V. TEST RESULTS

We are expecting a 3D printer to make a small scale prototype which can be put into a use of mechatronics based industries which have an accuracy upto 90% and is of very cost efficient.

Firstly the prototype is tested to check whether every motor is working in x,y and z axis in correct direction respectively followed by the end stop is triggering or not,then the heat bed is checked, which is properly heating at 50-110 degree centigrade.To melt the plastic filament, the hot end started heating at range 200-240 degree centigrade.As in we use aluminium extrusion there was no vibrations in the mechanical part of the printer.



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