

3D PRINTER USING FUSED DEPOSITION MODELING

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Abstract- Prototyping is a method of system development which is built, tested, and then altered as required until an tolerable prototype is achieved from which the complete system can be developed. It is this symbiosis that has brought about a revolution in the field of development in large scale manufacturing industries and at the same time given birth to precision engineering required to perform complex tasks with higher dimensional and time constraints. Multi layering process is used to print any 3D objects. 3D printers require input from a CAD program in the form of an STL file, which describes a shape by a list of vertices. Majority of 3D printers use techniques like, FDM (Fused Deposition Modelling), SLS (Selective Laser Sintering), Stereo lithography, Laminated Object Manufacturing etc.

Index Terms- 3D printer, Fused Deposition Modelling,

I. INTRODUCTION

Technology has affected recent human history probably more than any other field. We have a better life compared to earlier life, all thanks to the technology that has opened up new possibilities.

The basic principle that differentiates 3D printing is that it is a different manufacturing method based on advanced technology that builds the parts in layers at the sub “mm” scale. This is different from any other existing manufacturing techniques.

There are a number of limitations to manufacturing which is happening in today’s time. It has widely based on human labour and “made by hand” ideology taking back to the older times. And so to bring a change or we can say a revolution in the traditional technology and to make it simple, we have started developing various new technologies and 3D printing is one of them, that will help to bring a change on a very large scale. 3D printing is an upcoming innovation with extraordinary design independence. Being a tool-less process, it reduces unreasonable costs. Components can be designed to avoid assemblage requirements with complicate the geometry.

Applications of 3D printing are used almost by the day, and, as this technology continues to infiltrate more widely across industrial, consumer sectors, this is only set to increase.

II. PROBLEM DEFINITION

Back in the 80’s, there was an accepted practice of producing the physical prototype of the product that is to be mass-produced. This process has its own challenges which include financial and time losses due to flaws detection in the created prototype which led to increased scrap release. Thus, to minimise the mentioned loses and improve the accuracy and speed of creating new products, a method called “DIGITAL PROTOTYPING”. This process involves the use of a 3D printer in conjunction with a 3D rendering software such as AUTOCAD or CURA and using the aid of modern electronic process devices such as Arduino. This prototyping concept reduces the amount of prototyping time and increases the accuracy of the prototype to be created. It has its application in various fields such as houses, fashion field, armaments, utensils and many more.

III. LITERATURE SURVEY

Author: Athanasios Anastasiou, Charalambos Tsirmpas, Alexandros Rompas, Kostas Giokas, Dimitris Koutsouris. [2]

Title: 3D Printing: Basic concepts Mathematics and Technologies [2].

Work Done: What is 3D Printing? How 3D Printing is made real by using Fubini Theorem, detailed explanation of Fused deposition modelling, Powder-Binder Printing and Bio printing. Also states a case study of 3D printing a heart.

Learning from this paper: Implementation of 3D printing mathematically using Fubini Theorem and understanding the flow about Fused Deposition method.

2 Author: KaufuiV. Wongand AldoHernandez. [1]

Title: A Review of Additive Manufacturing.

Work Done: Introduction to 3D printing, all types of 3D printing processes.

Learning from this paper: Additive manufacturing processes take the information from a CAD file that is converted to a STL file and the relevant additive manufacturing processes and their applications [1].

IV. METHODOLOGY:

The hardware device is controlled using software. The designing of the shape and size is done using CURA software. There are three stages of printing; Modeling, 3D file export and slicing file export. This software translated the 3D STL file into G code; this is the code which the printer understands. Using a G code, the arduino tells the printer when, where and how to move and how much to extrude throughout the entire printing process [7].

V. FUSED DEPOSITION MODELLING

Fused Deposition Method (FDM) is the most preferred method here. This method has been modified to use a material called bio-plastic which is a nature friendly material. By using this material, the speed of prototyping can be increased and the desired prototype can be constructed in a quarter of time. It uses the “additive” principle of stacking the material in the form of layers which unwinds from a metal coil.

It uses a process called Stereo Lithography file format (STL) which mathematically orients the model for build and slice process. The final model is formed by stacking the strings of material extruded from the nozzle followed by quick hardening. In order to push the filament through the nozzle, a worm drive is used to attain a controlled rate of fusion which facilitates easy rectification of errors.

The molten polymer used can be cooled by exposing it to low temperature in the presence of an inert gas such as argon, which significantly increases the in-layer adhesion and results in improved mechanical properties of the 3D printed objects.

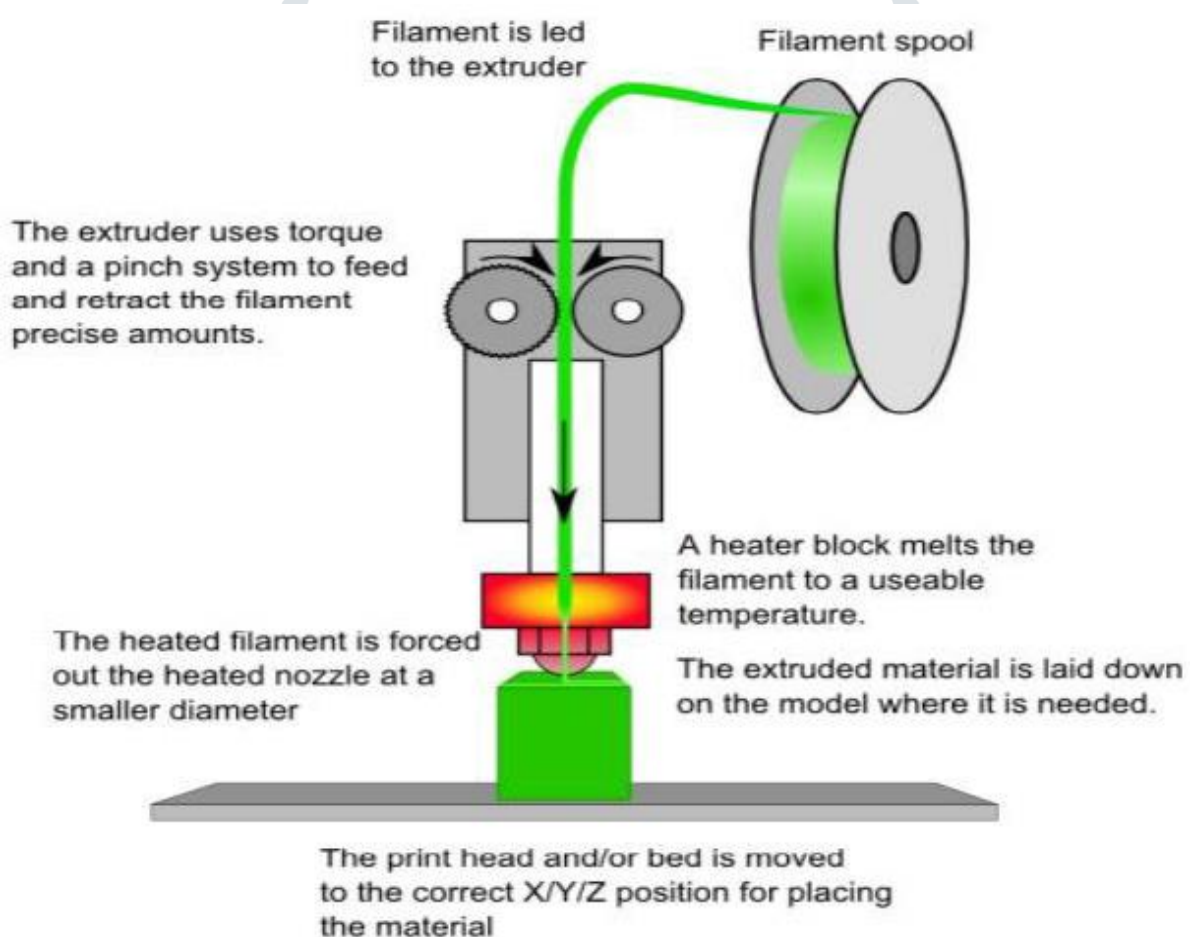


Fig 1: Work flow of FDM

5.1 Block Diagram:

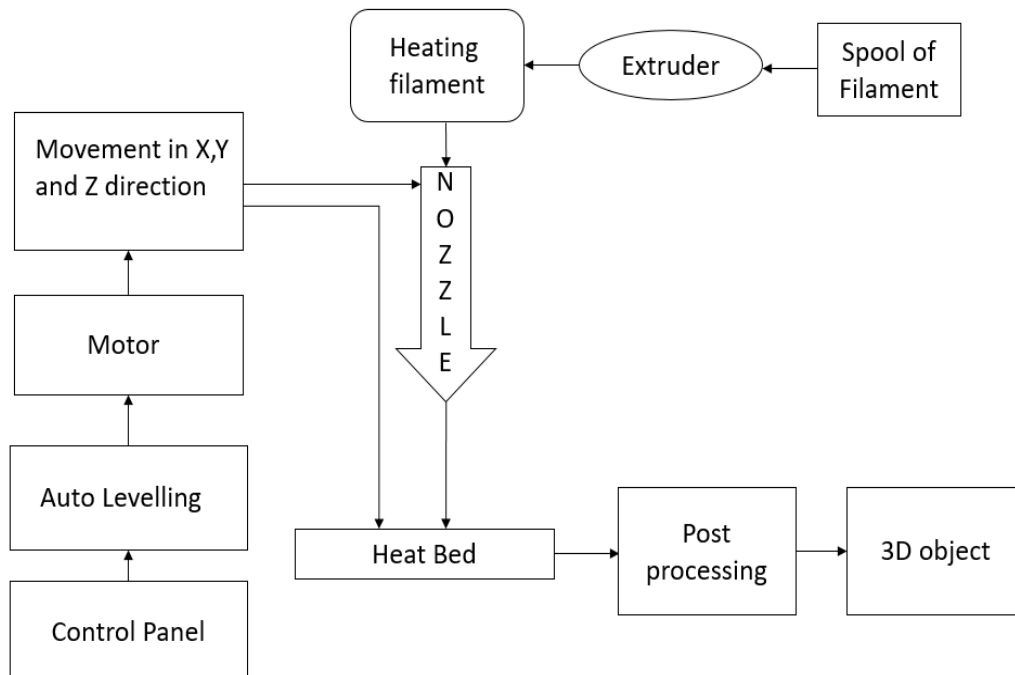


Fig 2. Block Diagram of 3D printer

5.2 Steps for using the designed printer:

1. **Develop the 3D object (AUTOCAD):** It is a 3D design and rendering software which helps the user create 3D models of the possible prototypes. This helps the industry to visualize the product before its market testing and reduce the manufacturing and production cost by a large amount. This also helps in the reduction of scrap. AutoCAD is universal design software which has its application in various fields such as architecture, civil, mechanical, electronics and more. It is a very versatile design tool for manufacturing and innovation industries. These are the AutoCAD models that were prepared in order to make the design and implementation easier.
2. **Conversion into STL file format:** 3D prints are most commonly generated from an STL or .stl file. Standing for “stereo lithography” this file format is to 3D print the .doc file. To open and operate on an STL file, use computer-aided design (CAD) software. We have used AutoCAD as stated above.
3. **Transfer to Cura Software to obtain the G-code:** This software helps to bring any 3D creation into the real world but for doing this it needs to be converted into a G-code file, as the 3D printer can read the G-code format only and process as per the file. Cura prepares the 3D file in fraction of seconds, while carefully checking any areas that need correction. Once the preparation of the 3D file is done, the powerful 3D virtual previews that the software provides allows the user to pan around the design, so one can check everything as one imagined the object to be and make the necessary changes required. This 3D data generated can be used for research purposes in domestic and military fields as per the requirement.
4. **Setup the Machine:** Firstly, we have to generate a code in Arduino which commands the nozzle to move along x, y and z axis as per the requirement. Arduino is an open-source hardware which comprises of a board and a compatible software made by the same manufacturer. Arduino boards are able to read inputs and turning it into an output in forms. Arduino boards are completely open-source, allowing the users to build them independently and adapt them to their needs. The things that make Arduino so special are that it is inexpensive, provides cross-platform software, and simple programming environment.
5. **Print:** To start printing a LCD screen is used as the information screen. Pressing the knob on the information screen main menu is accessed. The menu displayed depends on the state of the printer. If it is waiting to run a job, it offers the menu “prepare” and while you are printing it offers the menu “tune”. The voices and the features available in these two modes are different and it is important to know them, to avoid losing time looking for functions that are in another mode.

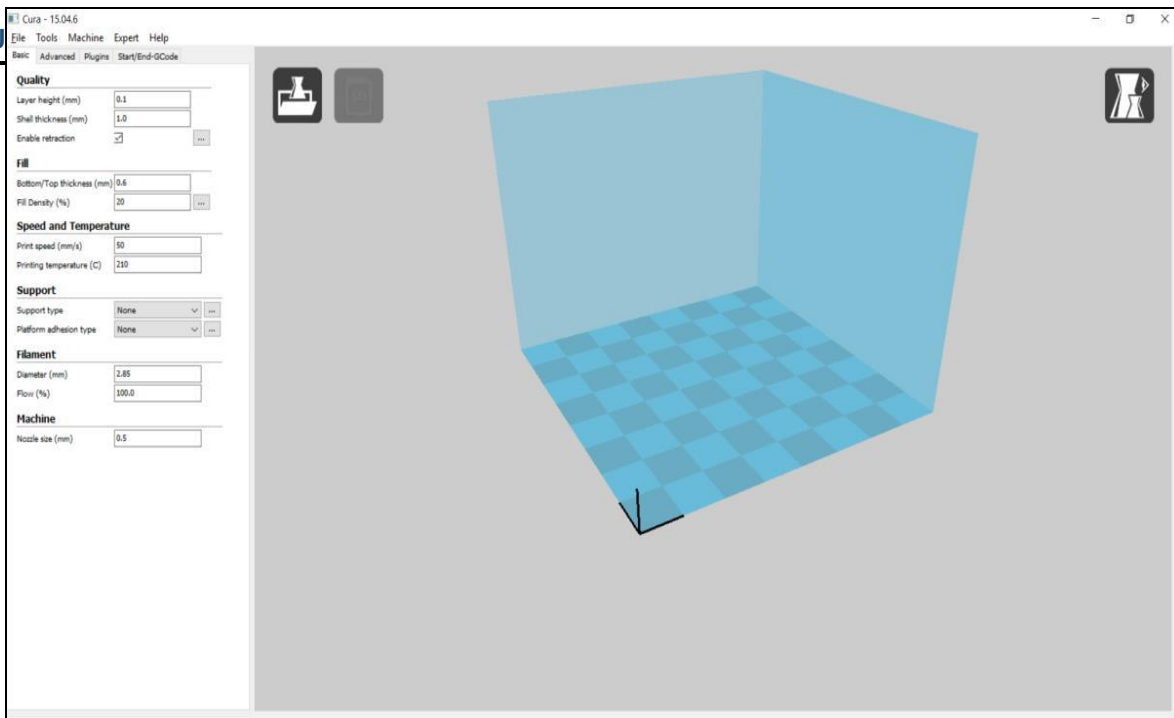


Fig 3. Designing with CURA



Fig 4. LCD screen displaying the details while 3D printing

6. **Remove the object for any post processing:** After going through all the process finally the desired prototype is seen and then the necessary tests are conducted on it and as the parts are build layer by layer it gives us a brief idea about what changes are to be done while making the final product which will in turn save a lot of time and also the investment in the terms of money. The product that will be made by the use of bio-plastic will be of great help and also is very easy to dispose without causing any harm to the environment.

The future of this printer is that it will be used on a very large scale in the medical industry and will help to solve the various medical related issues related to knee, heart etc. Also in the medical studies, it is of great help for the budding students to understand the various parts in detail which will enhance the knowledge to a great scale.

VI. RESULTS AND DISCUSSION

While executing the project we faced various difficulties and we proved to refine them using several solutions. The foremost problem faced was that the initial layer was not printing properly and the reason for this was that the length between the heat bed and the nozzle. The solution to this was the distance between the two should be no more or less than 0.1mm. And after all these variations and changes the problem was rectified and the proper prototyping was achieved. Secondly, when we began making the 3D object, the problem faced was that, the nozzle was not able to print the product along the desired place as anticipated and was leaping all over the heat bed. This trouble was resolved by tightening the fixed belt connected to the motor and responsible for the drift of the nozzle in X, Y and Z direction.

The third problem faced was that, the PLA or the ABS material used for constructing the prototype was not securely attached to the heat bed, due to which the filament was not capable to stick properly on the heat bed and so printing was not as per expectation. We came up with two simple solutions and they are, the first by simply increasing the temperature of the heat bed, the reason for this is that, the first layer being firmly attached to the heat bed and will not leave the heat bed. And the second solution is that by creating slurry of the filament used and then applying on the heated bed. The slurry is prepared by just breaking up the PLA or ABS filament into acetone and an alternate to this is to apply glue that does not react with the filament used.

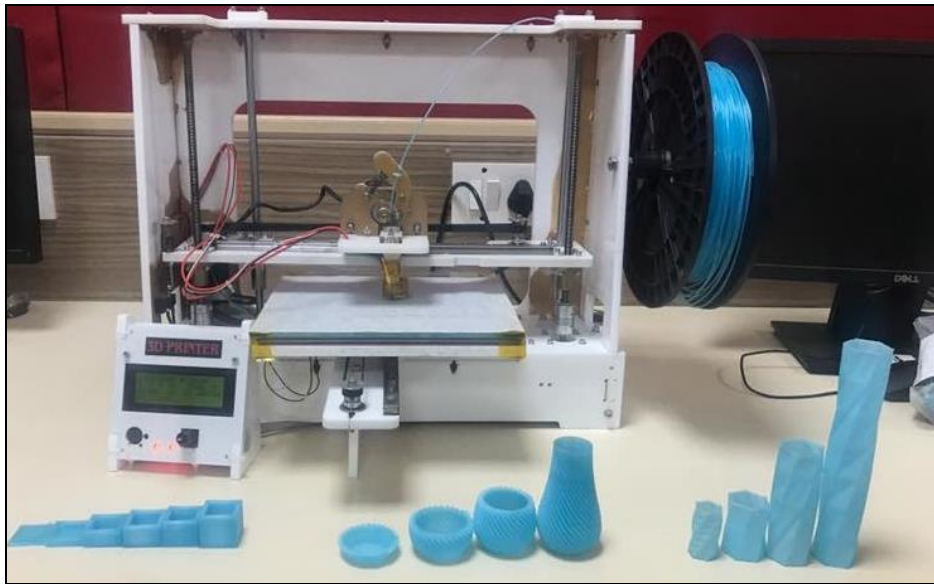


Fig 5. Objects Printed with the designed 3D Printer

VII. CONCLUSION

On a concluding note it would be great to say that the 3D printing technology has revolutionized and re-shaped the world. The manufacturing or the design is based on the Computer Aided Design and then sliced up into thin layers, to prepare a 3D model. The extensive use of 3D printing technology will result in reduced manufacturing cost, design cost; reliance on manpower, improved speed and accuracy of prototyping, less connection between parts of a product resulting in improved material properties and better life expectancy. 3D printing is the future technology that will help solve complicated engineering problems and speed up the innovation. The finishing achieved on this printer is as good as an industry standard. Table 1 shows the comparison of 3D printer available in market and the designed printer

Table 1: Comparison of Market and Designed Printer

Parameters	Dremel 3D Idea Builder (Market)	LARNS – to create the future (Designed)
Build Resolution	100 micron	12.5 micron
Build Platform	Removable	Removable
Interface	Full colour touch screen	Smart LCD control support
Extruder	Pre installed	Pre installed
Workshop	Fully Enclosed	Fully open
Cooling Fan	Pre installed	Not installed
Warranty	One Year	
Certification	UL Certified	Not certified

Following are the specifications of the designed printer:

Key Specifications:

1. Build resolution: 12.5 micron
2. Linear speed: 1mm/s
3. Smart LCD Control Support.
4. Can be printed with both PLA and ABS.

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