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3D Printer by Fused Deposition Modelling Method

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Abstract: ***3d printing is a form of additive manufacturing where a 3-dimensional object is created by laying down successive layers of material.The main purpose of the research is to make a 3d printer with low cost and easy fabrication. Many industries use the traditional method for making prototype for analysis which is time consuming. 3d printer can reduce this time and the cost but the initial cost of 3d printer in the Indian market is around 20,000-30,000Rs. So, in this research paper our aim is to develop a low-cost printer for commercial use.***

Keywords: Additive manufacturing, 3D printing, Rapid Prototype, FDM

1. Introduction

To be more precise, 3d Printing Is a process of converting a 2dimensional CADdesign into 3Dimensional actual model using electronic data source.

1.1History

The first 3D printing attempts are granted to Dr Kodama for his development of a rapid prototyping technique in 1980. He was the first to describe a layer by layer approach for manufacturing, creating an ancestor for SLA. In the same time, Charles Hull was also interested in the technology and deposited a first patent for stereolithography (SLA) in 1986. In 2000, the millennium saw the first 3D printed working kidney. At present 3d printed buildings, food items, coloured products are manufactured by this 3d printing technology.

1.2 Working of 3d printer

The FDM 3d printer deposits the material on a heating bed by heating and extruding the filament resin and setting it layer upon layer. This process is simple and includes 3 phases:

Pre-processing: In this phase we make cad design using cad software such as AutoCAD, Solidworks. After this, the design model is converted into stl (standard triangle language) format which slices the model geometry and determines the path of layer deposition.

Production: The 3d printer heats the thermoplastic resin and converts it into a semi liquid form. Then it deposits the resin in anultra-thin bead to form the model. Where support is needed the 3d printer deposits removable material that acts as scaffolding.

Post processing: The actual finished model is ready and does not need any further machining. The support material is removed by hands or by dissolving it into a detergent or water.

Advantages of FDM 3d printer

- It is a clean and simple process.
- Complex geometries can be easily made.
- The prototype making process is fastened
- Variety of geometries can be modelled.

Material jetting: The material used in FDM printers are ABS (Acrylonitrile butadiene styrene) and PLA (Polylactic acid). We are using the PLA resin which is widely used for commercial purpose and has a good thermosetting property.

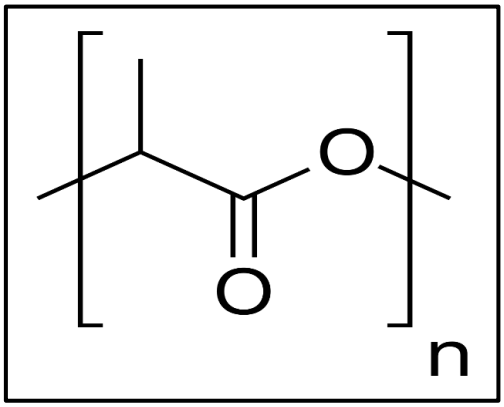

Figure 1: Skeletal formula of PLA

The material jetting takes place from the extruder nozzle kit. The temperature maintained at the nozzle is around 180°C to 240°C.

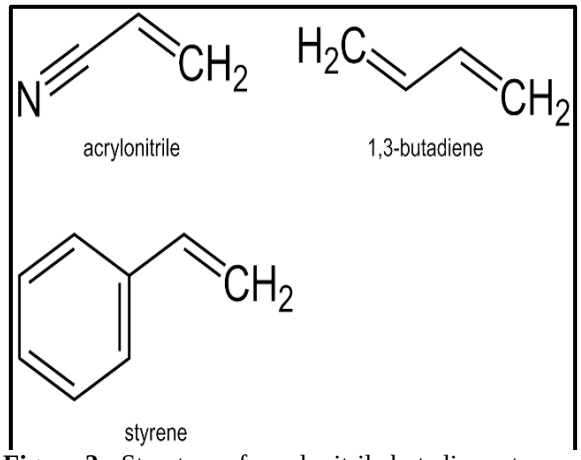

Figure 2: Structure of acrylonitrile butadiene styrene

2. Design and Fabrication of 3 Printer

The design of the printer was determined as per the required printing area. The frame, base and supporting structure was done by using low weight material.

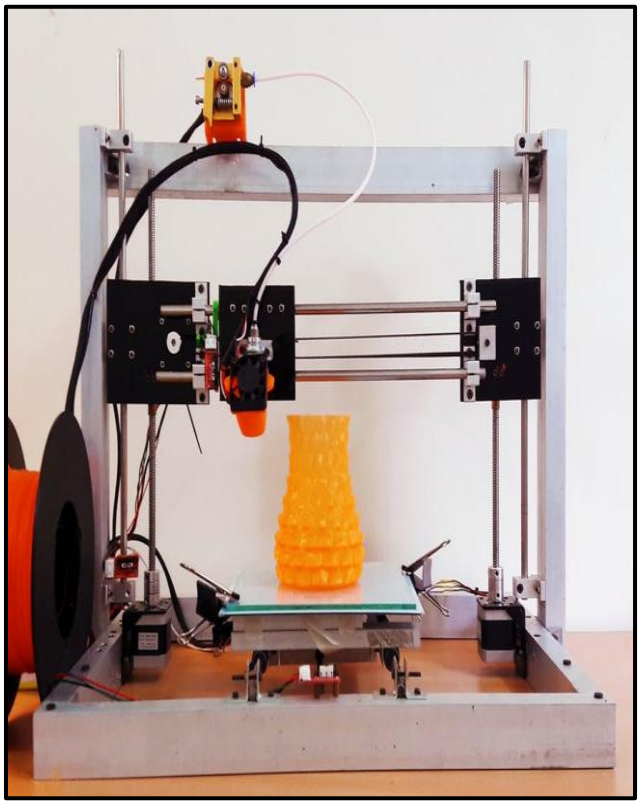

Figure 3: Actual model of FDM 3d printer

Table 1: Part Specifications

SR NO	PART NAME	SPECIFICATION	QUANTITY
1	RECTANGULAR ALUMINIUM BARS	50cm x 5cm x 2.5cm	6
2	RECTANGULAR ALUMINIUM BARS	60cm x 5cm x2.5cm	1
3	SMOOTH STEEL RODS	8mm dia	6
4	THREADED RODS	8mm dia	2
5	ED3 HOT END MODULE	v6	1
6	SC8UU BEARING	8mm dia	8
7	RAMPS	1.4 shield	1
8	NEMMA 17 STEPPER MOTOR	45N-cm torque	5
9	FLEXIBLE COUPLINGS	8mm dia	2
10	623ZZ BEARINGS	8mm dia	2
11	GT2 PULLEY	5mm dia	2
12	GT2 TIMING BELT	2m	1
13	POWER SUPPLY	12V SMPS	1
14	A4988 STEPPER DRIVER		5
15	END STOPS		3
16	ARDUINO MEGA 2560		1
17	M3 SCREWS	1/2 inch	50
18	M3 NUTS		50
19	ANGLE BRACKETS		10
20	HEAT BED	250mm x 300mm	1
21	MK8 EXTRUDER MODULE		1
22	CONNECTING WIRE	F-F	20
23	CONNECTING WIRE	M-F	20

Table 2: Cost Estimation

SR NO	PART NAME	COST PER UNIT	QUANTITY	TOTAL COST
1	RECTANGULAR ALUMINIUM BARS	80	6	480
2	RECTANGULAR ALUMINIUM BARS	80	1	80
3	SMOOTH STEEL RODS	110	6	660
4	THREADED RODS	80	2	160
5	ED3 HOT END MODULE	4000	1	4000
6	SC8UU BEARING	140	8	1120
7	RAMPS	400	1	400
8	NEMMA 17 STEPPER MOTOR	700	5	3500
9	FLEXIBLE COUPLINGS	150	2	300
10	623ZZ BEARINGS	90	2	180
11	GT2 PULLEY	150	2	300
12	GT2 TIMING BELT	100	1	100
13	POWER SUPPLY	1200	1	1200
14	A4988 STEPPER DRIVER	90	5	450
15	END STOPS	100	3	300
16	ARDUINO MEGA 2560	1100	1	1100
17	M3 SCREWS	0.6	50	30
18	M3 NUTS	0.7	50	35
19	ANGLE BRACKETS	10	10	100
20	HEAT BED	960	1	960
21	MK8 EXTRUDER MODULE	350	1	350
22	CONNECTING WIRE	1	20	20
23	CONNECTING WIRE	1	20	20
	TOTAL			**15845**

3. The actual 3D printing process

3.1 Design of the CAD model

In design software such as Solidworks, AutoCAD, Inventor we design the object to be produced. This software is user friendly and we can design any complex geometry.

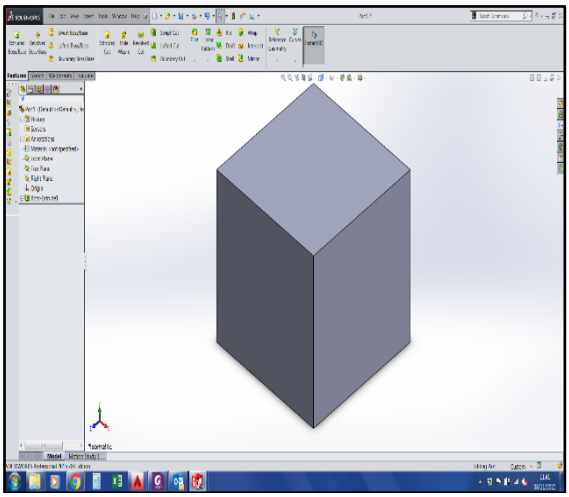

Figure 4: CAD model of Simple cube in solidworks

3.2 Converting the design in STL format

Once the design is completed in the cad software, we then convert this drawing file in STL format.

This file format is supported by various packages and 3d printers.

An STL file describes a raw unstructured triangulated surface by the unit normal and vertices (ordered by the right-

hand rule) of the triangles using a three-dimensional Cartesian coordinate system.

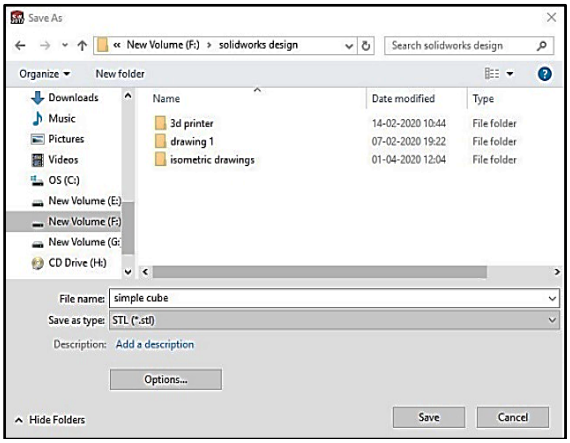

Figure 5: Converting in .stl file

3.3 Opening the file in slicer software

We use Slic3r software to slice the file and determine the position of the object in which it is going to be printed. Once this is done then we generate g-codes from 'Export G-code' option.

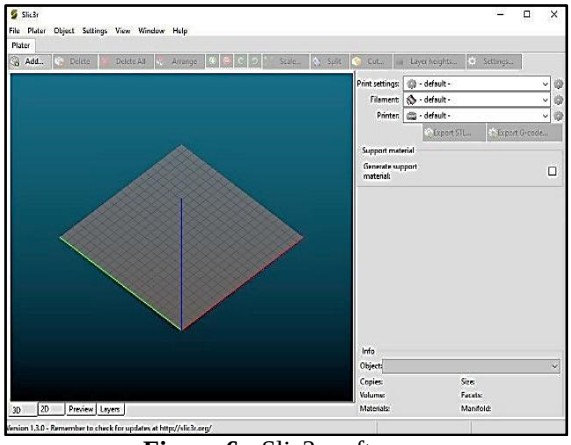

Figure 6: Slic3r software

3.4 Importing of g-codes and printing in Pronterface software

The Pronterface software connects the Arduino mega 2650 with the computer.

We can print the model by using this software.
Once we select print option then the Arduino mega 2650 send the command to the stepper motor and then the object is printed.

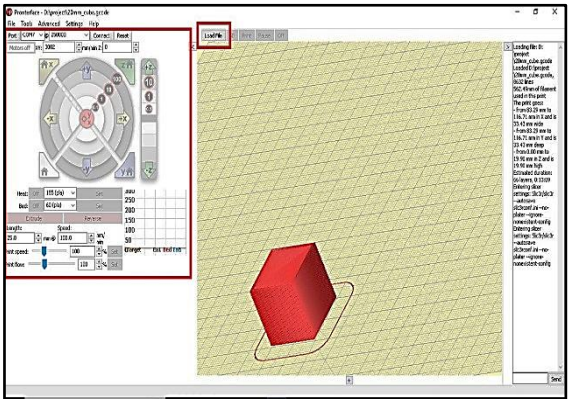

Figure 7: Pronterface software

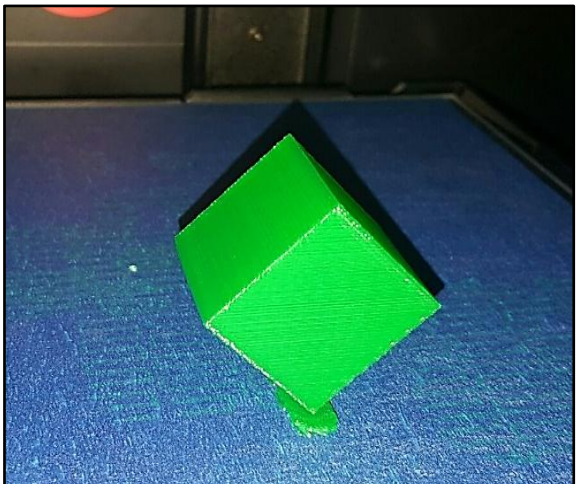

Figure 8: 3d printed object

4. Conclusion

From our survey and research, we conclude that by using various alternatives we are successful in reducing the cost of the 3d printer. Due to this it becomes easy for using the 3d printer for commercial use.

5. Future Scope

- More advancements can be done by increasing the smoothness of printed objects.
- Furthermore, advancements can be done by increasing the variety of printing materials.

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