Implementation Paper on Design of Low-Cost 3D printer using Digital Video Disc

Nitin D. Pawar[1] Dr. A. M. Rawate[2] P. B. Kamble[3]
[1]Student [2,3]Assistant Professor
[1,2,3]Department of Electronics and Telecommunication Engineering
[1,2,3]CSMSS College of Engineering, Aurangabad, Maharashtra, India

Abstract— This is an implementation paper on 3D printing & various materials used in 3D printing. First, define what is meant by 3D printing and what is significant of 3D printing. We will go through the timeline of 3d printing technology from the 19th century. The main purpose of the research is to develop 3D printing technology for special purpose machines at a low cost. Many industries use traditional methods for developing a prototype for analysis rather than using technologies like 3D printing because it is expensive. In this CD drives are used instead of a stepper motor to develop a printer which is cost-effective and to encourage manufacturers to adopt the method of 3D printing.3D printing significantly challenges mass production processes in the future. This type of printing is predicted to influence industries like automotive, medical, education, equipment, consumer products industries, and various businesses.

Keywords: 3D printer demo model, filament material its technical parameters, merits, demerits, future scope

I. Introduction

Fig. 1: 3D printer Machine

3D Printing Technology means a 3-dimensional physical object creating process also known as additive manufacturing processes. Herein this technology 3D Printer creates an object by lying down the material on the platform of the printer until the desired object is formed. In this melted material or powder used to create an object. 3D printing or additive manufacturing (AM) is a group of technologies that are used to build prototypes, physical models and finished parts from three-dimensional (3D) computer-aided design (CAD) data. A study showed the technology has developed rapidly and has proven its effectiveness, especially for design and small production.

II. Proposed System Design

Parameters considered to develop 3D Printer using CD Drives

1) Extruder Temperature:

We are using PLA and ABS materials for that PLA printing temperature 205 0C and ABS material printing temperature is 230 0C[5]. Therefore, we are choosing the extruder temperature 1800ºC to 2700ºC.

2) Extruder Diameter:

Generally, extruder diameter can be varied as per the requirement; it needs to simply change the extruder. Accuracy depends on nozzle diameter, as reducing diameter accuracy will increase. That's why we use the standard diameter of 0.2mm to 0.4mm.

Parameters	Specifications
Maximum Printable Area	60mm x 60mm x 30mm
Input Power	230V AC ->12V DC
Extruder Diameter	0.2mm/0.3mm/0.4mm
Extruder Temperature	180ºC - 270ºC
Number Of Extruders	1
Filament Diameter	1.75mm
Recommended Materials	ABS, PLA
Maximum Print Speed	80mm/s - 200mm/s
Software Supported	Repetier, Cura, Pronterface
Layer Thickness	Range 0.1-0.25mm
Print Monitoring System	Through Computer

Table. 1: System parameters and their specification

Complete Design and Fabrication of 3D Printer using DVD Drives is shown in fig. 2 below.

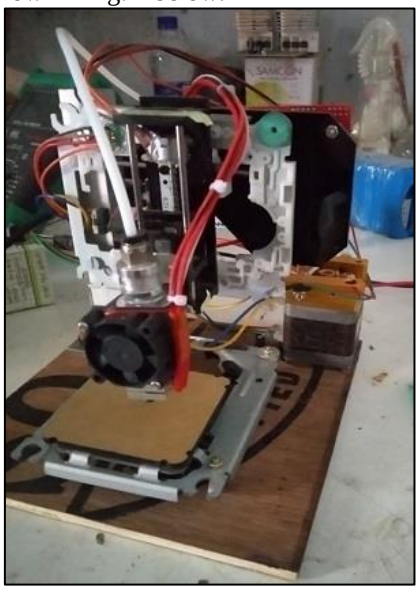

Fig. 2: Assembly of 3D Printer machine using DVD Drive

III. TESTING

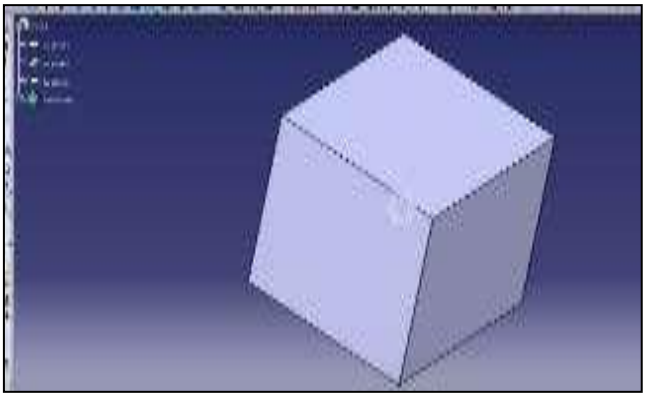

Fig. 3**:** CATIA Model of Cube

(1) The file created is then loaded in the Pronterface which connects Arduino with the computer.
(2) From the Pronterface software, we can give print command. The Arduino mega will thus send a command to the stepper motor & we get a 3D model.
(3) The figure above is a snapshot of Pronterface software showing the wagon wheel through which the motions of the 3D printer can be controlled.

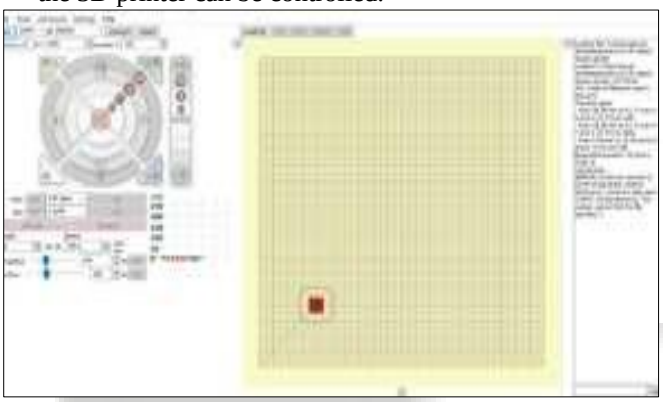

Fig. 4: Pronterface Software

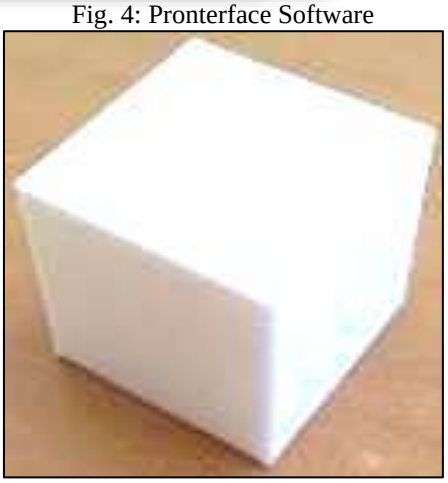

Fig. 5: After printing object

A. General Principals in 3D Product designing

(1) Modeling of Product
(2) Printing of Product
(3) Finishing of Product
(4) Final Product Checking

Fig. 6: 3D Printer filament non-transparent

Fig. 7: 3D Printer filament transparent

B. Technical Specification of product ABS

Acrylonitrile Butadiene Styrene [ABS] One of the most widely used material since the inception of 3D printing. This material is very durable, slightly flexible, and lightweight and can be easily extruded, which makes it perfect for 3D printing.

- Density: 1-1.4 gm/cm^3
- Dielectric constant: 3.1 to 3.2
- Dielectric Strength [Breakdown Potential]:15-16 kV/mm [0.59-0.63 V/mil]
- Elastic modulus: 2 to 2.6 GPa
- Elongation at break: 3.5 to 50%
- Flexural modulus: 2.1 to 7.6 GPa
- Flexural strength: 72 to 97 MPa
- Heat deflection temperature at 1.82 MPa: 76 to 110°C
- Heat deflection temperature at 455 KPa: 83 to 110°C
- Strength to weight ratio: 37 to 79 kN-m/kg
- ensile strength: 37 to 110 MPa
- Thermal expansion: 81 to 95 µm/m-K

1) Material Properties of Acrylonitrile Butadiene Styrene [ABS]

- Temperature: 225°C
- Flow Tweak: 0.93
- Bed Temperature: 90°C
- Bed Preparation: apply glue stick 2 layer & then abs glue 1 layer

C. Technical Specifications of PLA

Poly lactic acid (PLA) (is derived from corn and is biodegradable) is another well-spread material among 3D

printing enthusiasts. It is a biodegradable thermoplastic that is derived from renewable resources.

- Density: 1.3g/cm^3 (81lb/ft^3)
- Elastic (Young's, Tensile) Modulus: 2.0 to 2.6GPa(0.29 to 0.38x 10^{3}psi)
- Elongation at Break: 6.0%
- Flexural Modulus: 4.0GPa (0.58x 10^{6}psi)
- Flexural Strength: 80MPa(12x 10^3 psi)
- Glass Transition Temperature: 60°C (140°F)
- Heat Deflection Temperature At 455 KPa (66 psi): 65°C (150°F)
- Melting Onset (Solidus): 160°C(320°F)
- Shear Modulus: 2.4GPa(0.35x 10^{3}psi)
- Specific Heat Capacity: 1800J/kg-K
- Strength to Weight Ratio: 38kN-m/kg
- Tensile Strength : Ultimate (UTS): 50MPa(7.3x 10^{3}psi)
- Thermal Conductivity: 0.13W/m-K
- Thermal Diffusivity: 0.056

1) Material Properties of Poly Lactic Acid [PLA]

- Temperature: 180°C
- Flow Tweak: 0.95
- Bed Temperature: 60°C
- Bed Preparation: apply glue stick 2 layer

IV. Merits & Demerits

A. Merits

(1) Less wastage of filament material
(2) Easy to design
(3) The semi-skilled person required.
(4) Cheaper process.
(5) Low design complexity

B. Demerits

(1) Cost of raw material is high
(2) 3D Printer is also expensive.
(3) More time to create a single object using stl format

V. Application

(1) In manufacturing, who needs to develop a better product in less time the can use it.
(2) It is used for architecture to design a full-color model.
(3) It is used in the medical field to improve the preparation of the student.
(4) In geospatial, colourful 3D maps more impactful & understandable than traditional paper maps.
(5) In marketing, 3D color model more impact than broachers for the customers

VI. Conclusion

After review of this paper, I designed a low-cost 3D printer using a DVD drive and its simulation result concluded on Pronterface software using g code and stl format and I present this result on my paper of implementation. The main aim of our project was to reduce the cost of the 3D printer by replacing the high-cost stepper motor (1 stepper motor price is near about 18000 Rs Indian High Quality) by CD drives and floppy drives. We have been successfully reduced the cost of a 3D printer machine. We have developed a 3D printer machine with the use of CD drives in Rs. 7000.

References

[1] Parth R. Kantaria, Shyam. A. Pankhaniya, "Implementation of 3D printer", International Journal for Technological Research in Engineering Volume 1, Issue 9, May-2014.
[2] Siddharth Bhandari, B Regina,"3D printing and its applications", International Journal of Computer Science and Information Technology Research ISSN 2348-120X (Online) Vol. 2, Issue 2, pp: (378-380), Month: April-June 2014.
[3] W. M. Keck"3D Printing for the Rapid Prototyping of Structural Electronics", IEEE Access March 13, 2014, date of current version April 7, 2014. Digital Object Identifier 10.1109/ACCESS.2014.2311810
[4] Vivek srinivasan, jarrod bassan, "3D Printing and the Future of Manufacturing", CSC LEADING EDGE FORUM, 2012.
[5] D. Phamand R. Gault, ''A comparison of rapid prototyping technologies,'' Int. J. Mach. Tools Manuf., vol. 38, nos.10–11, pp. 1257–1287, 1998.
[6] C. Chua, K. Hong, and S. Ho, ''Rapid tooling technology. Part 1. A comparative study,'' Int. J. Adv. Manuf. Technol., vol. 15, no. 8, pp. 604–608, 1999.
[7] S. Rahmati and P. Dickens, "Rapid tooling analysis of stereo lithography injection mold tooling," Int. J. Mach. Tools Manuf., vol. 47, no. 5, pp. 740–747, Apr. 2007.
[8] M. Ruffo, C. Tuck, and R. Hague, ''Make or buy analysis for rapid manufacturing,'' Rapid Prototyping J., vol.13, no. 1, pp. 23–29, 2007.
[9] M. Navarrete et al.," Integrated layered manufacturing of a novel wireless motion sensor system with GPS," in Proc. Solid Freeform Fabrication Symp., 2007, pp. 575–585.
[10] R. Olivas, R. Salas, D. Muse, E. MacDonald, and R. Wicker, "Structural electronics through additive manufacturing and micro-dispensing" in Proc. IMAPS Nat. Conf., 2010, pp. 940–946.
[11] J. Lopes, E. MacDonald and R. B. Wicke, ''Integrating stereo lithography and direct print technologies for 3D structural electronics fabrication,'' Rapid Prototyping J., vol. 18, no. 2, pp. 129–143, 2012
[12] Abhijeet K-Swati N A "Review on 3D Printing Technology"-ijiere in Vol 2 issue 9 2015
[13] Infographic:AbriefHistoryof3DPrinting,"Troweprice,[Online].Available:http://individual.troweprice.com/public/Retail/Planning-&-Research/Connections/3D-Printing/Infographic.

