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DESIGN AND DEVELOPMENT OF LOW COST 3D PRINTER

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Abstract - *This is on 3D printing which has become a notable topic in today's technological discussion. 3D printing is a form of additive manufacturing technology where a 3D object is created by laying down successive layers of material it is also known as rapid prototyping [1], it is a mechanized method where by 3D objects are quickly made on reasonably sized machine connected to a computer containing blue prints for the objects. Here in this technology 3 steps are included such as Designing, Printing and Finishing. In 1st step we use any CAD software to create 3D design in 2nd step 3D printer creates an object using this design. And 3rd step finished object is removed from printer. This technology saves time and cost, it saves wastage of material. Fused Deposition Modeling (FDM) is an additive manufacturing technology for printing 3D objects layer by layer [2]. The main purpose of the research is to develop 3D printing technology for special purpose machine with low cost. Many industries use traditional methods for developing prototype for analysis rather than using technologies like 3D printing because it is expensive. In this CD drives are used instead of 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.*

Key Words: Rapid prototype, Arduino, 3D printing, Additive manufacturing, FDM

1. INTRODUCTION

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. Study showed the technology has developed rapidly and has proven its effectiveness, especially for design and small production. According to research, AM technology allowed for the direct fabrication of physically complex shapes from its corresponding CAD with minimum adjustments by using a layer-by-layer deposition technique [3,8].

Currently, high prices of rapid prototyping equipment's limit the promotion and application of rapid prototyping technology. So that we need to be reduce the cost of 3D printing machine. The reason behind this problem are high prices equipment's like stepper motors, guideways, etc. So that to eliminate this problem we need to be integration of 3D printing technology with other machine tools. We are integrating 3D printing machine with other machine tools likes waste **CD Drives** and **Floppy Drives** in which we are manipulating the CD Drives and Floppy Drives. Several parts of the 3D metal printer component are the custom design of a mechanical component which printed on RepRap 3D printer. After acquiring all the part need to the 3D printer is ready to assemble.

2. METHODOLOGY

Development of low-cost 3D printing machine was very difficult task for us. So that we are integrating CD drives and Floppy drives. We are eliminating the high cost stepper motors. We purchased CD drives and Floppy drives from scrap. Then this CD drives manipulated such that only guideways and motor arrangement are used. We used aluminium composite panel for base (floor), Acrylic plate used for bed, L-frame used for making structure of machine. To make machine fully automize we used Arduino ATmega 2560 Microcontroller with 1.4 Ramps for drive the motors and other accessories of machine [4].

First, we design the structure of machine in CATIA, according to this design drilled the aluminium composite panel, L-frame structure, acrylic plates. After that L-frame fitted by screws, also mount CD drives and Floppy drives on the structure, assemble the extruder head on the floppy drive with the help of fixture which is designed, bed is mounted on Y-axis of CD drive, adjust the clearance between nozzle and bed is 0.01mm. Do soldering all CD drives, floppy drives, limit switches. After that fix the position of Arduino and wiring is done according to circuit diagram which shown in fig.3.1. Attached spool feeding mechanism to stepper motor, material which is to be printed (ABS, PLA) feed through this mechanism [7,9]. After manufacturing of machine, we are done various trials on it.

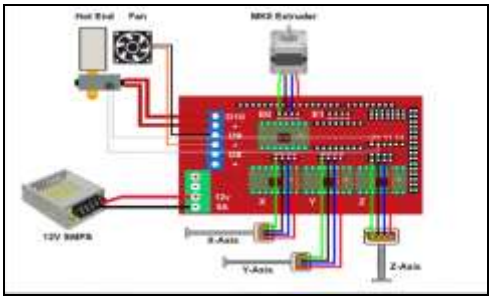

Fig -2.1: Circuit Diagram

3. PARAMETERS CONSIDER TO DEVELOP 3D PRINTER USING CD DRIVES

1. **Extruder Temperature:** We are using PLA and ABS materials for that **PLA** printing temperature **205 ^{0}C** and **ABS** material printing temperature is **230 ^{0}C**[5]. Therefore, we are choosing extruder temperature **180^{0}C to 270^{0}C**.
2. **Extruder Diameter:** Generally, extruder diameter can be varied as per the requirement, it is need to be simply change the extruder. Accuracy depends on nozzle diameter, as reducing diameter accuracy will increase. That's why we use standard diameter of **0.2mm to 0.4mm**.

Table - 3.1: Technical Specifications of 3D printer integrated with CD and floppy drives

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	180^{0}C - 270^{0}C
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

4. COMPLETE DESIGN AND FABRICATION OF 3D PRINTER USING CD DRIVES

For developing low cost 3D printing machine, material required as follows: guide ways and motors of CD drive and floppy drive, limit switch, stepper motor, poly-tetra-fluoro-ethylene (PTFE) tube and various fastener. The 3D printer consists of three axis which is x-axis, y-axis, and z-axis. Each axis has its respective function while moving, which is controlled by microcontroller [6]. The y-axis functions to move the printed bed where, the movement from rotating to linear is converted by a lead screw. The x-axis component is attached to the top of the printed bed and its function same as the y-axis but is different in terms of movement direction. The x-axis and y-axis are moves with the help of mechanism of CD drives. The third axis is the z-axis, on which extruder head is mounted and it moves the z-direction using mechanism of floppy drive. We using the **Pronterface software** for the slicing purpose.

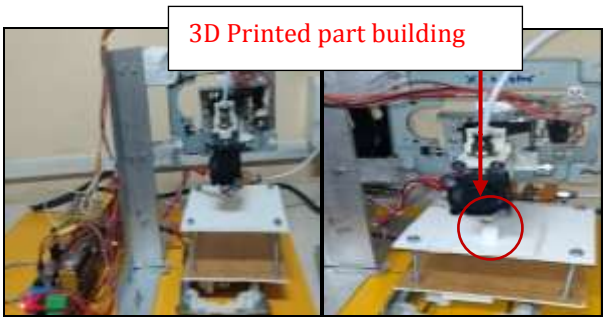

Fig - 4.1: Assembly of 3D Printer machine

5. CUSTOM DESIGN FOR MOUNTINGS OF EXTRUDER HEAD AND FLOPPY DRIVE

This custom design printed from other 3D Printer then it assembles to the floppy drives.

Table - 5.1: Custom Design for mountings of extruder head and floppy drive

Image	Printed component	Number
	Fixture -1 for extruder head which is mounted on floppy drives.	1
	Fixture-2 for extruder head which is mounted on fixture-1	1

6. TESTING

We are tested 3D printer machine by printing a simple component like cube. First, we draw the cube in CATIA software which is shown in fig.6.1. Then it saves as STL format for slicing the component in slicing software. We are using Pronterface software.

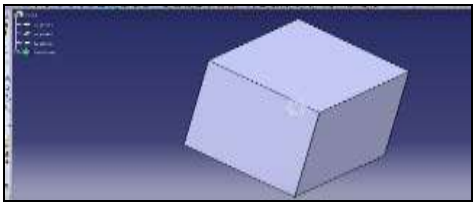

Fig - 6.1: CATIA Model of Cube

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

command to the stepper motor & we get a 3D model.

3. Figure above is a snap shot of pronterface software showing the wagon wheel through which the motions of the 3D printer can controlled.

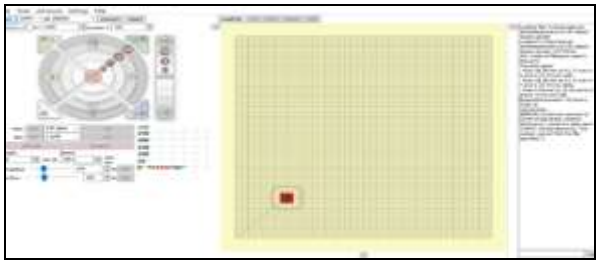

Fig - 6.2: Pronterface Software

Fig - 6.3: After printing object

7. FUTURE SCOPE

1. Scaling of machine.
2. Flexibility in choosing raw materials.
3. Increase productivity of machine.
4. Integration of system with laser.

8. COST ESTIMATION

Table - 8.1: Cost Estimation for developing low cost 3D printer

Sr no	Parameters	Price
1.	Arduino mega with ramps & connecters	2700/-
2.	Neema 17 stepper motor	995/-
3	0.4mm hot end (extruder)	570/-
4.	12 volt power supply	620/-
5.	End stop	370/-
6.	3d printer filament	1250/-
7.	CD drives	200/-
8.	Floppy drive	100/-
9.	L shape plates	200/-
10.	Acrylic plate	250/-
11.	Aluminium panel	250/-
12.	Tools and accessories	2000/-
	Total	**9505**

9. CONCLUSION

3D printing has lot of problems, such as slow printing speeds [10]. The cost of 3D printing is decreasing and the number of 3D printers sold worldwide has been growing progressively. The main aim of our project was to reduce cost of 3D printer with 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 3D printer machine. We are developed 3D printer machine with use of CD drives in 9000 Rs.

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