Arduino based 3D Printer with Predestination Paradox

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Abstract - *The most innovative technology in the current world of science is 3D printing. This technology is also called rapid prototyping that is building three dimensional objects quickly using a compactly designed low weight machine which is controlled by programming the arduino mega 2560 and using CAD software like Slic3r, pronterface. With the help of 3D printer we can print any 3D designs and this reduces the cost of buying and thus it is economic. Any complex shaped objects can be easily made using CAD designs and can be printed. Almost all of the 3D printers are working in open loop systems that is it does not recheck the works. Even if any steps are missed it will continue to print and will give an unfinished products. This reduces the efficiency of a 3D printer. We propose the closed loop system in this paper. The steps and direction of printing are checked by using a stepper motor controller connected to the stepper motor. Here closed loop mechanism is employed where it checks the number of steps. Whenever a step is missed it come back to correct position and then continue with printing. Additive manufacturing is the mechanism behind the working of 3D printer in which an object is printed layer by layer. There are various method of 3D printing but the most common method is Fused filament fabrication. The material used for printing can be a plastic, metal or powdered form of metal or plastic.*

Key Words: **FFF - Fused Filament Fabrication, PLA - Polyastic Acid, CAD Computer Aided Design, AM - Additive Manufacturing, Rapid Prototyping, Slic3r, Pronterface, Thermoplastics, Arduino Mega.**

1. INTRODUCTION

 3D Printing is a process of building a three dimensional object. 3D printing is an extraordinary hype that exists in the technology area. The object to be printed is uploaded using slic3r and pronterface software.In this new generation we can make everyday things using 3D Printer. From a single machine itself we can make a wide variety of objects of different materials. This process of 3D printing is called as "Additive Manufacturing".Additive manufacturing is nothing but building layer by layer of an object. The first 3D printer was invented by Charles Hull in 1987. He invented the SLA printer and it costed $300K but today it would cost up to $650K.

There are various methods in 3D printing. We are using fused filament fabrication technology to build object layer by layer. The material used for printing is PLA filament (Polyastic acid). Fused filament fabrication technology is uses PLA (Polyastic Acid) which is completely biodegradable thermoplastic polymer is used as fusing filament.

1.1 Additive Manufacturing

3D printer works on the principle of additive manufacturing. It is the process of laying several layers of materials to form a 3D object. Now-a-days additive manufacturing is also used for printing human organs by using tissue or cellulose from plants. The advances and improvements in additive manufacturing made it a popular field of development in present world of science. The product is created by joining several minuscule layers with on another. We can upgrade the production by adopting to additive manufacturing technique. The product printed will have an even structure throughout and it will not have any weak spots.

Before the invention of 3D printing the products were made by subtractive manufacturing process. In subtractive manufacturing the extra material is removed by using machines which may result in wastage of resource material. To print a 3D object we have to create a 3D model using a CAD (Computer Aided Design) software. Before uploading a file to 3D printer we have to slice the object to be printed using a slicer. It divides a 3D model into a number of horizontal layers. This can be done using a slicing tool like Slic3r.

2. Problems in Existing Method

It is an open loop system does not check if any mistake occurs..It takes more time for printing. Whenever some steps are missed while printing or when the filament used is extruded too much, this open loop system does not notice and keep on printing over it. Oscillations can occur on the printing surface caused by vibration this process is also called as "Ringing". The process involved in its working is complex, as it involves too much fiddling with format, parameters, and mechanical adjustments.

The major problem involved in 3D printing is we cannot expect for a perfectly finished output there can be minor deviations from the expected output which are caused due to some reason like overheating of filament used, missing some steps and not going for it again. In some cases in this existing system the first layer adhesion occurs which means due to excessive temperature the first layer will

stick to the base and after completion of printing it cannot be taken out of the printing surface.

Most of the 3D printing machines are not user-friendly. One cannot operate the 3D printer without any basic skills and knowledge. They must know how to clear any faults, so they must have basic knowledge in programming language of arduino and g-code developed. Building a 3D printer is still an expensive process, each and every part costs nearly $3. As we are using plastics for printing they produces pollution while melting. Metal based 3D printers consume lot of power since large amount of heat is required to melt down the metal material.
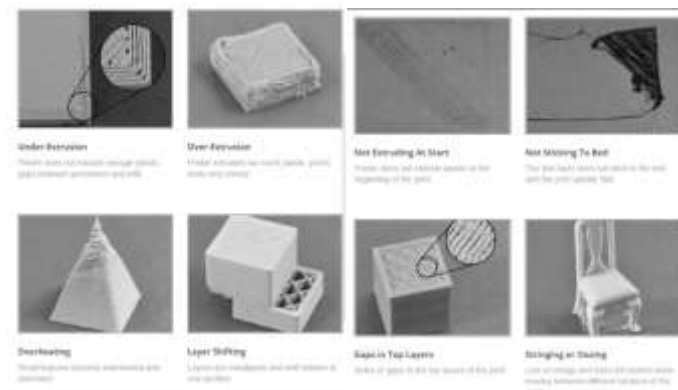

Fig (1)   **Fig (2)**

3. Materials and methodology

Materials

The most common material used for 3D printing is plastic. It is used to print toys and household appliances. The various types of plastics are polyastic acid, acrylonitrile butadiene styrene, polyvinyl alcohol plastic and polycarbonate. They also use powders like polyamide and alumide which are melted and then used for printing. The rarely used material is resins which is obtained from three categories like high-detail resins, paintable resins and transparent resins.

Next to plastic the most commonly used material is metal. The types of metals used are stainless-steel, bronze, gold, nickel, aluminium and titanium. Products printed with metals are used in aerospace industry and the process to use the metal is called direct metal laser sintering. Other materials used in 3D printing are carbon fibre, graphite, graphene, nitinol and paper. We are using polyastic acid (PLA) filament for 3D printing in our project.

Fig (3) METAL POWDER

Fig (4) POLYASTIC ACID (PLA FILAMENT)

Methods   Materials like thermoplastic filament are used in fused deposition modelling (FDM). It is a 3D printing technology which is also called fused filament fabrication (FFF). It gives better finishing and used in printing electrical housing and fixtures. This process is also called material extrusion. Resins are used in Vat processing stereolithography (SLA) and direct light processing (DLP) technologies. The products will have smooth finish and fine details. It is used for printing hearing aids, jewellery and dental applications.

Thermoplastic powders like nylon are used in selective laser sintering (SLS) technology. These products will have good mechanical properties and geometrics. It is used for printing hollow designs. Photopolymer designs are used in material jetting (MJ) and drop on demand (DOD) technologies. They are available in full colours and are used for printing medical models, prototypes and injection moulds. Metals or silica sand are used in binder jetting (BJ) technology. They are low cost and are used in printing metal parts and sand casting. Metal powders are used in direct metal laser sintering (DMLS), selective laser melting (SLM) and electron beam melting (EBM) technologies. They are used in printing aerospace and automotive as they are the strongest of all other materials. Human tissues and organs are printed using 3D bioprinting.
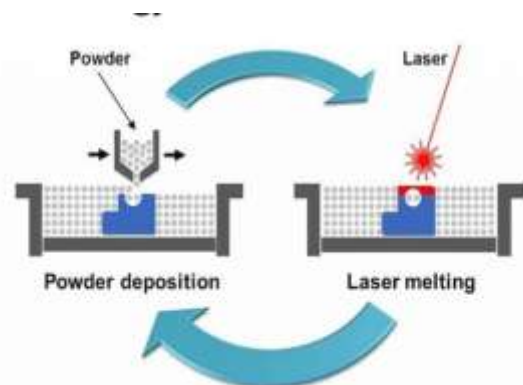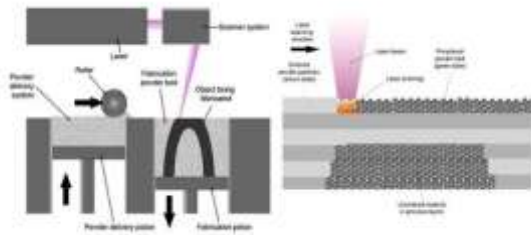

Fig (5) SELECTIVE LASER MELTING

Fig (6) SELECTIVE LASER SINTERING

4. Working

We are using fused filament fabrication technology to print and the material used is polyastic acid (PLA) filament. The printer setup is made and it includes the following materials arduino mega 2560 R3, RAMPS 1.4 shield, stepper motors, stepper motor driver and controller, extruder, hotend, heatbed and endstops. All the stepper motors are connected to the arduino board through stepper driver. The x-axis stepper motor driver is replaced with a stepper motor controller. The program for operation of 3D printer is uploaded to the arduino board.

The object to be printed has to be sliced into several horizontal layers using Slic3r. The sliced object is converted to g-code file. To send the g-code to printer we are using pronterface software. The printer is connected to this software and g-code of the corresponding object to be printed is uploaded and monitored. While printing when ever steps are missed the stepper motor controller connected to x-axis will keep checking on it and will redo the printing in missed steps in the correct direction. Thus we can get a complete finished product by the end of this process. The simulation of this model can be done using proteus software.
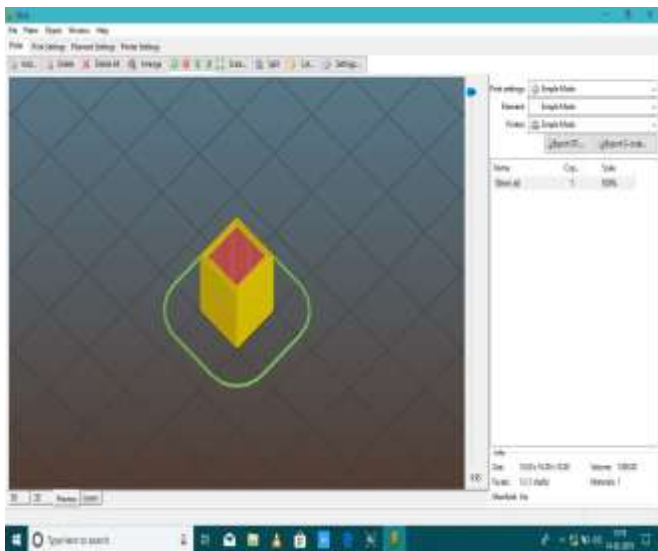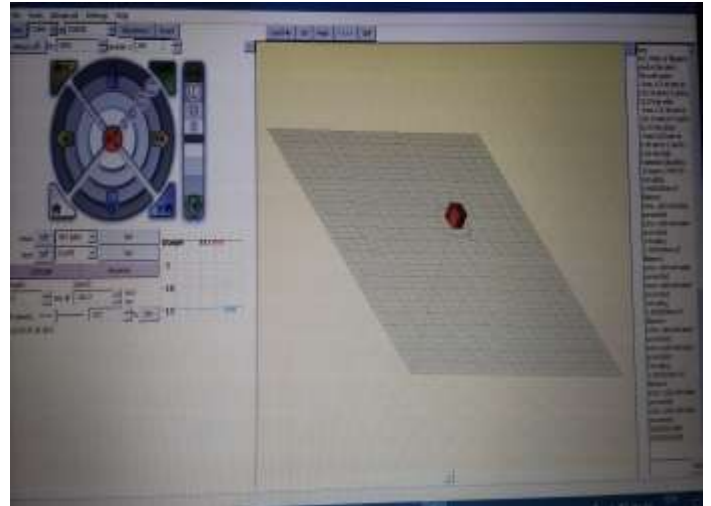

Fig (8) SLIC3R SOFTWARE

Fig (9) PRONTERFACE SOFTWARE

5. Mechanical setup

The mechanical setup includes the completely assembled 3D printer which is ready to be operated.
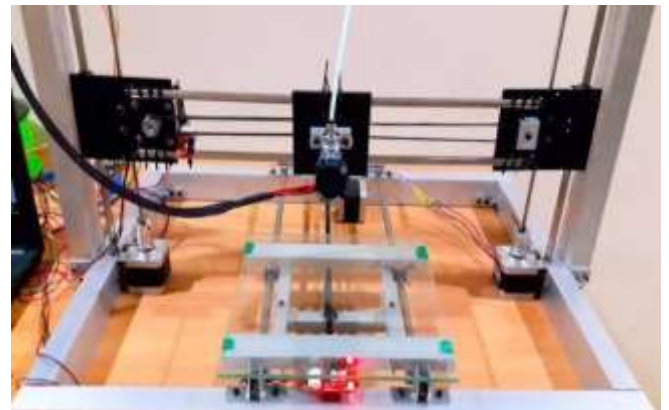

Fig (10) MECHANICAL SETUP

6. Electrical setup

Most of 3D printers require 240W of power supply and it is provided using a 12V 20A dc supply.

7. Conclusion

The trending breakthrough technology in the current world of science is 3D printing. 3D printing is very much useful in the field of science and medical. It is also used for saving lives by printing human organs using tissue like material. Though it has these many advantages, the biggest drawback of 3D printer is that any one can print whatever they want using 3D printer even dangerous weapons can be made when it is used by wrong hands. But its very essential for students in schools and colleges for their project works. This will reduce the cost of building hence improves active participation of students in doing various projects.

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