DESIGN AND DEVELOPMENT OF CNC BASED FDM 3D PRINTER USING MULTIMATERIAL

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ABSTRACT:- 3D printers are device which create a 3-dimentional solid objects from a digital file .3D printing is a rapidly developing and cost optimized form of rapid prototyping.The creation of a 3D printed object is achieved by additive manufacturing processes. In this modern world, there are various 3D printing methods but fused deposition modelling(FDM) is commonly used method because it is cheapest and FDM based 3D printers are small in size. FDM create an object by adding material layer by layer and fusing these layers together. 3D printing can produce complex shapes using less material than traditional manufacturing methods. There are different materials can be used for 3D printing like ABS(Acrylonitrile butadiene styrene), PLA(polylactic acid),or ninja flux etc. The concept of 3D printing have application in the field of automation industries, aerospace, manufacture and architectural engineering, construction of design industries, dental & medical fields and many more.The use of 3D printing is beneficial to consumer's products in wide range. This paper focused on 3D printing procedure.

Keywords: FDM ,PLA,ABS

I. INTRODUCTION

There are various machining processes like turning, milling, drilling etc. We are using these methods from many years they help us to build things. The technology of traditional machining has many limitations so, manufacturing world has changed and involve non traditional machining such as electric discharge machining or electric chemical machining ,and at present every industry require computer and robot technology . This process involves removal of material, from larger mass of block to get the required shape of desired product. There are drawbacks of such production processes are fixtures and assembly for many traditional designs which are also expensive, as Compared to traditional machining 3D printing is process of creating object using digital model is more beneficial. This technology allows the design of complex components therefore avoiding assembly requirement at no additional cost.

3D printing is also known as desktop fabrication which is a process of prototyping where the structure is synthesis from its 3D model. The 3D design is stored in STL format and after that forward to 3D printer. The 3D printer printers the CAD design layer by layer creating real object 3D printing process is derived from inkjet desktop printers in which multiple deposits jets and the printing material layer by layer derived from CAD 3D data.3D printing is diversifying and accelerating our life getting various qualities of product to be synthesize easier and faster .3 dimensional printing has the ability to impact the transmission of information in way similar to the influence of such earlier technology as such photocopy. This identifies sources of information on 3D printing, its technology required software and applications. Along 3D printing companies are able to extract and innovate new ideologies and various design applications with no time or tool expenses. The term 3D printing originally referred to a process that deposits a binder material on to powder bed with inkjet printer heads layer by layer.

II. PROCESS OF 3D PRINTING

3D printing process can be described and defined in the following steps :

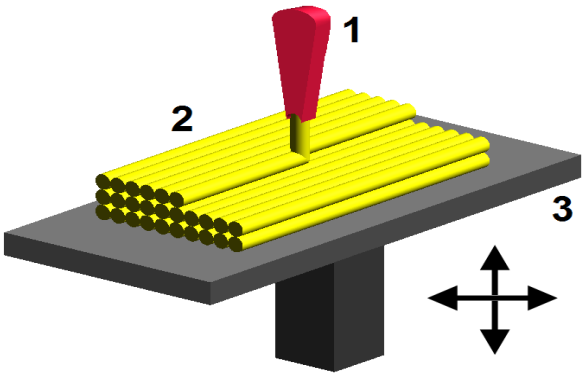
CAD MODEL CREATION : Initially , items to be 3d printed is designed utilizing a computer aided design software ,solid model for ex: CATIA and SOLIDWORKS have tendency to represent 3d object more precisely than wire frame model for ex**:** AUTOCAD .This procedure is comparative for the majority of the rapid prototyping building methods .

CONVERSATION TO STL FORMATE : the different CAD models use different methods to present solid parts to Have consistency ,the stereolithography format has been followed as the standard of the 3D printing industry .

SLICE THE STL FILE : A pre-processing computer program is done which readies the STL format going to be build .numerous program are there , which permit the user to tweak the model .the pre-processing cuts the STL model into numerous layers from

0.01 mm to 0.7 mm thickness, in the view of the building methods .the program like wise makes an auxiliary structure to help the model amidst of building . sophisticated structures are bound to use auxiliary support.

LAYER BY LAYER CONSTRUCTION : THE 4TH step is the actually construction of the part . Using one of various techniques RP machines build one layer at a time from polymers or powdered metal.



1 – nozzle ejecting molten plastic

2 – deposited material(modeledpart)

3 – controlled movable table

FIG:PRINTING PROCESS

III. PRINTING METHOD : FUSED DEPOSITION MODELLING

FDM is a 3D printing process that uses a continuous filament of a thermoplastic material(thermoplastic is a material or we can say plastic polymer which becomes moldable at a certain high temperature and back to its solid state after cooling). Filament is fed from a large coil through a moving, heated printer extruder head, and is deposited on the growing work. The print head is moved under computer control to define the printed shape. Fused filament printing is now the most popular process (by number of machines) for hobbyist-grade 3D printing. Other techniques such as photopolymerization and powder sintering may offer better results, but they are much more costly.

The 3D printer head or 3D printer extruder is a part in material extrusion additive manufacturing responsible for raw material melting and forming it into a continuous profile. A wide variety of filament materials are extruded, including thermoplastics such as acrylonitrile butadiene styrene (ABS), polylactic acid (PLA), high-impact polystyrene (HIPS), thermoplastic polyurethane (TPU) and aliphatic polyamides (nylon).

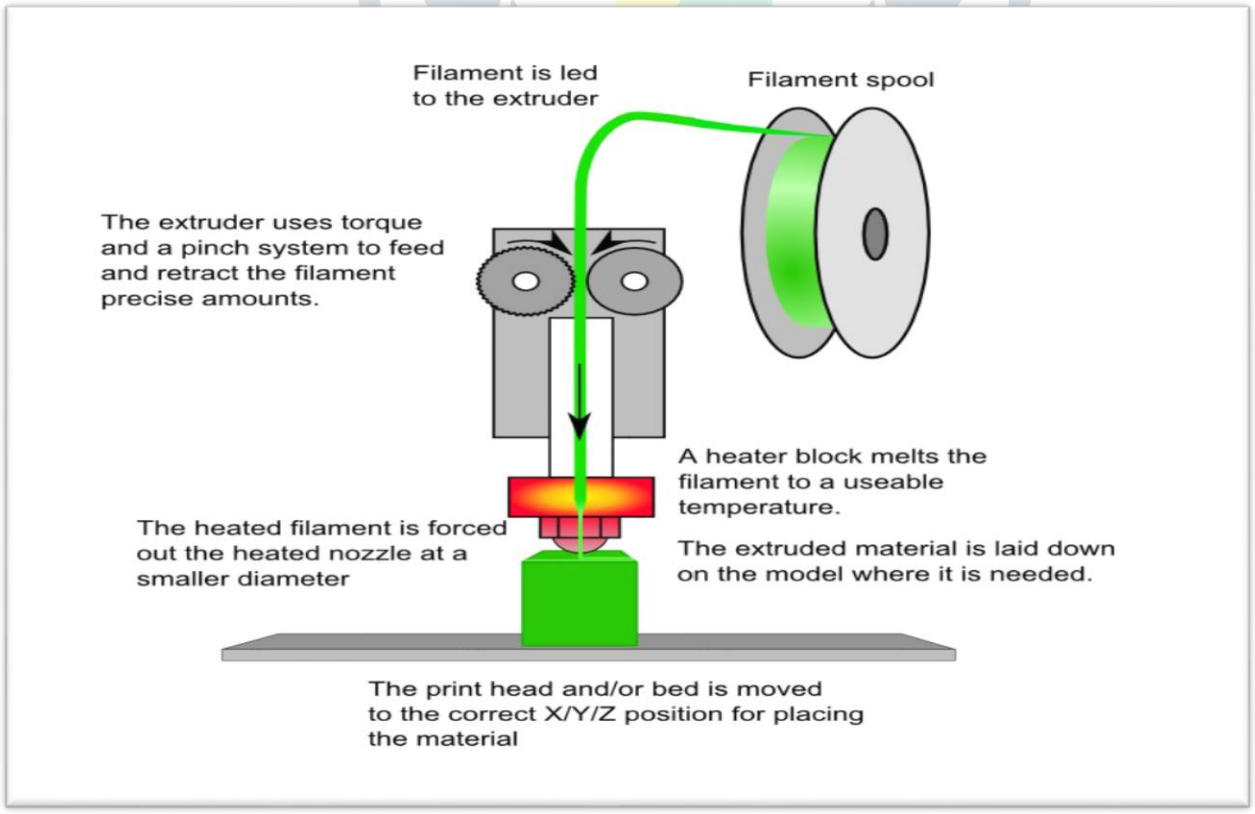


FIG: FUSED DEPOSITION MODELLING

MECHANICAL COMPONENTS OF 3D PRINTER

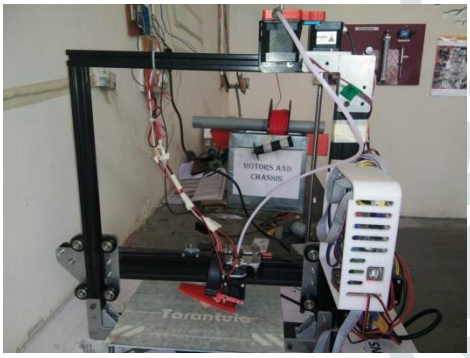
1. FRAME: Frame is important component of 3D printer. It looks simple in look but complex in design. This is because many design possibilities are available in desigining frame. Frame supports all mechanical and electronic components that are attributed on 3D printer to carryout actual 3D printing work. The frame of 3D printer has a robust look as well as its aesthetic apperance. Aesthetics may be great considered in design and business. The printer solely used for experiments or for prototyping. In recent development the frame is provided with slots to avoid drilling and vibration.

2. HEAT BED : Previous model had moving bed now we use heat bed. The heat bed is module for 3D printer that controlls cooling process of 3D printed materials. The heat bed prevent issues such as poor adhesion between layers, thermal run way and wrapping. The temperature of heat bed is maintained at 50 degres celsius.

3. EXTRUDER:Extruder is also most important component of 3D printer. It works on principle of extrusion process,which is manufacturing process.Extruder is used to sending correct amount of filament to the hot end where the material is melted and extruded thin layer by layer to make your desired product.The important point to note down about an extruder is it is not same as hot end,it is commonly refferd to as cold end because the filament is cold when it pass through an extruderon the way of hot end.The thermistors are provided to melt the material.

4. LEAD SCREW:Lead screw is mechanical component used to transmit turning motion into linear motion.In 3D printer lead screw provide up and down motion. The lead screw are used on printers Z-axis. Cheap printers use threaded steel rods which are essentially extra long bolts. Higher quality printers use chrome plated lead screws to minimize backlash.

5. BELT:The belts are used mechanical linkage of two or more shafts.belts are made up of lather,rubber,fibers. The X andY motors have sprokets to drive the belts. Most printers also have some way of adjusting tension on belts.



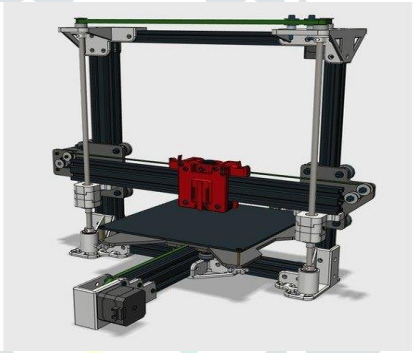


FIG: FRAME OF 3D PRINTER

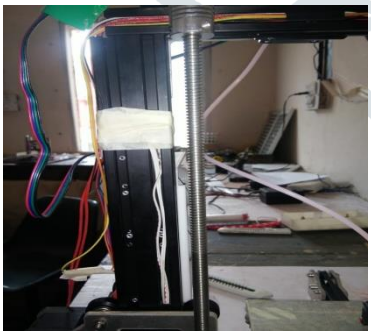


FIG:LEAD SCREW

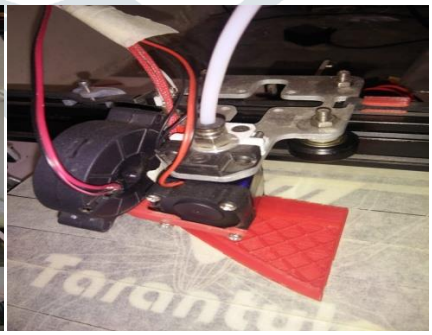


FIG:EXTRUDER

ELECTRONICS COMPONENTS OF 3D PRINTER

1. STEPPER MOTOR: Stepper motor is DC electric motor that divides full rotation into number of equal steps. The stepper is known as by its property to convert train into pulses. The shaft is moved in fixed angle by each pulse. Four steppers weighted 60gmswith specification NEMA17.Three steppers are provided for three axis and fourth one is for extruder.
2. LIMIT SWITCHES: Limit switches are used to control the travel of an object in mechanism above some predetermined point. It is an electromechanical device that consists of an actuator, the devices that makes and break an electrical connection. It identifies maximum limits of a machine also provide known reference point for incremental motion.
3. CONTROLLER BOARD: The control board is brain of printer. It receives commands given by computer in the form of G-code. We have used MKS v1.3 controller board which is an Arduino based 3d printing control board with inbuilt stepper motor drivers .It has connections for – Motors, heated bed , hot end , limit switches , LCD and SD card module, cooling fans and the thermistors.
4. COOLING FAN: The cooling fan is provided to cool up the plastic immediately after it deposited from nozzle it maintains the shape and size of an object. The slicer will turn this fan ON and OFF under different circumstances.
5. THERMISTOR: While printing it is very important to maintain a proper and constant temperature for both the heated bed and the hot end to maintain the desired flow of material Thermocouples are used in order to measure the temperature and switch the heaters on and off as per the requirements.

FIG:CONTROLLER BOARD

FIG:STAPPER MOTOR

FIG : THERMISTOR

FIG:LIMIT SWITCHES

IV. WORKING OF 3D PRINTER

A typical 3D printer is very much like an inkjet printer operated from a computer. It makes 3D model one layer at a time, from the bottom upward, by repeatedly printing over the same area in method known as fused deposition modeling (FDM). It works automatically, the printer creates a model over a period of hours by turning a 3D CAD drawing into lots of 2D, it separates 2D prints that sit one on top of another, but without the paper in between. Instead of using ink, the printer deposit layer of molten plastic or powder and fuses them together with adhesive or ultraviolet light. Warping is a common 3D printing problem, which happens when the first layers of heated plastic are cooling down too rapidly and begun to contract. This causes the edges of the model to bend upwards. Printer prints a 3-dimensional object by extruding a stream of heated or melted thermoplastic material, which is carefully positioned into layer upon layer, working from the bottom up. Just imagine a heated print head that is oozing out a permanent flow of molten plastic onto a surface in order to form, through multiple layers, the virtual object you chose to print. By adding layer upon layer, which will almost immediately harden upon leaving the hot print head, you will see the object that you chose to create materialize right in front of you. In order to be able to print a physical object, i.e. an object in 3 dimensions, a 3D printer needs to be able to move on 3 coordinate axes (i.e. most commonly referred to as length, width and height).The general convention is to use the X, Y and Z axes in order to map a specific point in a 3D coordinate system. In 2 dimensions, i.e. the X and Y axis and may therefore help you understand the process. Once you had finished typing your document, the computer translated the document into coordinates for your printer. A moving head printed the letters on paper, usually on one fixed axis (going from left to right and back - i.e. the horizontal axis) while little motors drove wheels which advanced the paper page on the other axis (up and down - i.e. the vertical axis). The principles are the same for a 3D printer, except that it is able to move in one more direction (depth) and thus is able to physically print objects. Nearly every 3D printer is built around the principle that its 3 principal axes are linear. This means that their axes are at right angles to each other and that they move in straight lines (that is: they do not rotate). Machines which use this principle are known as linear robots or Cartesian coordinate, as opposed to Delta- or Polar-type robots. Typical examples of linear robots are 3D printers, but also computer numerical control (CNC) machines. In order to move along these 3 axes, 3D printers generally make use of fixed rods, timing belts and pulleys, in order to print head(s) and or the print platform to the exact position needed. These timing belts and pulleys are connected to small motors, which are generally referred to as "stepper motors". These relatively small motors permit extremely precise movements, often in the vicinity of a fraction of a mm. The stepper motors form an important part of any printer, as they are in a great part responsible for the quality of your print, i.e. a cheap stepper motor is not able to realise the same accuracy as more expensive models. Also, when working, they tend to make quite some noise and cheap stepper motors can be especially noisy. However, more recent models have been addressing this particular issue and are far quieter then the older models.

V. PROBLEM IDENTIFICATION

The major problems faced during the working Process are as follows:

1. Mainly the Problem arrived from the software side proper STL files cannot be achieved. This reduces the accuracy of 3D printers.

2. Also the electronics associated with the axial movements of the servo motors are difficult to achieve accurately. The layers are large enough that it reduces the wall surface finish, the layers are visible to human eye.

3. To avoid this problem the layers width can be minimized to a great extent, but this arises another problem of more time consumption. As there will be more layer decomposition when is reduced to minimum.

VI. SOLUTIONS

1. The problem arising with software has been removed by using better software also maintaining accuracy of product.
2. The vibration problem with frame also removed by providing slots to the frame so that hardness of material is maintained.
3. Problem with layer by layer deposition is removed by using heat bed as it keep the product stick to bed up to final layer has reached.

VII. CONCLUSION

Creating a part layer by layer, instead of substractive methods of manufacturing leads 3D printing lowor cost in raw material. Instead of starting with a big chuck of plastic and carving away (millingor turning) the surface in order to produce our product.Additive manufacturig only prints what we want , where we want it. 3D printing is the ultimate just in time method of manufacturing. No longer do we need a warehouse full of inventory waiting for customers. Just have a 3D printer waiting to print our next order .We can also offer almost infinite design options and custom products. The sky is the limit for additive manufacturing .Additive manufacturing open up our designs to a whole new level because undercuts, complex geometry and thin walled parts are difficult to manufacture using traditional methods , but are sometimes a piece of cake with 3D printing.In addition, the mathematics behind 3D printer are simpler than substractive methods .For instance the blades on a centrifugal super charger would require very difficult path planning using a 5-axis CNC machine. The same geometry using additive manufacturing techniques is very simple to calculate, since each layer is analysed separately and 2D information is always similar than 3D. This mathematical difference, while hard to explain is the fundamental reason why 3D printing is superiour to other manufacturing techniques.It almost always better to keep thing simple and additive manufacturing is simple by its very nature.

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