DESGIN AND DEVELOPMENT OF 3D PRINTING MACHINE

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ABSTRACT: 3D printing is an additive manufacturing technique where the 3D parts are made with the addition of multiple layers one top of other with the help of CAD software. The printing can be done with the help of different procedures like SLS (Selective Laser Sintering), LOM (Laminated Object Manufacturing), SLA (Stereolithography), etc. 3D printing machine have 4 axis in which 3 axis are x,y,z and the fourth one is extruder. The process adopted by us is FDM technology in which different materials such as ABS (acrylonitrile butadiene styrene), HIPS (high impact polystyrene), PLA (polylactic acid), etc can be used. By heating any filament material upto its melting point and laying it layer by layer. Combination of multiple layers one top of other will give required 3D object. Key words: 3D Printing, Rapid Prototyping, FDM, SLA, SLS, LOM.

1. INTRODUCTION

Rapid Prototyping is a procedure of taking a computerized 3D model and transforming that advanced document into a physical object. manufacturing across the globe are utilizing 3D printing as an approach to decrease costs, spare time, and deliver better items.

By never again expected to outsource the prototyping of parts, organizations can rapidly repeat upon plans on the fly, as a rule sparing a long time of sitting tight for outsiders to return molds or models. From car makers to hardware organizations and anybody in the middle of, 3D printing is an important innovation. Effective and precise generation of models or low-volume items can lessen an opportunity to market and increment item flexibility. This 3D printing technique is used by the manufacturers like aerospace, automotive, medical, dental, etc, due to accurate and efficient production of models[1].

2. LITERATURE SURVEY

3D Printing was concocted by Charles W. Hull in 1986 [2], it is an added substance producing system in which advanced 3D show is changed over document into a physical protest. Frame's creation focused exclusively on a manufacture procedure called Stereolithography (SLA). Since that time various other 3D printing advancements have been produced, for example, Stereo lithography (SLA), fused deposition modelling (FDM), selective Laser Sintering (SLS), PolyJetting and others, all of which depend on layer-by-layer manufacture and depend on a G-code encouraged to the printer. While there are various advancements which can be utilized to 3D print a question, the larger part of 3D printers one will discover inside a home or an office setting depend on the FDM or SLA forms, as these advancements are presently less expensive and less demanding to actualize inside a machine.

3. METHODOLOGY

The following flow chart shows the methodology used by us in construction of 3D printer. The first step is to select one of the additive manufacturing process among many

process. Then an appropriate mechanism is selected for X, Y and Z axis movements, considering various factors such as cost of fabrication, simplicity of design, synchronization, accuracy etc. Once the

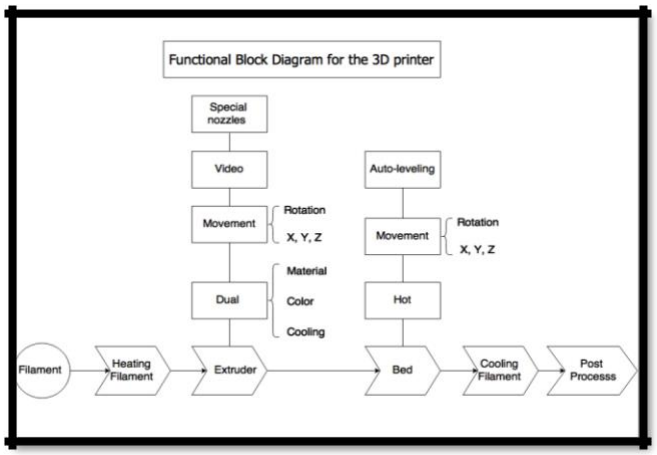

Figure 1.1 Flowchart

Once a 3D demonstrate is composed, the document (these generally have augmentations, for example, 3MF, STL, OBJ, and so forth.) must be changed over into G-code. G-code is a numerical control script utilized basically for PC supported assembling (both subtractive and added substance fabricating). It is a dialect which advises a machine how to move. Software such as, Slic3r are required so as to change over 3D show records into G-code. Once the G-code is made it can be sent to the 3D printer, giving a diagram regarding what its next a few thousand moves will comprise of. These means all indicate the total creation of a physical protest. There are other scripts out there and maybe many will in the long run pick up fame, yet until further notice G-code is by a wide margin the most critical.

4.Various Methods in 3D printing

Different strategies are there to make model. These strategies are utilized in view of the many-sided quality of the plan, the material utilized as a part of the plan, the motivation behind the mechanism is selected the next step is integration of electronics and software then the machine is designed and fabricated. The last step is, synchronization of mechanical, electrical and software elements of the machine.

outline, and the measure of the plan. They are as per the following:

- **Stereo lithography** –

Stereo lithographic 3D printers (known as SLAs) position a punctured stage just beneath the surface of a vat of fluid photograph treatable polymer [3]. An UV laser shaft at that point follows the in the first place cut of a question on the surface of this fluid, making a thin layer of photopolymer solidify. The punctured stage is then brought down somewhat and another cut is followed out and solidified by the laser. Another cut is at that point made, and after that another, until the point when a total model has been printed and can be expelled from the vat of photopolymer, depleted of overabundance fluid, and cured.

- **Fused Deposition modeling(FDM)** –

It is a procedure by which a machine stores a fiber (Thermoplastics or wax), to finish everything or alongside same material, keeping in mind the end goal to make a joint by warmth or attachment [4]. Here a hot thermoplastic is expelled from a temperature-controlled print head to obtain high accuracy object at the end.

- **Selective laser sintering (SLS)** –

The process builds the object with the help of Laser in order to fuse the successive layers of wax, ceramic, nylon, metal powdered. The powder gets liquefied and compacted to consolidate the grains to acquire a last item. Once the model is cooled the abundance powder must be essentially brushed [5].

- **Laminated object manufacturing(LOM)-**

In this method, the layered material is moved on a building platform. In this procedure, the adhesive covered layers which are stuck together by the warmed rollers and slice to the coveted shape with the assistance of laser layer by layer[6]. A roller with the material moves over each previous sheet and repeats same procedure until the model is finished.

- **Inkjet 3D printing** –

It makes the model one layer at once by spreading a layer of powder (mortar, or gums) and inkjet printing cover in the cross-area of the part. when the whole layers are framed by flying, to get uniform thickness a processing head is disregarded the layer.

The procedure to be rehashed to get a last question. After the procedure is finished, the material might be liquefied or broken down[7]. This innovation is the special case that Takes into account the printing of full shading models. Not at all like stereo lithography, inkjet 3D printing is advanced for speed, minimal effort, and convenience. No harmful chemicals like those utilized as a part of stereo lithography are required. Insignificant post printing complete work is required

5.Applications of 3D Printing

While at first 3D printing was principally an innovation for prototyping, this is rapidly evolving. Presently various makers are delivering end-utilize parts and whole items by means of added substance fabricating. From the aviation industry, to medicinal displaying and implantation, to prototyping of different sorts, 3D printing is being utilized by for all intents and purposes each real industry on the planet somehow. Rather than depending on 2D and 3D pictures on a PC screen or a printout, specialists can really touch and feel physical copies of the patient's organs, bone structures, or whatever else they are going to take a shot at . 3D printed models of human organs have been a regular instrument for specialists in the course of the last a few years, as they give a more multifaceted perspective of the current issues. Furthermore, there is inquire about in progress by many organizations to 3D print fractional human organs, for example, the liver and kidney of human beings [8]. Throughout the following decade, it's extremely conceivable that we will be 3D printing whole human organs for transplantation. Due to the special geometries offered by added substance producing, militaries around the globe, and additionally offices for example, NASA and the ESA, alongside various air ship producers are swinging to 3D imprinting keeping in mind the end goal to decrease the general weight of their airplane. Complex geometries and new materials offer predominant quality with less mass, conceivably sparing associations like NASA boatloads of fuel, and in this way cash, amid the starting of shuttle or rockets out of our air [9]. In the meantime, organizations like Boeing and Airbus are utilizing 3D printing to diminish the heaviness of their flying machine, enabling them to cut fuel costs for each.

6.FDM

Fused Deposition Modelling (FDM) is an additive manufacturing process, in this process, thermoplastics in the form of filament is passed through a heating element

which melts the filament and thrusts thorough a small nozzle [6]. The nozzle moves in three dimensions laying down the melted plastic layer by layer in the required shape resulting in realization of final physical object. Articles made with a FDM printer begin as PC helped outline (CAD) documents. Prior to a protest can be printed, its CAD record must be changed over to an arrangement that a 3D printer can see, for the most part .STL organize. FDM printers utilize two sorts of materials, a displaying material, which constitutes the completed question, and a help material, which goes about as a platform to help the protest as it's being printed. Amid printing, these materials appear as plastic strings, or fibers, which are loosened up from a loop and nourished through an expulsion spout. The spout dissolves the fibers and expels them onto a base, in some cases called an assemble stage or table. Both the spout and the base are controlled by a PC that deciphers the measurements of a protest into X, Y and Z facilitates for the spout and base to take after amid printing. In a run of the mill FDM framework, the expulsion spout moves over the assemble stage on a level plane and vertically, "drawing" a cross area of a question onto the stage. This thin layer of plastic cools and solidifies, quickly official to the layer underneath it. Once a layer is finished, the base is brought down — as a rule by around one-sixteenth of an inch — to prepare for the following layer of plastic. Printing time relies upon the extent of the protest being made. Little protests — only a couple of cubic inches — and tall, thin questions print rapidly, while bigger, all the more geometrically complex items take more time to print. Contrasted with other 3D printing techniques, for example, stereolithography (SLA) or specific laser sintering (SLS), FDM is a genuinely moderate process. Once a question falls off the FDM printer, its help materials are expelled either by absorbing the protest a water and cleanser arrangement or, on account of thermoplastic backings, snapping the help material off by hand. Items may likewise be sanded, processed, painted or plated to enhance their capacity and appearance.

7. Design of 3D Printing

The figure 1.2 demonstrates the rendered perspective of CAD model of the instrument for development every which way [3]. The 3 – Dimensional movement is accomplished by synchronization of developments in X, Y and Z direction. The Extruder nozzle is the main part of the printer in which the plastic which is in the form of filament melts and prints on a heated bed. The objective of the instrument is to ensure that this extruder nozzel will have the capacity to print anyplace inside the foreordained print volume. This component utilizes 4 stepper motors, one for X – axis development (Lateral development or Left – Right development), two for Y – axis development (back and forth development) and one for Z – axis development (Vertical development). This component utilizes single engine to control 4 lead screws to which the print bed is associated for the development in Z – axis direction. The lead screws are driven by the engine which thus moves the bed vertical way. For the development in Y – axis direction, two separate motors are utilized to

move two separate carriages[8]. Two motors have been utilized here on the grounds that the print volume is huge, there will be disturbance in development if just a single motor is utilized. For littler print volumes, single motor might be adequate. For the development is X – axis direction of a single motor is utilized which is mounted onto the carriage that moves in Y – axis bearing. The point by point working and outline of the system in particular ways are clarified in additionally areas. This system is intended for exactness, the stepper motors utilized is having determination of 0.36o, i.e., 1000 steps per revolution which provides high precision, the mechanism used for movement in Z – axis provides precision, ease of control and easy synchronization

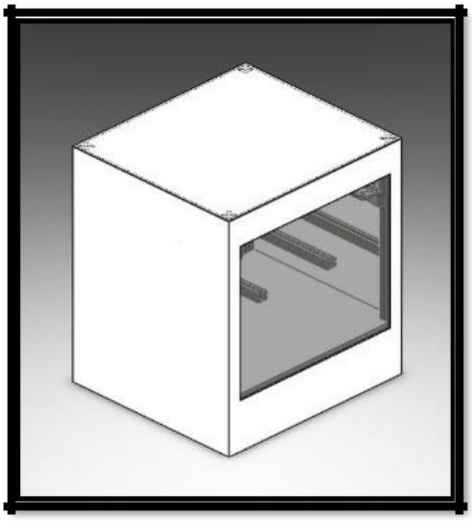

Figure 1.2: CAD model of the Printer

8. FEA ANALYSIS OF 3D PRINTER

FEA analysis forms a very important procedure in developing a new machine. FEA software can easy to use and has a tremendous amount of power to calculate stress and displacement for the complex shapes and sizes which is difficult to be calculated in the mechanical theory. FEA can be used for variety of analysis, from static to dynamic analysis, from modal to heat transfer, etc.

The Analysis of the x axis rod is as given in the table 1.

Name	**Minimum**	**Maximum**
Volume	**1.85982e-005 m^3**	
Mass density	**7800 kg/m^3**	
Von Mises Stress	9.00429e-5Mpa	1.14285MPa
Displacement	0 mm	0.0046861 mm
Safety Factor	8 ul	8 ul
X Reaction Force	**0.000618599**	
Y Reaction Force	**20.2494**	
Z Reaction Force	**-2.5155e-005**	
Equivalent Strain	2.26962e-009	3.56398e-006

➢ **Stress**:

The figure 1.3 demonstrates the reaction force and the stress acting in the bars, the response powers are acting close to the limitations given where the most extreme pressure is created close to the settled district and close to where the heap is acting from the carriage. The most extreme stress and the base stress created is given in the table 1.1.

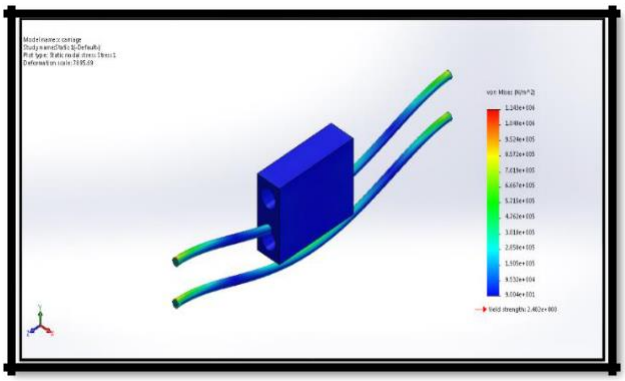

Figure 1.3: Von-Mises Stress for x-axis

➢ **Displacement:**

For a successful design, the displacement has to be minimum, the rod has been selected in such a way that the displacement has to be minimum. Thus the rod is selected as per the Theoretical calculation and then Analyzed. In figure 1.4, the maximum displacement is near the carriage where the load of 30N is acting on it. The rods selected for the x axis is able to withstand the load and thus the material and diameter can be selected as per analysis done.

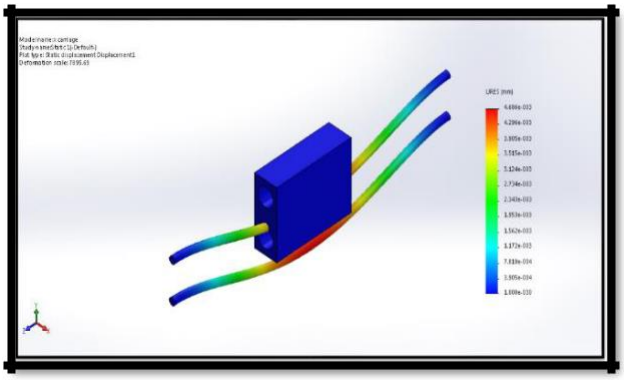

Figure 1.4: Displacement pattern for x-axis rods

➢ **Strain:**

The Hooke's law stated that stress is directly proportional to strain, in the figure 5, the Strain is as low as 3.56398e-006. This low strain value allows us to select a suitable diameter for the rod and to select the material for the rod. Since the displacement and the stress is minimum for the selected material which can be used for the development of the machine.

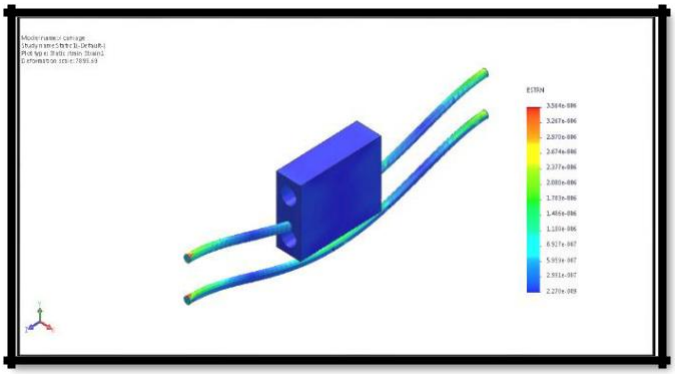

Figure 1.5: Strain for x-axis rods

9. CONCLUSION

This machine is intended for accuracy. Utilizing a solitary motor for vertical development makes Bed leveling simple and the bed development can be observed with determination in microns. In some machines, the extruder nozzle is made to move in Z – axis direction and bed is made to move in Y – axis direction, these mechanisms face problem of mutilation of printed parts while printing at high rates because of fast development of bed in Y – hub bearing. The outcome of this paper was to build a portable 3D Printer which has been successfully completed. The design of the frame is made robust and compact using aluminum sections. The material selection of the various elements is economical. Using a single motor for vertical movement along with a proximity sensor makes bed leveling easy and the bed movement is monitored with resolution in microns. The drawback in few of the 3D Printer which uses bed movemen

in Y axis has distortion of the printed layer at high rates of printing. To overcome this drawback, a new mechanism has been developed which uses bed movement in Z. The control of the mechanism becomes easy because of less number of motors and good synchronization can be achieved using this new 3D printer technique.

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