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3D PRINTING MACHINE – A FACTORY AT YOUR DESK

Hrishikesh Uttekar[*1], Rushikesh Gaikwad[*2], Minal Randive[*3], Siddhi Shidruk[*4], Suvarna Bahir[*5]

[*1,2,3,4]Student, Dept Of Computer Engineering, Sinhgad Academy Of Engineering, Pune-411048, India.

[*5]Prof., Dept Of Computer Engineering, Sinhgad Academy Of Engineering, Pune-411048, India.

ABSTARACT

3D printing is associate degree additive producing technique wherever the 3D elements area unit created with the addition of multiple layers on of others with the assistance of CAD code. The printing is often through with the assistance of various procedures like SLS (Selective optical maser Sintering), LOM (Laminated Object Manufacturing), SLA (Stereolithography), etc. 3D printer has four axes during which 3 axes area unit X, Y, Z, and therefore the fourth one is associate degree extruder. the method adopted by North American country is FDM technology during which totally different materials like ABS (acrylonitrile hydrocarbon styrene), HIPS (high impact polystyrene), PLA (polylactic acid), etc. are often used. By heating the filament material to its freezing point and giving birth it layer by layer. a mixture of multiple layers on high of the opposite can offer the specified 3D object.

Keywords: 3D Printing, Rapid Prototyping, FDM, SLA, SLS, LOM.

I. INTRODUCTION

Rapid Prototyping is a procedure of takinga computerized 3D model and transforming that advanced document into a physical object. manufacturing across the globe is utilizing 3D printing as an approach to decrease costs, spare time, and deliver better items by nevermore expecting to source the prototyping of components, organizations will quickly repeat upon plans on the fly, as a rule stinting an extended time of sitting tight for outsiders to return molds or models. From carmakers to hardware organizations and anybody in the middle of it, 3D printing is an important innovation. Effective and precise generation of models or low-volume things will reduce a chance to promote and increment item flexibility. This 3D printing technique is used by the manufacturers like aerospace, automotive, medical, dental, etc. due to the accurate and efficient production of models.

II. LITERATURE SURVEY

3D Printing was concocted by Charles W. Hull in 1986, it's another substance manufacturing system during which advanced 3D show is modified over document into a physical protest Frame's creation focused exclusively on a manufacturing procedure called Stereolithography (SLA). Since that time various other 3D printing advancements have been produced, for example, Stereolithography (SLA), fused deposition modeling (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 various advancements canbe utilized to 3D print a question, the larger partof 3D printers one will discover inside a home oran office setting depends on the FDM or SLA forms, as these advancements are presently less expensive and less demanding to actualize inside a machine.

III. HISTORY

The first record in 3D printing with the addition process was made by Japanese designer Hideo Kodama in 1981. He developed a product that used ultraviolet lamps to strengthen polymers and to make solid materials. Charles Hull invented stereolithography, a process similar to 3D printing that uses technology to create smaller types of objects. The seeds of 3D printing began to take root in the 1980s and have now evolved into a set of different technologies that could eventually change the concept of the production process in various fields. Fused Deposition Modelling (FDM), developed by Scott Crump, is the most common form of 3D printing today. It allows you to do anything by simply creating a computer file. Generally, according to the size of the printers, can be divided by desktop.

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IV. METHODOLOGY

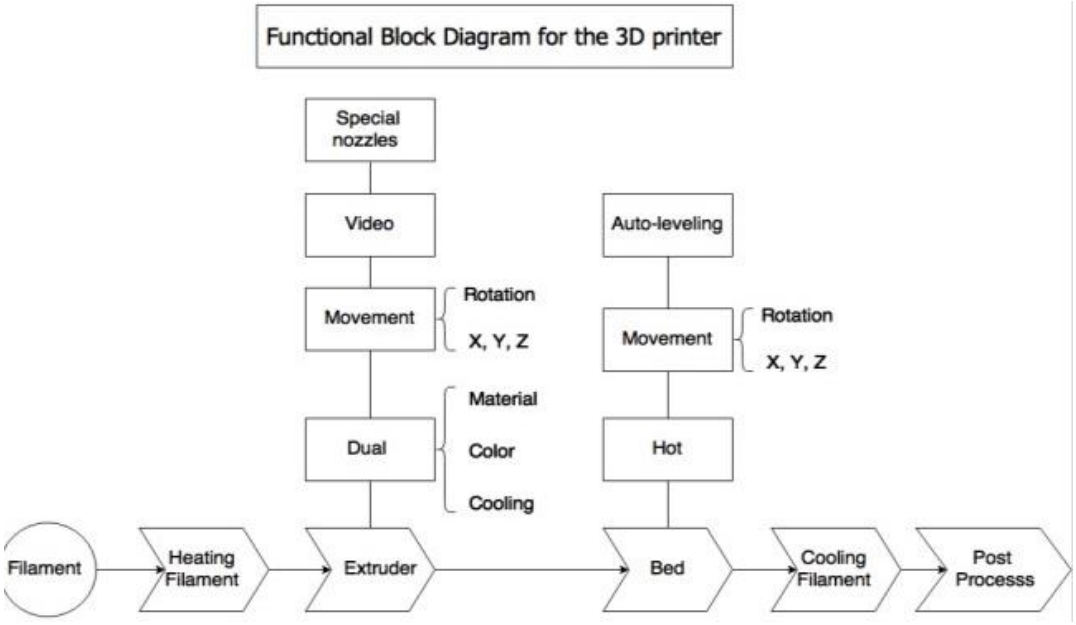

Figure 1: Flowchart

This proposed system begins with a visualization of the structure of the object you want to build. The visual design is used as a template for a visual object to be constructed. The basic premise of FFF technology is to extract the molten material with a microcontroller and insert it into the parts in a defined way. In extrusion-based 3D printing, the supply method of the material can be in the form of tablets and thread. If the feed is in the form of a thread. PLA and ABS thermoplastics are widely used. FFF/FDM printer content starts as computer-assisted design (CAD) files. Before an item can be printed, its CAD file must be converted into a 3D format that can be understood that is in STL format, printers use two types of building materials, modelling, finished materials, and support materials, which act as scaffolding to support the object as it is being printed. During printing, these materials take plastic strings(filament), or threads, which are opened from the coil and inserted into the extrusion tube. The microcontroller melts the fibers and extends them to the base, Both the mouth and the base are controlled by a computer that converts the size of the object into an X, Y, and Z as shown in Fig 1. This thin layer of plastic cools and hardens, quickly binding the layer below it. Once the layer is finished, the bottom is lower down. Printing time depends on the size of the item being produced. Smaller objects: a few inches cubic and tall, thin: objects print quickly, longer: more complex objects take longer to print. Compared to other 3D printing methods. When an object is already an FFF/FDM printer, its support items are removed and Items can also be sanded, milled, painted, or covered to improve their performance and appearance. The following flow chart shows the methodology used by us in the construction of a 3D printer. The first step is to select one of theadditive manufacturing processes among many processes. then associate acceptable mechanism is chosen for X, Y, and Z axis movements, considering varied factors like price of fabrication, simplicity of fashion, synchronization, accuracy, etc. Once a 3D demonstration consists, the document (these typically have augmentations, as an example, 3MF, STL, OBJ, then forth.) should be modified over into G-code is a numerical control script utilized basically for PC-supported assembling (both subtractive andadded substance fabricating). It is a dialect thatadvises a machine how to move. Software such as Slic3r is required 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 to a few thousand moves will comprise of. There areother 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.

V. VARIOUS METHODS IN 3D PRINTING

Different strategies are there to make a model.These strategies are utilized given the many-sided quality of the plan, the material utilized as a part of the plan, the motivation behind the and software then the machine

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is designed and fabricated. The last step is the synchronization of mechanical, electrical, and software elements of the machine. They are as per the following: mechanism is selected the next step is the integration of electronics.

1. Stereo Lithography –

Stereolithographic 3D printers (known as SLAs) position a punctured stage just beneath the surface of a vat of fluid photograph treatable polymer. A UV laser shaft at that pointfollows the in the first place cut off a question onthe 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.

2. Fused Deposition Modelling (FDM) –

It is a procedure by that a machine stores a fiber (Thermoplastics or wax), to end everything or aboard constant material, keeping in mind the top goal to create a joint by warmth or attachment [4]. Here a hot thermoplastic is expelled from a temperature-controlled print head to get high accuracy object at the top..

3. Selective Laser Sintering (SLS) –

The process builds the object with the help of a Laser to fuse the successive layers of wax, liquefied and compacted to consolidate the grains to acquire the last item. Once the model is cooled the abundance powder must be essentially brushed.

4. Laminated Object Manufacturing (LOM)-

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

VI. FUSED DEPOSITION MODELLING- 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 through a small nozzle The nozzle moves in three dimensions laying down the melted plastic layer by layer in the required shape resulting in the realization of a final physical object. Articles made with an FDM printer begin as PC helped outline (CAD) documents. Before a project can be printed, its CAD record must be changed over to an arrangement that a 3D printer can see, for themost part. STL organize. FDM printers utilize 2 types of materials, a displaying material, that constitutes the finished question, and a facilitate material, which matches regarding as a platform to assist the printer as it's being printed. The spout dissolves the fibers and expels them onto a base, in some cases known as Associate in Nursing assemble stage or table. Both the spout and therefore the base area unit controlled by a laptop that deciphers the measurements of a protest into X, Y and Z facilitates for the spout and base to require once amid printing throughout a normal FDM framework, the expulsion spout moves over the assemble stage on level plane and vertically, "drawing" a cross house of a matter onto the stage, "drawing" a cross space of a matter onto the 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 tothe layer underneath it. Once a layer is finished, the base is brought down — as a ruleby 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, onaccount of thermoplastic backings, snapping the help material off by hand. Items may likewise be sanded, processed, painted, orplated to enhance their capacity and appearance.

VII. DESIGN OF 3D PRINTING

The Three-Dimensional movements are accomplished by synchronization of developments in X, Y, and Z direction. The Extruder nozzle is the main part of the printerin which the plastic which is in the form of filament

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melts and prints on a heated bed. The objective of the instrument is to make sure that this extruder nozzle can have the capability to print anywhere within the predestinate 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 a single-engine to control 4 lead screws to which the print bed is associated for the development in the lead screws are driven by the engine which thus moves the bed vertical way. For the development in the Y-axis direction, two separate motors are utilized to move two separate carriages. Two motorshave been utilized here because the print volume is huge, there will be a disturbance in development if just a single motor is utilized. For littler print volumes, a single motor might be adequate. For the development is X-axis direction of a singlemotor 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 inadditional areas. This system is intended for exactness, the stepper motors utilized is having the determination of 0.36o, i.e., 1000 steps per revolution which provide high precision, the mechanism used for movement in Z-axis provides precision, ease of control,and easy synchronization.

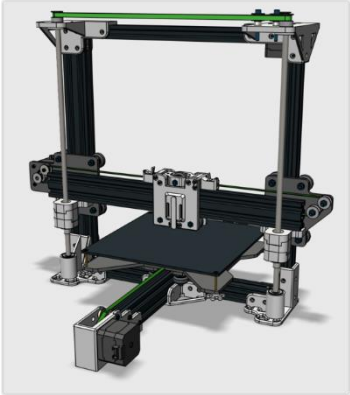

Figure 2: Model of the Printer

VIII. FEA FINITE ELEMENT 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 complex shapes and sizes which is difficult to be calculated in the mechanical theory. FEA can be used for a variety of analyses, from static to dynamic analysis, from modal to heat transfer, etc

Table 1: The analysis of X-Axis Rod

Name	Minimum	Maximum
Volume	1.85982e- 005 m^3	
Mass Density	7800 kg/m^3	
Von Mises Stress	9.00429e-5Mpa	1.14285MPa
Displacement T	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

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- **STRESS**: -

Figure 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 are given in table 1.

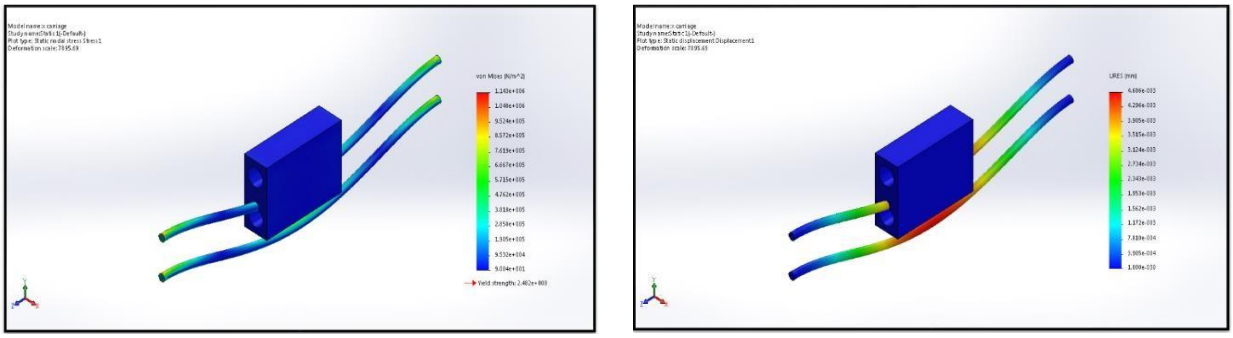

Figure 3: Von-Mises Stress & Displacement for X-Axis

- **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 4, the maximum displacement is near the carriage where the load of 30N is acting on it. The rods selected for the x-axis can withstand the load and thus the material and diameter can be selected as per analysis done.

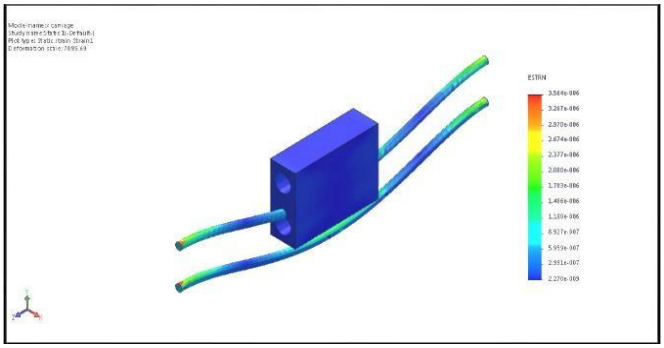

Figure 4: Strain For X-Axis Rods

- **STRAIN**: -

Hooke's law stated that stress is directly proportional to strain, in 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.

IX. ADVANTAGES

1. Market Strategies: 3D printing makes ideas to develop quicker and fast. Being able to print a plan or ideas on a similar day it absolutely was designed dimmish a development method from what might need been months to variety of days.

2. Save Money: The 3D printing permits the creation of components and/or tools through additive producing at rates a lot of below ancient machining.

3. Mitigate Risk: having the ability to verify a style before finance in a fashionable moulding tool is price its weight in 3D written plastic, so some. it's way cheaper to 3D print a take a look at example than to revamp or alter Associate in Nursing existing mould.

4. Feedback: With an example, you'll be able to take a look at the market by unveiling it at a tradeshow, showing it to consumers or raising capital by pre-selling on Indigo or Kick-starter. obtaining buyer's response to the

merchandise before it truly goes into production may be a valuable thanks to verify the merchandise has market potential.

5. Personalize It: With customary mass-production, all components return off the line or out of the mould a similar. With 3D printing, one will alter, customise an area to unambiguously match their desires, that permits for custom fits within the medical industries and helps set individuals to elaborate their plan in new world.

6. Build your Imagination: within the fashionable boom of digital art and style, the probabilities don't seem to be solely fast however limitless. One will currently 3D prints virtually everything they imagine once drawing it up just about or by alternative. in a very comparatively short time, an idea, concept, dream or invention will go from a straightforward thought to a created half.

7. Fail Fast, Fail Cheap: 3D printing permits a product developer to form breakthroughs at early stages that are comparatively inexpensive.

X. DISADVANTAGES

1. Limitations of size: 3D printing technology is presently restricted by size constraints. terribly giant objects square measure still not possible once engineered victimization 3D printers.

2. Limitations of raw material: at the moment, 3D printers will work with more or less a hundred completely different raw materials. this can be insignificant compared with the large vary of raw materials utilized in ancient producing. a lot of analysis is needed to plot strategies to change 3D written product to be a lot of sturdy and sturdy.

3. Fewer producing Jobs: like all new technologies, producing jobs can decrease. This disadvantage will have an outsized impact to the economies of aggregation countries particularly China, that rely upon an outsized variety of low talent jobs.

XI. CONCLUSION

This machine is intended for accuracy.Utilizing a solitary motor for vertical development makes Bed leveling straightforward and also the bed development is ascertained determinedly in metric linear unit. In some machines, the extruder nozzle is made to move in Z-axis direction, and the bed is made to move in Y–axis direction, these mechanisms face the problem of mutilation of written components whereas printing at high rates attributable to the quick development of bed in Y–hub bearing. The outcome of this paper was to build a portable 3D Printer which has been completed. The design of the frame is formed sturdy and compact exploitation atomic number 13 sections. the fabric choice of the assorted components is economical. employing a single motor for vertical movement beside a proximity sensing element makes bed leveling simple and therefore the bed movement is monitored with resolution in microns. the downside in few of the 3D Printer that uses bed movement.

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