

Review on 3D-Printing Aspects, Processes and Future Scope in 3D-Printing Technology

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ABSTRACT

A 3D-Printer is used a CAD model to perform rapid prototyping 3D-Printer have the ability to print in a three dimension(x,y and z axis). 3D printing or Additive manufacturing is method of manufacturing parts directly from digital model by using layer by layer material build up approach. In this technology 3 steps are included such as designing, printing & finishing. 3d design is create by using CAD software in 1st step. 3D printer create an object using this design in 2nd step. And finished object is removed from printer in 3rd step. This technology is time and cost saving. It saves wastage of material. It is useful in industries . By using this technology we can turn our imagination into the physical object. It is a very flexible technology, no need of skilled person required to handle the printer. It is useful to one & all who have an idea to create something. This review presents overview of 3D printing technologies, Literature Review, Types, steps,Advantages, Disadvantages and Application of 3D metal printing technology.

Keyword: - 3D printing, additive manufacturing, CAD, Flexible

1. INTRODUCTION

The 3D-Printing process builds a three dimensional object from a computer aided design(CAD) model, by successively adding material layer by layer, which is called additive manufacturing. 3D-Printing or additive manufacturing (AM) is a process for making a 3D-object of any kind of shape from a 3D-model or other electronic data source through additive processes in which successive layers of materials are laid down under computer controls. Hideo Kodama of Nayoga Municipal Industrial Research Institute is generally regarded to have printed the first solid object from a digital design [1]. The credit for the first 3D printer goes to Charles Hull, who in 1984 designed it while working for the company he founded, 3D Systems Corp. Charles a Hull was a pioneer of the solid imaging process known as stereolithography and the STL file format which is still the most widely used in 3D printing. He also regarded to have started commercial rapid prototyping that was concurrent with his development of 3D printing. Initially he used photopolymers heated by ultraviolet light to achieve the melting and solidification effect. Since 1984, when the first 3D printer was designed and realized by Charles W. Hull from 3D Systems Corp., the technology has evolved and these machines have become more and more useful, while their price points lowered, thus becoming more affordable [2].

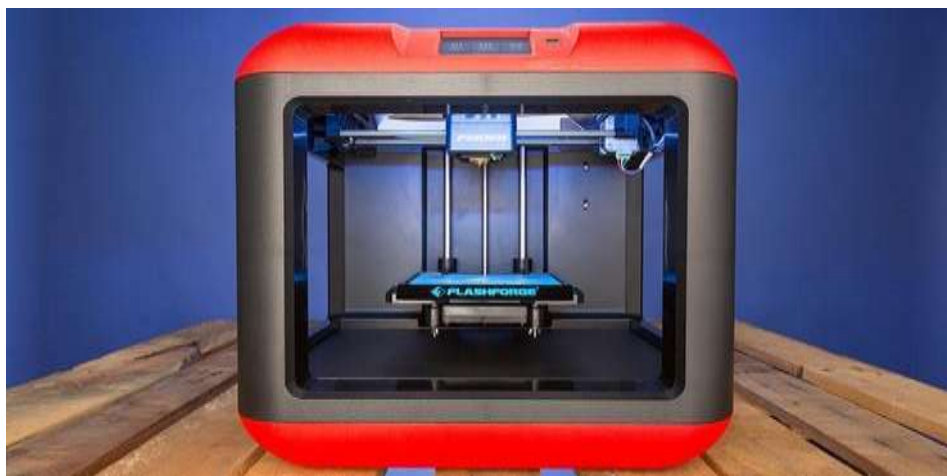


Fig -1: 3D-Printer

2. LITERATURE REVIEW

3D Printing technology was first invented by Charles Hull in 1984; he gives the name to this technique as stereolithography. This technology had become popular in 1990s. and others technology were introduced like Fused deposition moulding and selective laser sintering. In 1993 MIT institute of technology was change the name from stereolithography to 3D Printing Technology. In 1996 three major products were introduced by three different companies such as “Genisys” from stratasys, “Actua 2100” from 3D system, and “Z402” from Z Corporation[3].

In 2005 Z Corporation were launched 1st 3D HD colour printer in the market named as Spectrum Z510[3]. Another 3D printer introduced in 2006 named as Riprap which was aimed at self replicating 3D printer. In 2007 Z450 were introduced with the focus of ease of use & office compatibility. Likewise in 2008 Z650 with increase size & performance and in 2009 Z350 with a new level of 3d printing affordability [3].

In late 20th century, 3D printers were extremely expensive and could only be used to print a limited number of products. 3D printing has grown dramatically in last 20 years and is now being incorporated into many big manufacturer names such as Ford, Mattel, and General Electric. It was still in limited development, the printing technology was a combination of modeling science and construction technology, using some of the newest technological advancements of the time. In the past, surface design was mainly dependent on the production process. However developments in the field of 3D printing have allowed for the design of products to no longer be limited by complex shapes or colors .

3. TYPES OF 3D-PRINTING TECHNOLOGY

Following are the 3 types of Printing technology which are as :

- Selective laser sintering (SLS)
- Fused deposition Moulding (FDM)
- Stereolithography (SLA)

3.1 Selective Laser Sintering (SLS) :

SLS is an additive manufacturing process which uses high laser to fuse the material which is going to use to create an object. In this material is in powder form. Material such as plastic, metal, ceramic, glass etc. The selective laser fuses the powder by scanning the digital data on the surface of powder bed. The powder bed is lowered by thickness of one layer after completed the scanning of all cross-section and a new layer of powder is applied on the top and process is repeated until the product is completed. [4]. Most of the machine use two type of powder coated powder or mixture of powder because in a single component powder laser melts only the outer surface of the particles, fusing the solid state non melted core into each other.

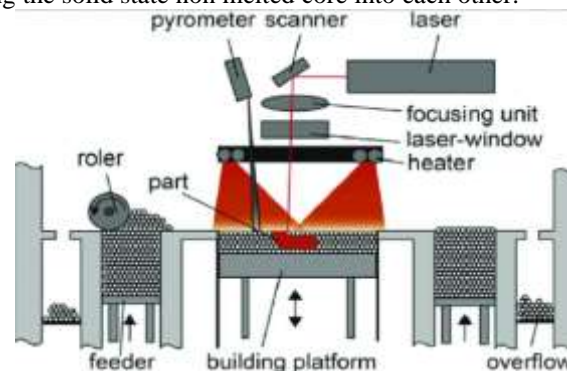


Fig -2: Selective Laser Sintering

3.2 Fused Deposition Molding

This is an additive manufacturing process use to moulding prototype & production of applications. [5]. It works on additive principle by laying down the material layer by layer we can create an object in which plastic filament or metal wire uses. This filament is connected to the extrusion nozzle and the Nozzle is heated for melting the filament, it is moved both the horizontal and vertical direction by using controlled mechanism. This mechanism controlled by using the reference of CAM (Computer Added Manufacturing). Stepper motor or servo motor is used to move the extrusion head [5]. When we send the CAD design to printer, extrusion nozzle heated to melt the plastic filament or metal wire and it moves horizontally and vertically to form the object layer by layer. The material hardens immediately after extrusion from nozzle.

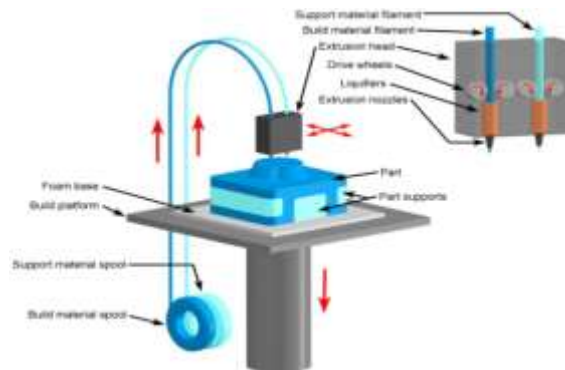


Fig -3: Fused Deposition moulding

3.3 Stereolithography

In stereolithography liquid photopolymer and ultraviolet laser is used to build the object layer by layer. For each layer laser beam traces a cross-section of the part pattern on the surface of the liquid resins [5]. Exposure to the ultraviolet laser light cures and solidifies the pattern traced on resins and joins it to the belloved layer. After that SLA’s elevator platform moves downward by a distance equal to the thickness of single layer, typically 0.05 mm to 0.15 mm and the process is repeated until the object is completed. After the completion of this process object throws into the chemical bath in order to clean excess resins and subsequently cured in an ultraviolet oven [5].

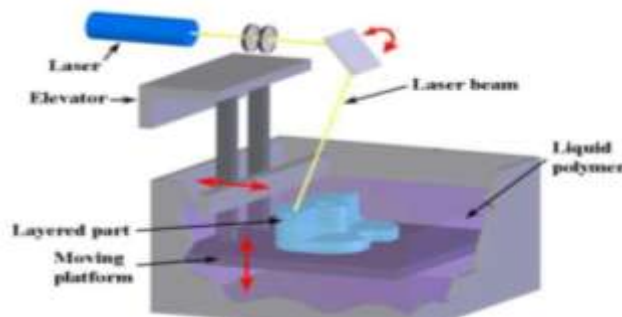


Fig -4: Stereolithography

4. STEPS OF 3D-PRINTING

To develop a project via 3D printing, you need to perform the following steps [6],[7].

- Develop a project of the desired object in 3D CAD software, such as Solid Works, Inventor, Auto CAD, among others;
- Convert the project to STL (Standard Tecelation Language) format. This format describes surfaces of an object through a set of triangles of different dimensions. The more triangles there are, the greater the project accuracy;
- The next step is to choose a reference plane from the STL file, and so the object will be divided into layers parallel to the chosen reference plane. The smaller the size of the layer, the more accurate the print will be;
- Each of these layers is described by a file called GCODE. This code has the numerical commands for the manufacture of each of the layers, possessing information of temperature, trajectory, speed, positioning, among others;
- Finally, printing is done using the GCODE code, which directs the printer to obtain the desired object.

4.1 Advantages

Less wastage of raw material and reduce design complexity [3]. It also provides freedom of design, complexity for free, potential elimination of tooling [8] .A user can make any complex shape on 3D printer by just making on CAD software or by scanning with 3D scanner [9].It is very easy to use, skill operator is not required. Lighter, stronger and the less assembly is required

4.2 Disadvantages

3D printing technology is currently limited by size constraints. Very large objects are still not feasible when built using 3D printers [8]. At present, 3D printers can work with approximately 100 different raw materials.

Research is required to devise methods to enable 3D printed products to be more durable. [9]. Cost of raw material is high[3]. Printer is also expensive, It take more time to create a every single object

5. APPLICATION

3D printing is used for manufacturing hearing aids, some of the automobile parts which requires the greater accuracy. In automobile the buckets of crane [10]. Now a days aircraft components are made with 3D printers because they are strong enough and light in weight [11]. They are also used for making artificial eyes, jaws, faces and artificial ears. In AI field there are many use of 3D printing technology [10]. Nike produces a part of sports shoes with the help of 3D printers. [12]. For making new products in medical and dental industries, the technologies are also utilized to make Patterns for the downstream metal casting of dental crowns and in the manufacture of tools over which plastic is being vacuum formed to make dental aligners [10]. It uses in small level industry because of its high accuracy and low cost. [13]

6. CONCLUSIONS

It tell us about the additive manufacturing process then it tell us about the different principle methods which can be used for 3D printer which includes stereo lithography, Fused deposition modelling, selective laser melting process. Steps explain to develop a model by using 3D printer. Then different application are discuss which includes the medical field, automobile and aerospace industries. Then discuss the advantages and disadvantages of 3D printers are Advances in 3D printing technology can significantly change and improve the way we manufacture products and produce goods worldwide. An object is designed with Computer Aided Design software, then sliced up into thin layers, which can then be printed out to form a solid three dimensional product. As now we all know that 3D printing has application in all the stages of human need. 3D printing includes approximately 100 of materials now a days and the research is going on for increasing the range of material use in this technique.

7. FUTURE SCOPE

In future 3D printers would be available at a very low cost and can be even used in household applications as it would be affordable and also highly accurate and a multicolor extruder can be used and also the printers would be made Portable and easy to handle.

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