

DESIGN AND DEVELOPMENT OF 3D PRINTER

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Abstract: This is a research paper on 3D printing which has become a notable topic in today's technological discussion. 3 D printing is a form of additive manufacturing technology where a 3 D object is created by laying down successive layers of material it is also known as rapid prototyping, it is a mechanized method where by 3D objects are quickly made on reasonably sized machine connected to a computer containing blue prints for the objects. Here in this technology 3 steps are included such as Designing, Printing and Finishing. In 1st step we use any CAD software to create 3D design in 2nd step 3D printer create an object using this design. And 3rd step finished object is removed from printer. This technology saves time and cost, it saves wastage of material. It has the potential to radically transform many design, production and logistic processes.

Keywords: 3DPrinter, Rapid Prototyping, Successive Layer, Fused Deposition Modeling

I. INTRODUCTION

3D printing technology means 3 dimensional physical object creating process also known as additive manufacturing processes. Here in this technology 3D printer creates an object by laying down the material on the platform of printer until the desired object is formed. In this melted material or powder used to create object. Printing is nothing but the process of producing text or images. This technology mostly used in the industry to turn ideas into reality. This is leading technology now a day's which attracts the educated students and industries [8] Manufacturing, a fundamental industry provide people with daily used products and services, has been revitalized in recent years[6]. Under the fused deposition modeling technique in which a plastic filament is melted by a nozzle and placed layer by layer on the table where the part is build from the bottom up[4]. The printing based on fused deposition modeling (FDM) using thermoplastic is particularly widespread because of simplicity and potential ability of the method. However, the mechanical properties of metal fabricated by conventional FDM 3D printing are inherently poor because of thermoplastic resins used, the mechanical properties of thermoplastic resin parts of 3D printing has primarily been used for trial products or toys, the application of 3D printing to obtain mechanically strong components for aerospace and automotive structure is a major goal of industrial fabrication.[9]

II. LITERATURE REVIEW

3D printing technology was 1st invented by Charles Hull in 1984, he gives the name to this technique as stereo lithography. This technology had become popular in 1990's and others technology where introduced like fused deposition molding and selective laser sintering. In 1993 MIT Institute of technology was change the name from stereo lithography to 3D printing technology. In 1996 three major products where introduced by three different companies such as "Genisys" from "Stratasys", "Actua 2100" from 3D system and "Z402" from z corporation [2]. Winsun uses a massive printers 490*33*20' to print pieces of houses in a factory and then assembles them on sites, winsun makes the houses using recycled construction materials, industrial waste which are then reinforced with fiber glass and, most impressively, winsun has printed ten houses in less than a day, each measure in 200 sq.meters and costing less than 5000\$.the company even constructed it's own 10,000 sq.meter office in month using assembly line of four 3D printers [3].

Engineers at the University of Southampton design and -y the world's 1st 3D-printed aircraft. This unmanned aircraft is built in seven days for a budget of £5,000. 3D printing allows the plane to be built with elliptical wings, a normally expensive feature that helps improve aerodynamic efficiency and minimizes induced drag

For Ecologic unveils Urbee, a sleek, environmentally friendly prototype car with a complete 3D-printed body at the TEDxWinnipeg conference in Canada. Designed to be fuel efficient and inexpensive, Urbee gets 200 mpg highway and 100 mpg city. It is estimated to retail for \$10,000 to \$50,000 if it becomes commercially viable.

materialize becomes the 1st 3D printing service worldwide to offer 14K gold and sterling silver as materials potentially opening a new and less expensive manufacturing option for jewelry designers

III. METHODOLOGY

The methodology that was followed in his case study was to first identify and understand the problem of having brand new 3D printer. Some background research technology together with AR was done to understand the state of art and capability of each of them.

a) Fused Deposition Modelling

It was developed by strat a sys in Eden Prarie Minnesota. In this process, a plastic or wax material is extruded through a nozzle that traces the part cross sectional geometry layer by layer. FDM is a second most widely used rapid prototyping technology, after steriolithography. A plastic filament is unwound from a coil and supplies material to an extrusion nozzle. The nozzle is heated to melt the plastic and has a mechanism which allows the

flow of melted plastic to be turn ON and OFF. The nozzle is mounted to an X-Y plotter type mechanism which traces out the part counters; there is second extrusion nozzle for the support material (Different from the model material). As the nozzle is moved over the table in required geometry, it deposits a thin bed of extruded plastic to form each layer. The plastic hardens immediately after being squirted from the nozzle and bounce to the layer below. The object is built on mechanical stages which moves vertically downward layer by layer as the part is formed. The entire system is contained within a chamber which is held at a temperature just below the melting point of the plastic support structure are automatically generated for overhanging geometry and later removed by breaking them away from the object. A water-soluble support material is also available for ABS parts. A range of materials are available including ABS, polyimide and polycarbonate. [3]

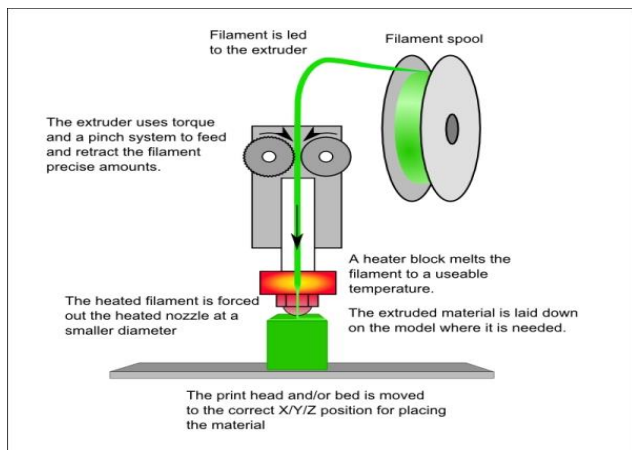


Fig. Fused Deposition Modelling (FDM) Process

IV. WORKING PROCESS

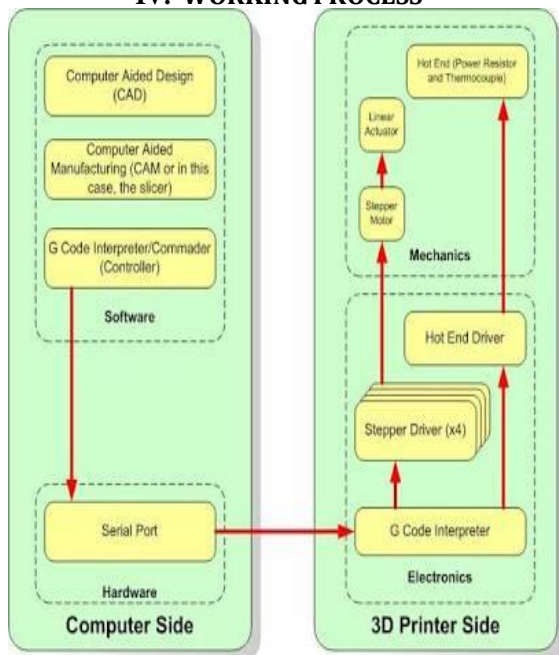


Fig. Steps in 3D Printing

Step (1) :- Computer Aided Design

In this process the CAD file is created using a 3D modelling programme, either from scratch or beginning with a 3D model created by a 3D scanner . The program creates a file that is send to the 3D printer along the way software slices the design into hundreds, or more likely thousands of horizontal layers. This layers will be printed one a top the other until the 3D object is done. Many programs are used for designing 3D objects such as solid works, AutoCAD and have a steep learning curve, there are number of other programs, many free that are easy to learn the free version of goggle sketch up, for example is very popular for it is ease of use and the free blender program is popular for its advanced features.[1]

Step(2):- Motoring

The operating of 3D printer requires motoring with low torque, high accuracy the best motor to do this function is stepper motor, 'is an electromagnetic device that converts digit pulses into mechanical shaft rotation. advantages of step motors are low cost, high reliability high torque at low speed and a simple they are special type of synchronous motors which are design to rotate specific number of degrees of every electric pulses received by its control unit, attraction of degree could be done using gears in order to move the printer head a specific displacement ,in 3D printer four stepper motors were needed to do the specific function, three of them were used for moving in X,Y,Z direction of the printer head, the fourth one was needed to move the plate(Bed).[1]

Step(3):- Processing

The AM335x microprocessors are enhanced with image, graphics processing and industrial interface options. The device supports the following high level operating system (HLOSS), The AM335x microprocessor contains this sub systems. 1) Microprocessors unit (MPO). 2) Graphics accelerator sub system for 3D graphics acceleration to support display.[1]

Step(4):- MOSFET drive

By polar stepper motor with MOSFET drive which will allows the motor to move in both direction, since stepper motor is one loop system, high accuracy components will used in order to print in the specific space so that MOSFET was used, because it has the fast frequency operations.[1]

V. ADVANTAGES

- 1. High strength of part:** with ABS plastic as a material, FDM process can fabricated fully functional parts that have the strength equal to 90% of the actual injection of moulded part.[1]
- 2. Temperature Stability:** The FDM process produces the parts which are stable over the wide temperature range.[6]
- 3. Easy support Removal:** In FDM process the supports can be easily broken or dissolved during post processing.[5]
- 4. Minimum Material Wastage:** In FDM process the parts are build by extrusion process, only that much material is used during extrusion which is

required to build a part therefore, the wastage of material is at minimum level.[7]

5. **Safe Operation:** In FDM process there is no use of laser hence it is a safe operation.[4]

VI. LIMITATIONS

1. **Limited Accuracy of Parts:** The material used in FDM process is in the form of filament.[2]
2. **Slow Building Process:** Speed of FDM process is restricted by the rate of extrusion of material from nozzle.[1]
3. **Poor shear stress of parts:** The part build by FDM process are weak direction
4. perpendicular to built axis i.e. shear strength.[3]
5. **Possibility of Shrinkage and Distortion**
The extruded material cool rapidly on deposition, Hence there is danger of shrinkage and distortion of the parts.[11]

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