

3D PRINTING TECHNOLOGY

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ABSTRACT

3D printing is a process of making a three -dimensional solid objects from a digital file using additive manufacturing techniques. In this process layers of material are successively deposited one above the other to create an object. Each layer can be visualized like thinly sliced section of the object.

The key to this 3D printer is the thermoplastic extruder which is coupled with a Cartesian XYZ platform. 3D printing by using PLA filament electronics are based around the popular Arduino development platform, utilizing a custom made board for interfacing with the Arduino development Board and allowing stepper motor and extrusion temperature monitoring and control.

In very simple terms, 3D Printer (not to be confused with printers we see in everyday life) is electromechanical device that builds physical object with very high precision(100 micron or 0.1mm) at a very low cost.

INTRODUCTION

A 3D printer is a limited type of industrial robot that is capable of carrying out an additive process under computer control. While 3D printing technology has been around since the 1980s, it was not until the early 2010s that the printers became widely available commercially. The first working 3D printer was created in 1984 by Chuck Hull of 3D Systems Corp.

The 3D printing technology is used for both prototyping and distributed manufacturing with applications in architecture, construction (AEC), industrial design, automotive, aerospace, military, engineering, dental and medical industries, biotech (human tissue

replacement), fashion, footwear, jewelry, eyewear, education, geographic information systems, food, and many other fields. 3D printing could become a mass market item because domestic 3D printers can offset their capital costs by enabling consumers to avoid costs associated with purchasing common household objects. Objects that are manufactured additively can be used anywhere throughout the product life cycle, from pre-production (i.e. rapid prototyping) to full-scale production (i.e. rapid manufacturing), in addition to tooling applications and post-production customization. In manufacturing and machining in particular, subtractive methods refer to more traditional methods. Although fabrication has included methods that are essentially "additive" for centuries (such as joining plates, sheets, forgings, and rolled work via riveting, screwing, forge welding, or newer kinds of welding), it did not include the information technology component of model-based definition.

BASIC PRINCIPLE

The first step towards making a 3D Printed object starts with creation of virtual CAD modelling generally in the form of mesh model. Such digital models of real life objects can also be created by using a 3D scanner. The digital files are then processed using a slicing program that creates hundreds to thousands of horizontal layers. This file is then loaded into a 3 D printer which reads every slice and reproduces the object, blending each layer to another seamlessly.

Most popular materials for 3D printing are PLA (polylactic acid), ABS (Acrylonitrile butadiene Styrene). There are several 3D printing techniques like Fused Deposition Modelling., Selective Laser sintering (SLS) and Stereolithography (SLA) used for a wide range of applications. It may sound complex to new user, but all you need is a 3D CAD file in .stl or .obj format (widely available on internet also) to begin the printing process.

METHODS OF 3D PRINTING

A. FDM – Fused Deposition Moulding

Build-preparation software slices and positions a 3D CAD file and calculates a path to extrude thermoplastic and any necessary support material. The 3D printer heats the thermoplastic to a semi-liquid state and deposits it in ultra-fine beads along the extrusion path. Where support or buffering is needed, the 3D printer deposits a removable material that acts as scaffolding. The user breaks away support material away or dissolves it in detergent and water, and the part is ready to use.

B. SLS – Selective Laser Sintering

Objects printed with SLS are made with powder materials, most commonly plastics, such as nylon, which are dispersed in a thin layer on top of the build platform inside an SLS machine.

The laser heats the powder either to just below its boiling point (sintering) or above its boiling point (melting), which fuses the particles in the powder together into a solid form.

C. SLA – Stereo Lithography

In this a thin layer of liquid photopolymer is laid as per the design and is solidified by an ultraviolet laser beam. The un-solidified resin is reused. It was invented in 1984 by Charles Hull. Photopolymer resins that are cured with ultraviolet radiation, such as ABS (Acrylo-nitrile butadiene styrene) are supplied as liquids.

MAJOR COMPONENTS

A. Extruder

Extruder is cylindrical device which is used to melt the ABS and PLA material. It contains cartridge heater, Teflon sleeve and temperature sensor. Nozzle diameter of extruder is 0.4 mm.

B. Printboard

It is motherboard of 3 D printer. Various connections such as motor, limit switch, extruder heater, and ATX power supply are provided on it.

C. Lead screw

A Lead screw is a mechanical device used for converting rotary motion into linear motion and transmitting Lead. A Lead screw is called a translation screw. There are three essential parts of the Lead screw viz., screw, nut and a part to hold either the screw or the nut.

D. Stepper Motor

An electromagnetic actuator, it is an incremental drive (digital) actuator and is driven in fixed angular steps. This means that a digital signal is used to drive the motor and every time it receives a digital pulse it rotates a specific number of degrees in rotation.

Each step of rotation is the response of the motor to an input pulse (or digital command). Step-wise rotation of the rotor can be synchronized with pulses in a command-pulse train, assuming that no steps are missed, thereby making the motor respond faithfully to the pulse signal in an open-loop manner.

WORKING OF 3D PRINTER

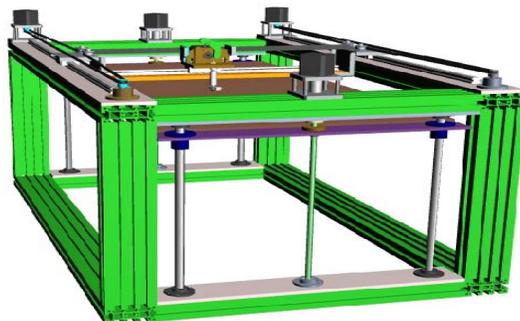


Fig.1 CAD Assembly Of 3D Printer

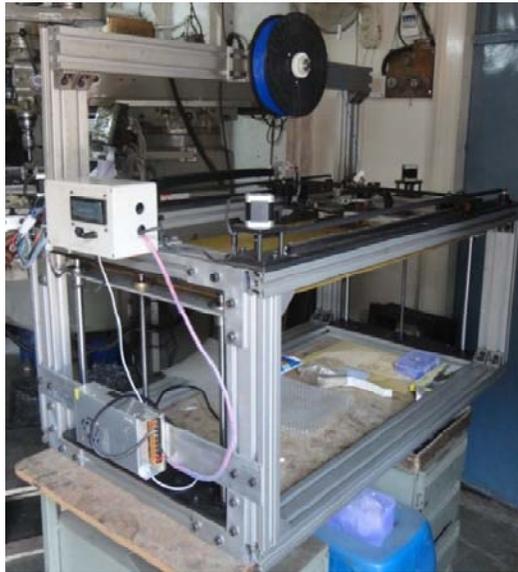


Fig.2 Actual Assembly of 3D Printer

The printing bed is lowered layer by layer at a time in the Z axis. The extruder is controlled in the X-Y axes by using core XY movement. The home position (0,0,0) of 3D Printer can be selected as per requirement. The plastic filament is feed into a heated extruder (like when you pull the trigger on a hot glue gun). The plastic melts and comes out of the extruder head nozzle which is 0.4mm in diameter. Being molten, it melts the surface of the material it touches to bond and build a new layer.

The fundamental purpose of a 3D printer is to quickly transform an idea into a physical object. That idea is usually first embodied in a 3D computer model created in 3D CAD software like Solid Works, Auto desk Inventor or Pro/ENGINEER. All of these software tools export 3D models as files in standard formats for 3D printing, including .STL, .WRL (VRML), .PLY, .3DS and .ZPR. The exported file is a mesh or series of triangles oriented in space that enclose a 3D volume. This mesh must be “water tight”. With the file now in a printable format, you open pronterface software on your PC. Using pronterface, you can scale up or scale down the file you wish to print, orient the part in the build chamber, and direct the 3D printer to print multiple versions of the part in the same build (with or without variations). Then Pronterface slices the 3D model file into hundreds of digital cross-sections, or layers. Each 0.004 inch (0.1 mm) slice corresponds to a layer of the model to be fabricated in the 3D Printer.

When ready to start the print job, you click “3D Print.” This sends the digital layer files to the 3D Printer, and the model begins printing immediately. The 3D Printer prints each layer, one a top another, as the physical part is constructed within the build area of the machine. Once the final layer is laid the printing is said to be complete. Then the physical object can be removed.

ADVANTAGES

1. 3D Printers are easy to use.
2. Print part with high strength.
3. 3D Printers are the faster than other Rapid Prototyping Technology.
4. Production cost is less.
5. It produces less waste compared to other techniques.
6. The materials used for printing are non toxic & completely safe.

APPLICATIONS

Industry

Fast prototyping of new designs for testing small quantity production runs.

Medicine

To develops tissue and structure using individual's own cells.

Architecture

Print scaled models to give perspective to customer.

Aviation

Print customised parts thereby reducing inventory and manufacturing cost.

Advertising / Packaging

A typical example will be development of a packaging bottle for a product company.

CONCLUSION

3D Printing technology could revolutionize and re-shape the world. Advances in 3D printing technology can significantly change and improve the way we manufacture products and produce goods worldwide. An object is scanned or 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. it will provide companies and individuals fast and easy manufacturing in any size or scale limited only by their imagination.

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