Object Fabrication Using 3d Printer: A Systematic Survey

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Abstract- *Nowadays, many times we come across a situation where we require some replacement part whether it may be part of any machine or it may be of any daily life useful material, but if it is not available in the required dimensions, then the question arises in front of us that how to make availability of such parts or objects.*

So this project has a solution over it in which we are going to implement a 3D printer which will be used in creating a 3D object as per the dimensions and shape we require. In this 3d printing process, our desired object is firstly designed using CAD software and then same object is printed using a CNC i.e. computerized Numeric control machine. CNC uses 3 axes, X-Y-Z axis to control the length, width, height or depth of the object. Software and Hardware part is also explained with detail information.

Keywords- 3 Dimensional (3D), CNC , Filament, G-code, Manufacturing, Printing

I. INTRODUCTION

3D Printing is a process by which 3d objects of any shape or any geometry is created by using digital file. Here digital file means the shape or geometry which is designed using digital technology. So if look into the history of 3D printing technology, this technology was firstly introduced in 1984 by the hands of Chuck Hull, who invented a process, called Stereo-Lithography. Later in 2006 first SLS (selective Laser Sintering), in 2008 first self-replication printer and in 2011 3D printer became commercially available.

II. MANUFACTURING PROCESS

Manufacturing process is a process in which the physical parameters of the job or physical properties of the job are changed to produce a desired object.

Manufacturing process is classified in two types:-

1) Additive Manufacturing

Additive manufacturing technique is a process in which the addition of material by layer-by-layer is carried out in order to print a3D object. In these process layers of material is added in the area specified in the design of the object.

2) Subtractive Manufacturing

Subtractive manufacturing technique is a process in which the unwanted part from the solid object is removed by means of drilling, cutting, etc. Basically the excess material from the raw material is removed and the final object is obtained.

III. TYPES OF ADDITIVE MANUFACTURING

1) Liquid Based Process

It is a process which creates objects layers by selectively solidifying a liquid resins that hardens when exposed to laser or other light source.

2) Powder based process

It is a very broad category of 3D printing hardware which builds objects by selectively sticking together successive layers of very fine powder or by fusing powder granules together using a laser or other heat source

3) Solid based process

It is the process in which the 3d printers creates object by extruding a molten or otherwise semi liquid from a print head nozzle. Most commonly molten thermoplastic is used because it sets very rapidly after it has left the print head.

4) Paper based process

This process is based on lamination. Here, successive layers of cut paper, metal or plastic are stuck together to build up a solid object where the sheets of papers are used as a build material and they are cut by blade or laser and glued together.

IV. TYPES OF 3D PRINTING TECHNOLOGIES

1) Stereo Lithography (SLA)

This is the first rapid prototyping process introduced in 1988 by 3D systems. Stereo Lithography builds plastic parts or objects one layer at a time by tracing a laser beam on the surface of liquid photopolymer. The photopolymer gets quickly solidifies in the area where laser beam strikes. Now the successive layer and previous layer are bonded due to self adhesive property of materials.

Liquid photopolymer used:-ABS, PBT, rubber, polypropylene.

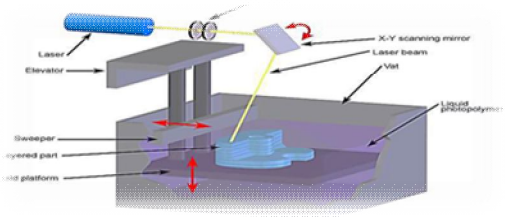

Fig.1.1. stereo lithography [3]

2) Fused Deposition Modeling (FDM)

This was first developed by Stratasys. In this process nozzle is used to heat the material which is extruded to trace the part of object designed. As soon as the material leaves nozzle it gets harden and the solid shape object is obtained. Filaments are inserted ass material which is melted in nozzle.
Filaments used: - ABS, polycarbonate, Elastomers.

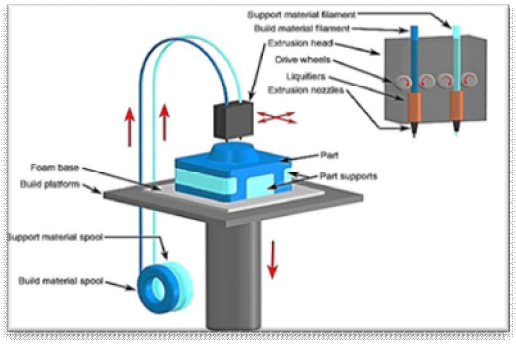

Fig.1.2. Fused deposition modeling (FDM) [3]

3) Laminated Object Manufacturing (LOM)

The first LOM technique was developed in 1991.In this process a sheet is placed on the layer and a pressure is applied to bond the sheet to below layer, then layer is used to cut the outline. In such way parts are produced by stacking, bonding and cutting layers of sheet material on top of previous one.

Sheets used: - thermoplastics such as PVC, paper, composites.

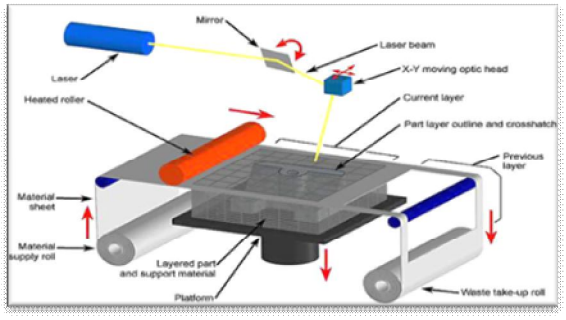

Fig.1.3. Laminated Object Manufacturing (LOM) [3]

4) Selective Laser Sintering (SLS)

It was developed at the University of Texas in Austin, by Carl Deckard and colleagues. Thermoplastic powder is spread by a roller over the surface of a build cylinder. The piston in the cylinder moves down one object layer thickness to form the new layer of powder. A piston moves upward incrementally to supply a measured quantity of powder for each layer. A laser beam is traded over the surface of this tightly compacted powder to selectively melt and join the grains together to form a layer of the object.

Powder used: - Nylon, polyamide and polystyrene.

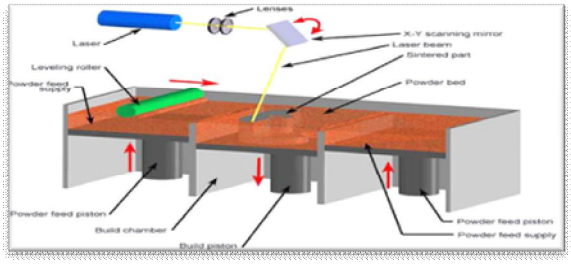

Fig.1.4. Selective Laser Sintering (SLS) [3]

5) Inkjet Printing

This method uses a single jet each for a plastic build material and a wax-like support material, which are held in a melted liquid state in reservoirs. The liquids are fed to individual jetting heads which squirt tiny droplets of the materials as they are moved in X-Y fashion in the required pattern to form a layer of the object. The materials harden by rapidly dropping in temperature as they are deposited.

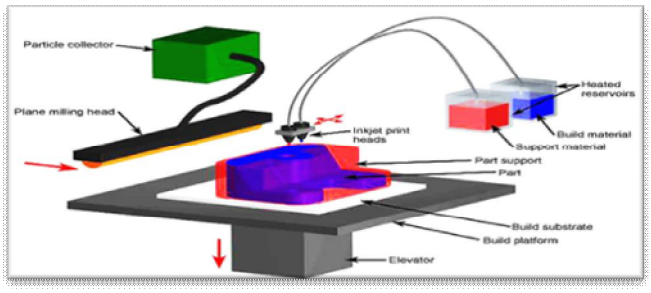

Fig.1.5. Ink Jet printing [3]

6) Poly Jet Printing

Poly jet process is very similar to the ink jet printing done on paper but in this process, instead of jetting drops of ink onto paper, the printer jets layers of liquid polymer onto a tray and then the UV rays instantly cure the model. The process is based on photopolymers, but uses a wide area inkjet head to layer wise deposit both build and support materials. The advantage of poly-jet systems over SLA systems is that the resins come in cartridge form (no vat of liquid photopolymer); the machines are clean, quiet and office friendly.

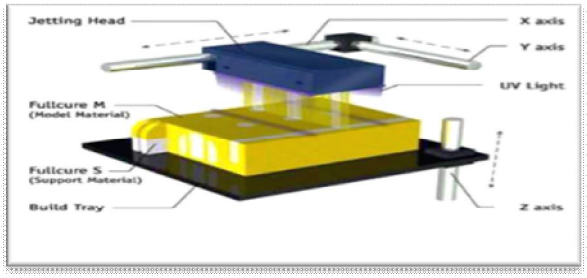

Fig.1.6. Poly Jet printing [3]

V. BLOCK DIAGRAM

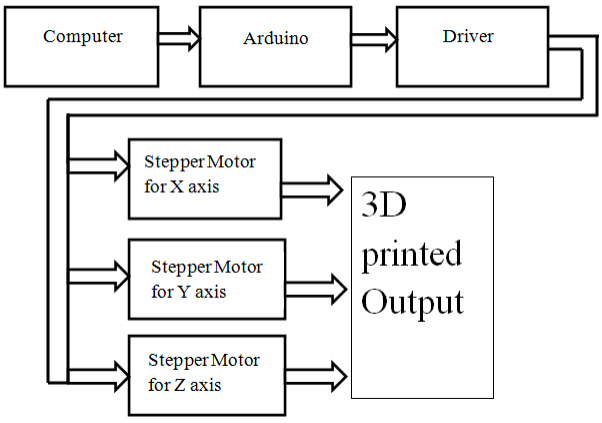

Fig.5.1. Block diagram of 3D printer

Block diagram of this project consists of the simple combination of the controller i.e. Arduino Mega, personal computer and stepper motor drivers to control or drive the stepper motor. Computer will upload the code to the arduino mega as per the designed 3d object and arduino mega uses three stepper motors to control the movement of X, Y, Z axis respectively. X axis corresponds to the breadth of object, Y corresponds to length of object and Z axis corresponds to height or depth of the object.

VI. HARDWARE

1) Arduino Mega

Fig.6.1 ArduinoMega2560

The Arduino Mega 2560 is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. The Mega 2560 board is compatible with most shields designed for the Uno and the former boards Duemilanove or Diecimila.

3)RepRap Arduino Mega Pololu Shield (RAMPS)

Fig.6.2.RAMPS

RAMPS is a low cost 3D controller board to use as a shield for the arduino mega board. RAMPS interfaces an arduino mega with powerful arduino mega platform and has plenty room for expansion.

2) Stepper Motor and Driver

Fig.6.3 Stepper Motor

A stepper motor or step motor or stepping motor is a brushless DC electric motor that divides a full rotation into a number of equal steps. The motor's position can then be commanded to move and hold at one of these steps without any position sensor for feedback (an open-loop controller), as long as the motor is carefully sized to the application in respect to torque and speed. A NEMA 17 stepper motor is a stepper motor with a 1.7 x 1.7 inch (43.2 x 43.2 mm) faceplate. The NEMA 17 is larger and generally heavier than for example a NEMA 14, but this also means it has more room to put a higher torque. However, its size is not an indication of its power.

4) 3D Printing Pen

3D printing pen is a type of extruder used in many types of 3D printers. It is used to melt the PLA or ABS material to print a line to create object. Internal mechanism of 3D printing pen includes the following: -

i) Heated Nozzle

It is a combination of heater and nozzle. It is used to heat and melt the filament and allows the molten plastic to exit from nozzle to form a thin line of plastic to make a 3d object.

Fig.6.4. Heated Nozzle [2]

ii) DC gear motor

It is used in 3d printers as a feeder which is used to insert the filament wire inside the pen which will be melted to form an object. As this motor is of mini size it can easily fit inside the pen. It has less rpm and torque.

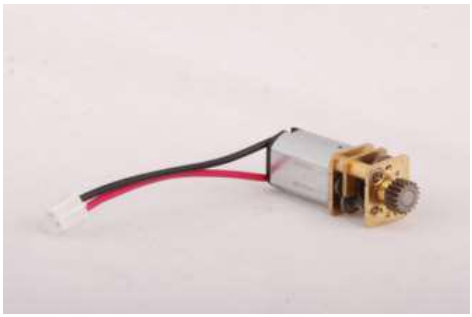

Fig.6.5 DC gear motor [2]

iii) Motherboard

In electronics system, motherboard is one of the most essential parts. It holds together many parts in the computer including the CPU (central processing unit), memory and connectors for input and output devices. It is used to control the forward extrusion or backward extrusion of the material; it also used to set the temperature used to melt the filament.

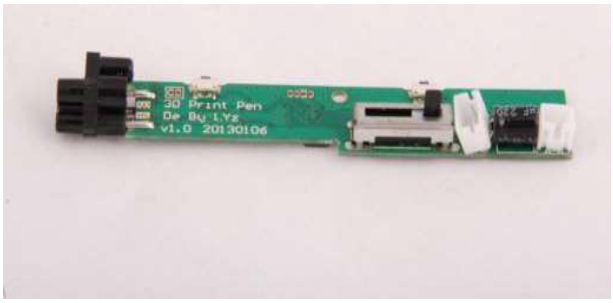

Fig 6.6 Motherboard [2]

VII. SOFTWARE

Software tools used in 3D printing technology are:-

1. Designing tools
2. Slic3r tools
3. Pronterface

1. CAD Tools

Computer Aided Design or CAD tools are used to design the shape or geometry of object to be printed. They usually represent parts in the constructive solid geometry on shapes like cylinder, cubes, spheres, etc.

Basically in such programs the geometry is stored in a format in which the dimensions can be varied numerically.

2. Files

Most of the times 3D software save their files in application-specific format. The most widely used interchangeable mesh file format is STL. STL files are important because they are used by CAM tools.

Working procedure of software: -

1] Firstly we have to design 3D object using CAD software or any designing software.

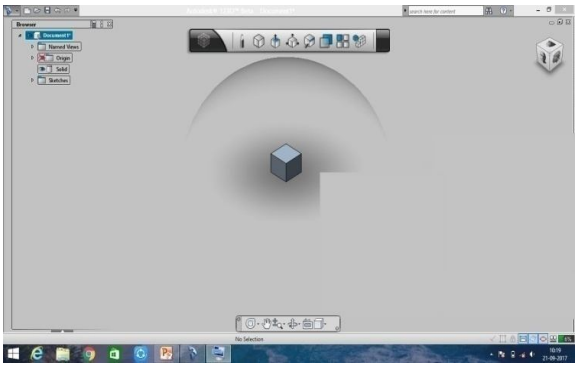

Fig.7.1 Autodesk 123D Software

2] Then save the file as .STL after designing.

3] Now convert the .STL file to G-code using Slic3r software.

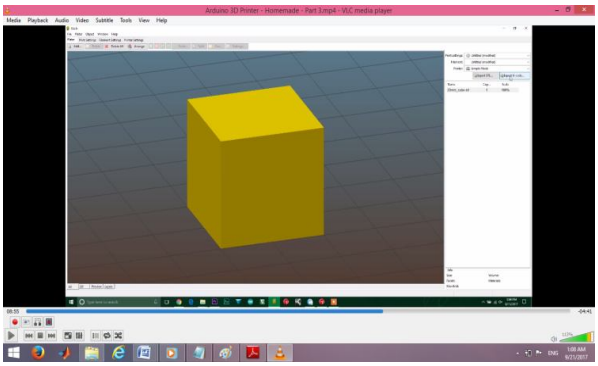

Fig.7.2 Slic3r Software

4] Now open Pronterface software.

5] Select the port and speed and click on connect button.

6] Now add the g-code file in the software and press on Print button

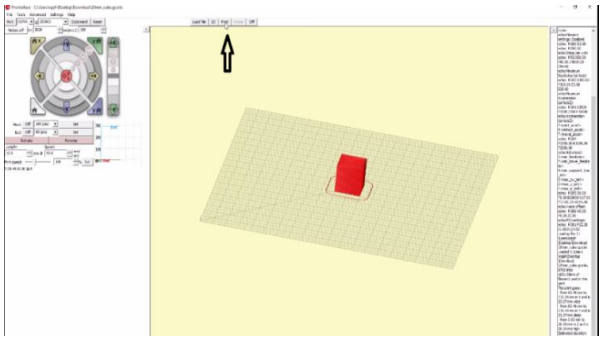

Fig.7.3 Pronterface Software

7) 3D printer starts printing 3D object and the object is ready.

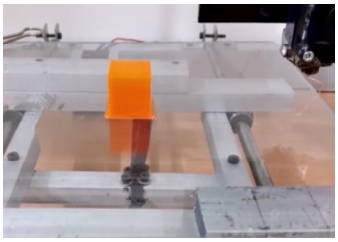

Fig.7.4 Ready Object

VIII. APPLICATIONS

1) Automation and Aviation industry

About 70 of the parts that are used to make the rover are built using the process of fused deposition modeling or additive manufacturing.

Fig.8.1 Urbee-1st car printed out of 3D printer

2) Architecture Industry

3D printing is used in architecture industry in order to design architectural models.

Fig.8.2 Architectural model

3) Medical industry

Physicians can use 3D printing to make hearing aids, artificial teeth and bone grafts.

Fig.8.3 Teeth and bone models

4) Food processing:

In food preparation, to apply item in liquid or paste Form such as cheese, iceeing & chocolate.

Fig.8.4.Food processing

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