Design and developmet of 3Dprinting

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ABSTRACT

Abstract *This is a research paper on Design and development of 3D printing which has become a important topic in today's technological discussion. 3 D printing is a form of additive manufacturing process technology where a 3 D object, parts or model is created by laying down successive layers of material it is also known as rapid prototyping, it is a mechanized method where the 3D models or parts are quickly made as per the given size machine connected to a computer containing blue prints for the model . Here in this technology there are 3 steps are included such as Design, Printing and Finishing object or model which we want. In 1st step we use any CAD software which is to create 3D design in 2nd step 3D printer create an model (object)using this design. And 3rd step finished product or object is removed from printer. This technology saves time and cost, it saves wastage of material that used to make a deposation or the layers to print a object. It has a potential to the radically transformed to many designs production and logistics processes to create.*

Key words: *Stereo- lithography (SLA);Fused Deposition Modeling (FDM); Laminated Object Manufacturing (LOM); Selective Laser Sintering (SLS) & Direct Metal Laser Sintering (DMLS);Ink Jet Printing &Poly-jet printing.*

1. Introduction:-

3D printing technology, commonly referred to as additive manufacturing procedures, is the process of making three-dimensional physical objects. Using this technology, a 3D printer forms an object by depositing material onto its platform until the desired shape is achieved. In this case, the object is made of melted material or powder. The process of creating text or images is called printing. In the industry, this technology is primarily employed to bring ideas to life. These days, cutting-edge technology like this draws in industries and intelligent pupils. The manufacturing sector, which is essential to the economy and provides people with everyday goods and services, has seen a resurgence in recent times. Using the fused deposition modeling method, a nozzle melts plastic filament, which is then applied layer by layer.

1.1 LITERATURE REVIEW

3D printing technology was 1st invented by Charles Hull in 1984, he gives the name to this technique as stereo lithography. This is a technology that had become more popular in 1990's and so others technology where introduced

that to like fused deposition molding and selective laser sintering. In 1993 MIT change the name from stereo lithography to 3D printing technology. In 1996 there is three major products that where introduced by the three different companies such as the Genisys from "Stratasys Actua 2100 from 3D system and Z402 from z corporations.
Winsun employs large printers 490'*33'*20' to produce or print pieces of houses in a factory and then assembles them on sites, using recycled construction materials, industrial waste winsun makes the houses which is to be then reinforced with fiber glass and most impressive winsun has printed ten house in less than a day, each measure in 200 sq.meters and costing less than 5000$.the company eve Engineers at the University of Southampton design and -y the world's 1st 3D-printed aircraft. Designed to be fuel efficient and affordable, Urbee gets 100 mpg city and 200 mpg highway. It is the estimate to the retail for $10,000 to $50,000 if it is to becomes a commercially variable.

2. METHODOLOGY

The first step in his case study's approach was to recognize and comprehend the issue with owning a brand-new 3D printer. In order to evaluate each technology's state of the art and present capabilities, some background research on AR and technology was conducted.

Fused Deposition Modelling:-

Stratasys in Eden Prairie, Minnesota, developed it. In this process, a nozzle extrudes wax or plastic material while adhering to the part's layer-by-layer cross-sectional shape. After stereolithography, FDM is the second most used fast prototyping technology. An ejection nozzle receives material from a plastic filament that has been unwound from a coil.
The nozzle is heated to melt the plastic, and it contains a mechanism that lets you turn on and off the flow of molten plastic. For accurate placement that draws out the part counters, the nozzle is attached to a device that resembles an X-Y plotter. A second extrusion nozzle is used for the support material, which is different from the model material. Each layer is formed by the nozzle depositing a thin bed of extruded plastic as it moves over the table in the necessary geometry. After being shot out of the nozzle and bounced to the layer below, the plastic instantly hardens.
The goal is to rely on mechanical stages that move down vertically layer by layer as the piece is formed. The whole system is enclosed in a chamber kept just below the melting temperature of the plastic support structure, which automatically applies the outstanding geometry and then removes them by cutting them off the object. In addition, a water-soluble backing material is available for ABS parts. Various materials are available, including ABS, polyamide and polycarbonate..

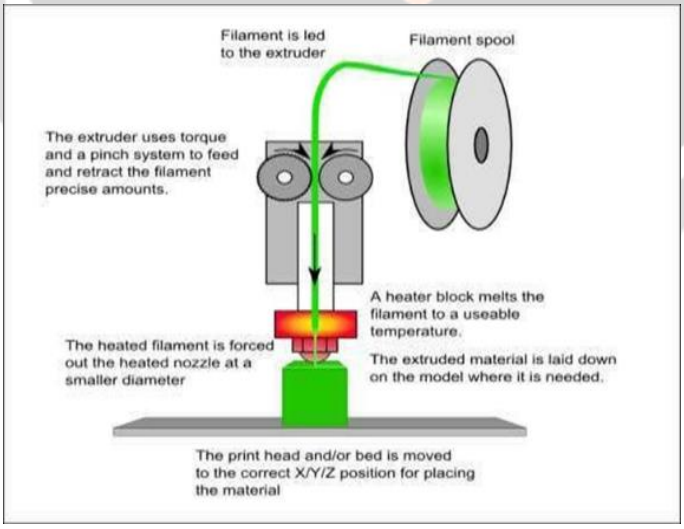

Fig -1: Fused Deposition Modelling (FDM) Process

2.1 WORKING PROCESS

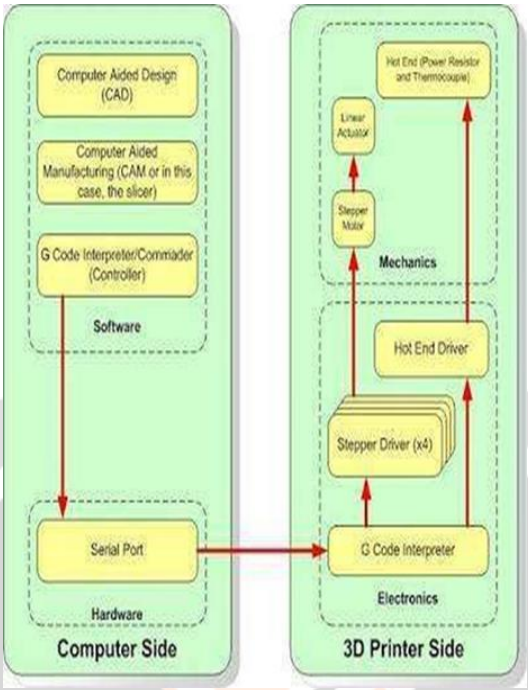

Fig. 2: Steps in 3D Printing

i. Computer Aided Design

In this procedure, a CAD file is created with a 3D modeling program, either from scratch or with a 3D model created with a 3D scanner.
The program develops a file that is sent to a 3D printer while the software cuts the design with the hundreds or thousands of horizontal layers. These layers are printed on top of each other until the 3D object
is complete. Many programs are used to design 3D objects such as solid works, AutoCAD and with a steep learning curve, many other programs, many free and easy to learn. For example, the free version of Goggle

Draft is very popular. is an easy-to-use and free mixer program popular for its advanced features**.**

ii. Motoring

A 3D printer requires a low-torque, high-precision motor. The best motor for this function is a stepper motor, which is an electromagnetic device that converts digital pulses into mechanical rotation of a shaft. the advantages of stepper motors are low cost, high reliability, high torque at low speed and simplicity, they are a special type of synchronous motor designed to rotate a certain number of degrees for each electrical pulse received from the control device, the degree of traction. can move the printer with gears with a certain movement, 3D -the printer needed four stepper motors to perform a certain function, three of which were used to move the print head in the X,Y,Z direction, the fourth. was to move the bed.

iii. Processing

The AM335x microprocessors added imaging, graphics processing and industrial interface capabilities. The device supports the following advanced operating system The AM335x microprocessor contains these subsystems.

1) Microprocessor Unit (MPO).

2) Graphics accelerator subsystem to accelerate 3D graphics to support the display.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 , MOSFET

has the fast frequency operations so MOSFET was used.

2.2 Selection of Mechanism

Currently, mechanisms such as SCARA, Cartesian, Delta, polar etc. are used to build FDM 3D printers. We chose a Cartesian development layout where the base moves vertically, ie. in the Z-joint bearing, and the extruder nose horizontally, i.e. in both the X and Y polar traces. Developing a Z-hub on a 3D printer like this is very precise and requires a low ramp speed, but requires a light bed to maintain accuracy, making it difficult to add a planar frame to a fully automatic platform. Using such a linear Cartesian frame is mechanically simple and also generally simple from a manufacturing perspective, which is why most 3D printers available today use this design. The Cartesian coordinate system has a long history of use in tools such as plotters, CNC milling machines and 2D printers..

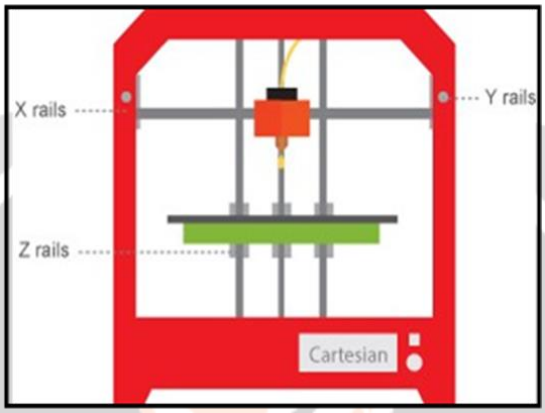

Fig 3: Cartesian Type Mechanism

3. ELECTRONICS

3.1 Controller

The controller acts as the central intelligence of our 3D printer. Almost all 3D printer drivers are based on the Arduino microcontroller. Although there are many variations. they are interchangeable and basically all do the same thing. Sometimes the controller is a single circuit load with chips, in some cases the controller is an Arduino Mega with an extra board called a "shield.

3.2 Stepper Motors

A stepper motor (or stepping motor) is a brushless direct current electric motor that divides a full joint into several corresponding steps. The position of the motor can then be controlled to move and hold one of these tools without a critical sensor if the motor is designed for a specific application. The stepper motor moves the known pause with every viable stroke. This energy pulse is provided by the step driver and is provided as a stage. Since each move moves a segment known to the engine, this makes them useful widgets for repeatable layout. We use a stepper motor to move bed carriages and various sets individually along the X-axis, Y-axis and Z-axis..

3.3 Endstops

Mechanical switches are easier to implement and less expensive than optical limit switches because they do not require a circuit and only use 2 wires to connect the switch. Pull up and pull down resistors can be placed near the motherboard. Contactless magnetic switches are called read switches. These are proximity switches that close (or tilt) when a magnet gets close enough (usually 1 mm or less) and open when the magnet moves away. Reed switches are used as sensors in home alarm systems to detect open windows and doors.

3.4 Heated Bed

The HBP heated build platform improves the print quality of the 3D model by helping to prevent warping. Extruded plastic shrinks slightly as it cools. If this shrinkage does not occur evenly throughout the printed part, the result is a warped part. This deformation is very often seen as a lifting of the corners of the construction platform. Printing on a heated substrate allows the part being printed to stay warm during printing and allows the plastic to contract even more as it cools below the softening point. The thermal layer creates a better overall quality that works with things like ABS and PLA. HBP allows customers to print without ferries.

3.5 Stepper Drives

A stepper driver is a motor that acts as a kind of intermediate between the stepper motor and the controller. It harmonizes the signals that should be sent to the stepper motor with the ultimate goal of making it move. Here and there, the stepper drivers are on independent circuits connected to the controller via links. Sometimes stepper controllers are located on small printed circuit boards that connect directly to the controller. In this situation, the controller has room for at least 4 small circuits (one for each stepper motor). Finally, step controllers are sometimes connected directly to the controller

4.0 Software

4.1 CAD Tools

Computer-aided design is used to design 3D parts for printing. Computer Aided Design (CAD) uses computer systems to facilitate the analysis or optimization of design changes. The purpose of computer-aided design software is to increase the efficiency of the creator, improve the nature of the configuration, improve the exchange through documentation and build a database for production.

In their truest form, CAD files are designed to allow easy modification and manipulation of parts based on parameters. CAD files are sometimes called parameter files. Components are represented as a tree of Boolean operations performed on primitive shapes such as cubes, spheres, cylinders, pyramids.

4.2 CAM Tools

Computer Aided Manufacturing (CAM) tools play a critical role in converting CAD files to a machine-friendly format used in 3D printer electronics. In this process, we use software that integrates object cutting, G and M code generation, object placement and other printers. Typically, CAM software requires an STL file to convert a 3D part into a machined shape. The machine-friendly format used for printing is known as G-code.

4.3 Firmware

3D Printer electronics are manipulated by a affordable CPU such as the Atmel AVR processor. Atmel processors are what Arduino-based microcontrollers use. These processors are exceptionally weak contrasted with even the normal 10 to 15-year-old PC you find in the landfill these days. However, these are CPUs so they do run basic software. This basic software they run is the firmware. The entire software chain that makes the 3D Printer work, the firmware portion of it is the nearest you get to actual programming. In fact, the term for what you are doing with firmware is called cross assembling.

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5.1 Objectives of our present work

The objectives of our present work is are as follows:

• Print complex and intricate parts

• Build large volumes with high precision

• Solve substrate alignment issues

5.2 COOLING FAN:

The fan cools the freshly pressed plastic as soon as it comes out of the nozzle. They either push cold air over hot parts or draw hot air from enclosed spaces. Either way, they create a cooling effect. Most hot components have heat sinks that are usually that small. occur during normal printing.

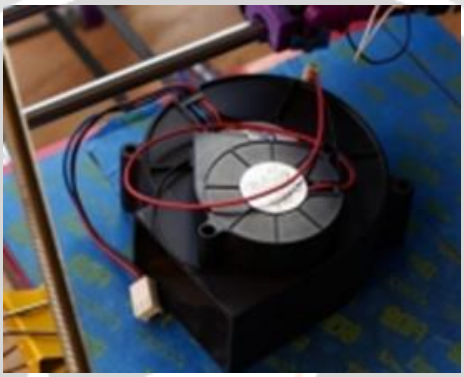


Fig -2: Cooling Fan

5.3 EXTRUDER:

Extrusion is a method of manufacturing objects with a fixed cross-sectional profile in which material is pushed or pulled through a mold with a desired cross-sectional profile. Extrude the molten plastic fiber which is the cold end and force the raw materials to the hot end. The feed filament then passes through the hot end of the extruder with the heater and out of the nozzle at a moderate speed.

Fig 3.2:-extruder

5.4 NOZZLE

A nozzle is a mechanical component or material from which the 3D printer object presses the filament. It directs the heat energy produced by the heating cartridge and block to the filament, melting it at the bottom. It is based on the properties of the material, and it is clear that there are three main types of nozzle design according to nozzle size, material and material inner diameter. The larger the nozzle, the greater the mass and surface area available to transfer heat to the filaments, making the process more efficient and capable of higher extrusion speeds. In this summary, all we know is that three cigarette characteristics can greatly affect the time it takes to print your model of a part or model, and whether or not the quality of the final object will be good..

Fig 5:- Nozzle

5.5 PITOT TUBE:

A pitot tube is used to control the supply of filament from the extruder to the nozzles. In terms of good surface quality and better strength, it is important to feed the right amount of material, this is done with a pitot tube.

Fig. 6:-Pitot Tube

- **Specification of printer**

1. Materials : PLA, ABS, ASA, HIPS, PETG, Nylon, Nylon-CF,PC these are the materials
2. Filament Sensor :Yes
3. Nozzles :0.25 mm, 0.4 mm, 0.6 mm in the High Temperature varient
4. Nozzle Technology :Fused Deposition Modeling (FDM)
5. Print Head :Direct Drive Extruder with Swap able Nozzles
6. Build Volume : 200mm x 200mm x 200mm ,800cc
7. Filament Diameter :1.75mm
8. Layer Resolutions :0.24 mm of Nozzle : 20- 150 micron 0.4 mm of Nozzle : 100 - 300 micron
9. 0.6 mm Nozzle8
10. XYZ position Resolution :X Y : 6.26 micronZ : 1 micron is there.
11. Build Speed :55 mm^3/min up to 971 mm^3/min with 0.6mm Nozzle
12. Build Plate Temperature : 130ºC

13. Build Plate Leveling : Active nozzles-tip to proper based leveling to 3d printng
14. Supported Temperature :Upto 290ºC
15. Power Rating :750 W
16. Connectivity :SD Card, USB to PC

6.1. Calculations

Design procedure:

- Maximum Printing Volume
- Length: 200mm , Width: 200mm , Height: 200mm are the length
- Volume =200*200*200 = 8000000 mm2
- Max. weight of printed object
- Weight = density * volume
- $=1250 * 5.72 * 10^{-3}$
- $=7.29$ kg $= 72.9\ \sigma \approx 73\ \sigma$

Design of heat Bed

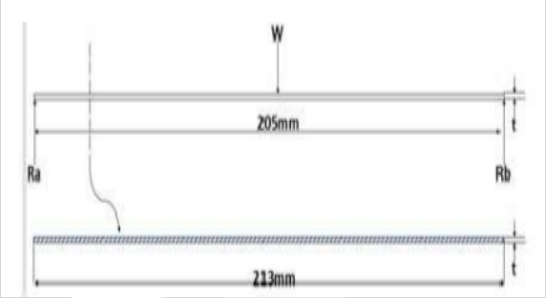


Fig. 3.5 Heat bed

$W = 73\ N$

$MA = MB = 73 * (205/2) = 7380\ N - mm$

By flexural formula:

Design and fabrication of 3D (FDM) Printer

$M/I = [\imath b]/y\ (1)$

For Aluminium 6065 : $\sigma u = 310MPa\ \sigma y = 276MPa\ \rho = 2700Kg/m^3\ \sigma b = 0.72MPa\ \sigma y =$

$98.72MPa\ Taking\ FOS = 3$

$[\sigma b] = 66.24MPa$

$[\zeta s] = 46MPa$

$7380/(bt3/12) = 66.24/(t/2)$

$b = 213\ mm$

$(7380 * 12)/213 = t2 * 2 * 66.24\ t = 1.77mm$ *we have available thickness of* 3mm.

6.2. Calculation of motor torque (for Z- axis)

Reaction force in L– section = 73 N

Taking lead screw of diameter 8 mm

$\& Dm = 7.183, P = 1.5$

$\Phi = tan\ -1\ (p * 4/\pi Dm)$

$= tan - 1\ (2/\pi * 7.183) = 5.1^0$

$\Phi = tan - 1\ \mu = tan - 1(0.25) = 14.03^0$

$Torque\ required\ to\ raise\ the\ load\ Traise = (FDm\ /\ 2)\ tan\ (d + \text{ij})$

$= [(73 * 7.183)\ /\ 2] * tan\ (5.1 + 14.03)$

$= 90.94\ N/mm$

$= 0.09094\ Nm$

$= 0.9094\ kg.cm$

There are some extra load that acting on the motors due to the machining error or misalignment by

Considering all these aspects we are selecting NEMA–17 motor with holding torque of 4.7 kg-cm

Design of chrome platted hardened shaft (for Z-axis)

$\sigma y = 700MPa$

$FOS = 2$

$[\sigma t] = 0.72,$

$[\sigma t] = 252MPa$

$M/I = \imath b/y$

$= (11716.5/2)/(\pi/64) * d4 = 252/(d/2)$

$d3 = 236.79$

$d = 6.186\ mm \approx 8mm$

6.3 Design for Belt and Pulley

As per applications of GT2 pulleys and belt are the suitable for application.

Specification:

Number of teeth=20

Pitch=2mm

Pulley Material: aluminium

Belt Material: Composite of Polyurethane and Rubber

6.4 Design of aluminum t slot section for frame

Aluminium 6065

σyt = 380MPa

N= 2

[σyt] = 190MPa

[σb] =0.72

[σyt] =136.8MPa

Checking of bending strength

M/I = δb/y

BMmax = (11716.5/2) + 5 * 200 +(11716.5/2)

= 2.5 * 400

RHA=RHV= 2.5N

BMMAX=13716.5 N-mm

y= 10mm I=6227.25mm4

13716.5/6227.25 = σb/10

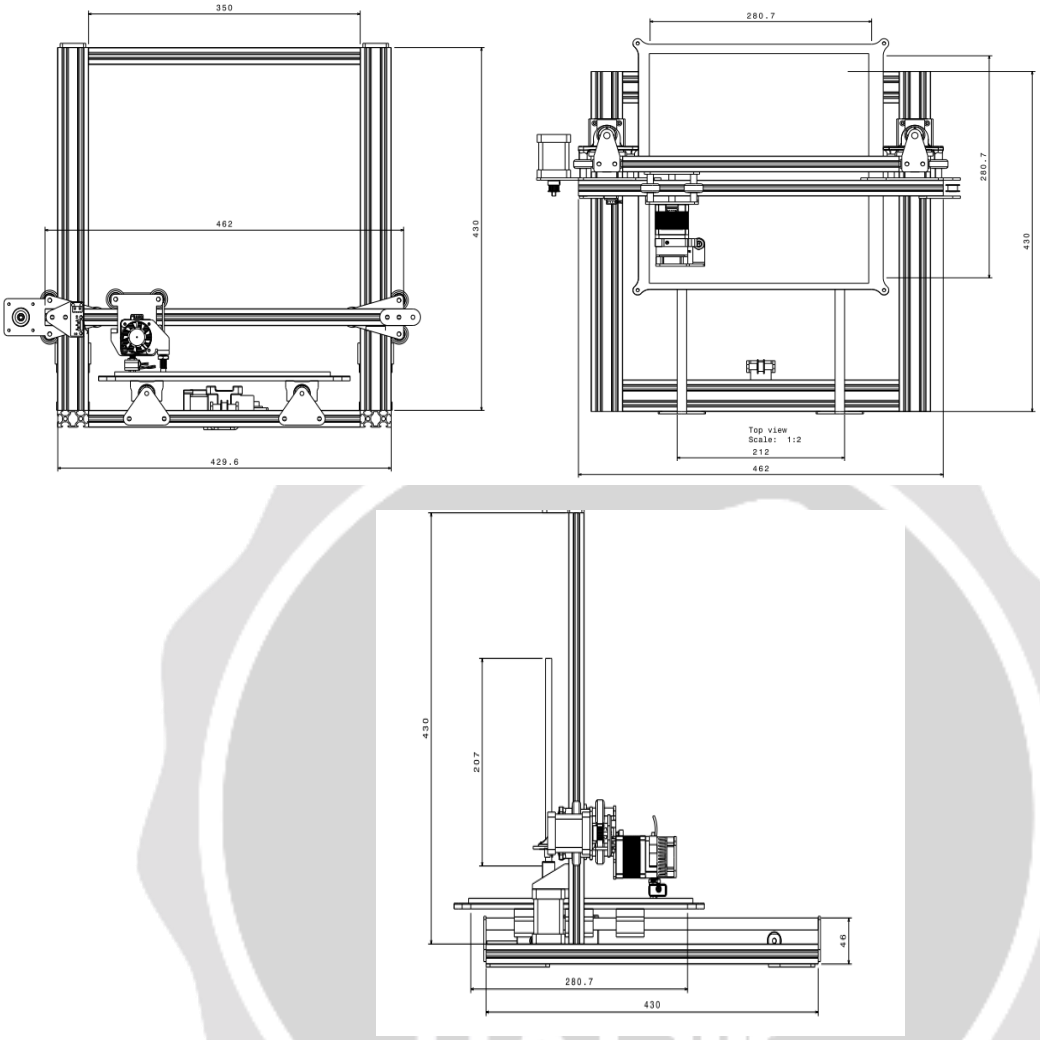
σb = 22.02Mυa < [σb]

There are two types of 3D Solid Modelling

Parametric modeling allows the user to use what is called design intent. The created object and property are modified. Any future changes can be made by changing the way the original models were created. If the function was intended to be placed in the center of the model, the user should place it in the center of the model. The function can be placed using any geometric part already available in the market, but this random placement would defeat the purpose of the design. When the operator designs the part as it works, the parametric model can make changes to the model while maintaining the geometric and functional relationships between them.

Direct, or explicit, is a modeling that offers the possibility to change the geometry without the history tree. In direct modeling, when sketches were used to design or create the geometry, the sketch is added to the new geometry and the designer's job is simply to edit the geometry without the original sketch. In addition to parametric modeling, direct modeling has the ability to include relationships between selected geometries. The top of the range offers the opportunity to add more organic, aesthetic and ergonomic features to the design. Freeform surface models are often combined with solid materials to allow designers to create products that fit the human form and visual requirements

and are machined at regular intervals.



7. ADVANTAGES

1) High part strength: Using ABS plastic as a material, the FDM process can produce fully functional parts or models with a strength of 89% of the actual injection molded part.

2) Temperature stability: The FDM process produces parts that are. stable at high temperatures in the region.

3) Easy support removal: In the FDM process, supports can easily break or separate during post-processing and removal.

4) Minimal waste: In the FDM process, the parts or model are built. by extrusion The process uses only as much material as is needed to build the model in the extrusion process, so the waste of material is minimal.

5) Safe operation: These FDM processes do not use a laser, this is the reason for safe operations .

6) Building large models or parts: FDM process can build a large part easily, but compared to other rapid prototyping processes.

8. LIMITATIONS

1) Limited accuracy of models: The material used in the FDM process is in the form of a filament.
2) Slow construction process: The speed of the FDM process is limited by the extrusion speed of the material from the nozzle.
3) Weak shear stress of the parts: The parts made by the FDM process are weak to the constructed axis, i.e. the shear force relative to.
4) Possibility of shrinkage and distortion: Extruded material cools quickly during setting, so there is a risk. of shrinkage. and partial distortions.

9. CONCLUSIONS

The outcome of this project was to build a portable 3D Printer which has been successfully completed. The design of that frame is made of robust and compact using aluminum sections on that. The material selection of the various elements is economical. Using a single motor for vertical movement along with a proximity sensor makes bed levelling easy and the bed movement is monitored with resolution in microns. The drawback is that in few of the 3D Printer which is uses for bed movement in

Y axis has distortion of the printed held by layer at high rates of printings. To overcome this drawback, a new mechanism has been develop which is uses to move the bed movement in Z. The control of the mechanism becomes so simple because of less number of motor and good synchronization can be done by using this new 3D printer technique in now a dayes. Conclusion is that the 3 d printing is specially used in the industries there fore the 3 d printing is used in the more industries for the next few months.

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