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Innovative and Modern 3D Printer Design Approach using Additive Manufacturing Techniques

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Abstract— *3D printing is called as additive manufacturing technology where a three dimensional object is created by laying down successive layers of material. It is also known as rapid prototyping, is a mechanized method whereby 3D objects are quickly made on a reasonably sized machine connected to a computer containing blueprints for the object. It is working under the principle of Fused Deposition Modelling (FDM). The 3D printing concept of custom manufacturing is exciting to nearly everyone. The basic principles include materials cartridges, flexibility of output, and translation of code into a visible pattern.3D Printers are the machines that produce physical 3D models from digital data by printing layer by layer. It can make physical models of objects either designed with a CAD program or scanned with a 3D Scanner. Here we are going to propose a model report on design and fabrication of a 3D printer.*

Keywords— *3D Printer, Additive Manufacturing, FDM, 3D Scanner.*

I. INTRODUCTION OF ADDITIVE MANUFACTURING

3D printing or additive manufacturing is a process of making three dimensional solid objects from a digital file. The creation of a 3D printed object is achieved using additive processes.

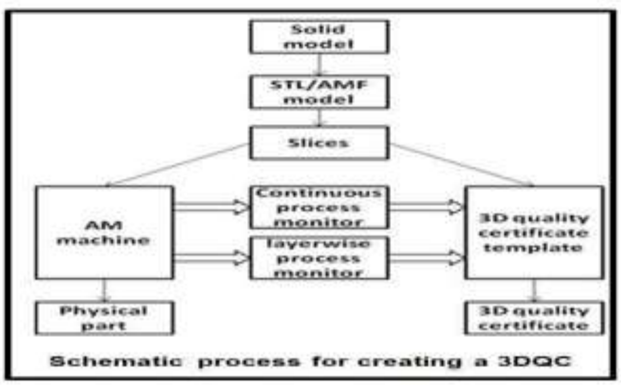

Figure 1 Additive Manufacturing

In an additive process an object is created by laying down successive layers of material until the entire object is created. Each of these layers can be seen as a thinly sliced horizontal cross-section of the eventual object.It all starts with making a virtual design of the object you want to create. This virtual design is made in a CAD (Computer Aided Design) file using a 3D modelling program (for the creation of a totally new object) or with the use of a 3D scanner (to copy an existing object). A 3D scanner makes a 3D digital copy of an object.Fused deposition modelling (FDM), also known as the material extrusion additive manufacturing technique, utilizes polymers as the raw material (filament). The filament is usually heated to a molten state and then extruded through the nozzle of the machine (3D printer).

Table 1 Different between Subtractive and Additive manufacturing:

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SUBTRACTIVE MANUFACTURING	ADDITIVE MANUFACTURING
It is also called as machining process	It is also called as 3D printing
Take a block of material and carve it out	Take a block of material and melt it out
Generate 3D model	Generate 3D model
Generate CNC program	Software slices the 3D model into thin slices
Machine away unwanted material	Machine builds it layer by layer
If possible, recycle waste	No waste produce
Uncovering a form	Creating a form
Less efficient	More Efficient
Take more time	Take less time
Replacement for manual machining process	Replacement for casting process
Example: CNC Machines	Example: 3D printers
Fig. Shows about this 	Fig. Shows about this 

To prepare a digital file for printing, the 3D modeling software "slices" the final model into hundreds or thousands of horizontal layers. When the sliced file is uploaded in a 3D printer, the object can be created layer by layer. The 3D printer reads every slice (or 2D image) and creates the object, blending each layer with hardly any visible sign of the layers, with as a result the three dimensional object.

Additive manufacturing is the official industry standard term (ASTM F2792) for all applications of the technology. It is defined as the process of joining materials to make objects from 3D model data, usually layer upon layer, as opposed to

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subtractive manufacturing methodologies. Synonyms are additive fabrication, additive processes, additive techniques, additive layer manufacturing, layer manufacturing, and freeform fabrication.

The primary applications of additive fabrication are design/modeling, fit and function prototyping, and direct part production.

Types of Additive Manufacturing

- Extrusion
- Light polymerised
- Powder bed
- Laminated
- Wire

Extrusion:

There are two types of principles used in extrusion type additive manufacturing. They are

- Fused Deposition Modelling (FDM)
- Robo casting or Direct Ink Writing (DIW)

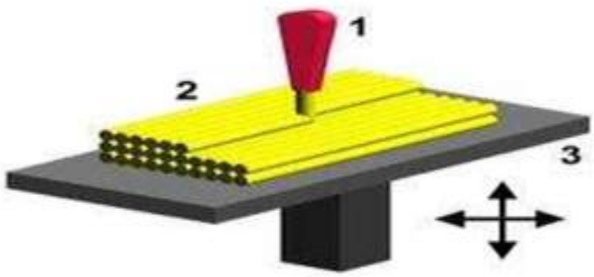


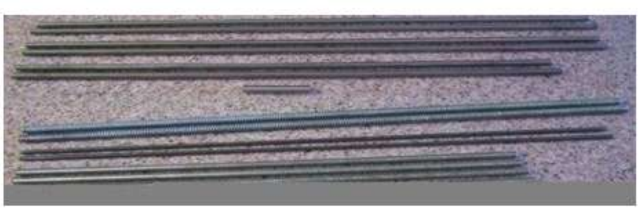
Figure 1 Fused deposition Modelling

II. Fused Deposition Modelling

Fused deposition modelling (FDM) was developed by S. Scott Crump in the late 1980's and was commercialized in 1990 by Stratasys. In fused deposition modelling the model or part is produced by extruding small beads of material which harden immediately to form layers.

Material Specifications:

- Plastic Parts – 26
- Shafts- 14Nos - AISI 430 grade rod
- Shaft type- Threaded and smooth
- Frame- 12mm - plywood
- Printing Size- 200mm x 200mm x 270mm
- Motor- 5 x Nema 17 - stepper motor
- Frame manufacturing- Basic wood tools
- Bill of Materials- 193 Nuts, Screws and Washers
- Bearings- 10 linear and 4 Ball bearing



Rapid Prototype Parts:

Part Name	Quantity	Design
Z-Axis Top	1	
Z-Axis Bottom	1	
Y- Axis Motor mount	1	
Y-Axis Idler	1	
Y- Axis Corner	4	
Y- Axis Belt holder	1	
is End MotorHolder	1	
X- Axis End Idler	1	
X- Axis Carriage	1	
Belt Guide	1	

Stepper Motor Design Specification:

- Nema 17 – 200 steps per revolution, 1.8 degrees
- Coil #1: Red & Yellow wire pair.
- Coil #2 Green & Brown/Gray wire pair.
- Bipolar stepper requires 2 full H-bridges!
- 4-wire, 12 inch leads
- 42mm/1.65"square body
- 31mm/1.22" square mounting holes, 3mm metric screws (M3)
- 5mm diameter drive shaft, 24mm long, with a machined flat
- 12V rated voltage (you can drive it at a lower voltage, but the torque will drop) at 350mA max current
- 28 oz*in, 20 N*cm, 2 Kg*cm holding torque per phase
- 35 ohms per winding

III. Machine Design - various Assembly view

Individual components and parts of this model are designed and each of them is assembled according to the axis.

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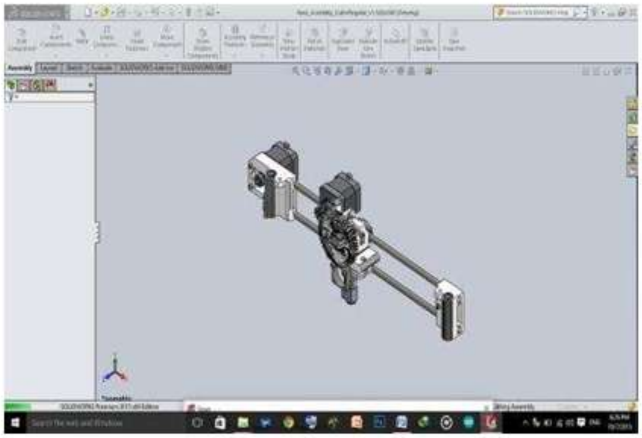

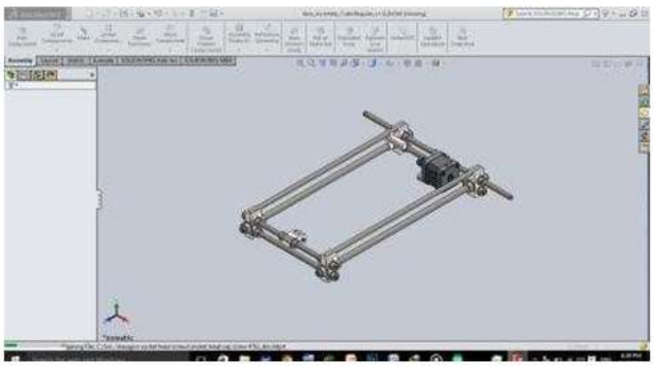

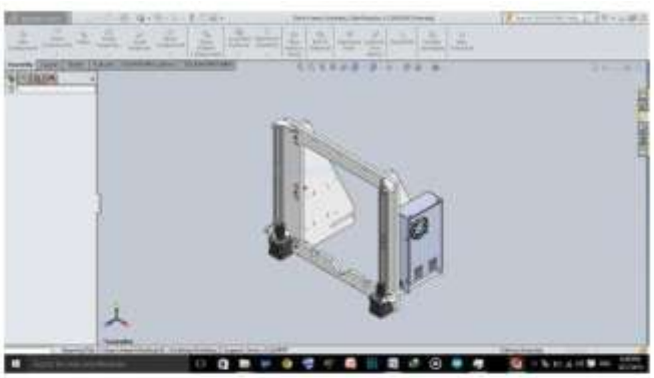

IV. WORKING MODEL - FINAL DESIGN 3D VIEW

All components and axis are assembled together. Finally the model is designed with required dimension.

Left Side View

Right Side View

Front View

Back View

V.WORKING PROCESS

Fused deposition modeling (FDM) is an additive manufacturing technology commonly used for modeling, prototyping, and production applications. It is one of the techniques used for 3D printing.FDM works on an "additive" principle by laying down material in layers; a plastic filament or metal wire is unwound from a coil and supplies material to produce a part.FDM begins with a software process which processes an STL file (stereo lithography file format), mathematically slicing and orienting the model for the build process. If required, support structures may be generated. The machine may dispense multiple materials to achieve different goals: For example, one may use one material to build up the model and use another as a soluble support structure, or one could use multiple colors of the same type of thermoplastic on the same model.

The model or part is produced by extruding small flattened strings of molten material to form layers as the material hardens immediately after extrusion from the nozzle. A plastic filament or metal wire is unwound from a coil and supplies material to an extrusion nozzle which can turn the flow on and off. There is typically a worm- drive that pushes the filament into the nozzle at a controlled rate.The nozzle is heated to melt the material. The thermoplastics are heated past their glass transition temperature and are then deposited by an extrusion head.

The nozzle can be moved in both horizontal and vertical directions by a numerically controlled mechanism. The nozzle follows a tool-path controlled by a computer-aided manufacturing (CAM) software package, and the part is built from the bottom up, one layer at a time. Stepper motors or servo motors are typically employed to move the extrusion head. The mechanism used is often an X-Y-Z rectilinear design, although other mechanical designs such as deltabot have been employed.Although as a printing technology FDM is very flexible, and it is capable of dealing with small overhangs by the support from lower layers, FDM generally has some restrictions on the slope of the overhang, and cannot produce unsupported stalactites.

Myriad materials are available, such as Acrylonitrile Butadiene Styrene ABS, Polylactic acid PLA, Polycarbonate PC, Polyamide PA, Polystyrene PS, lignin, rubber, among many others, with different trade-offs between strength and temperature properties. Recently a German company demonstrated for the first time the technical possibility of processing granular PEEK into filament form and 3D printing parts from the filament material using FDM-technology.

VI. CONCLUSION

It is generally accepted that 3D printing will be a revolutionary force in manufacturing, whether positive or negative. Despite concerns over counterfeiting, many companies are already using the technology to repeatably produce intricate components, for example in automotive and aerospace manufacturing. As 3D printers become more affordable, they will inevitably be used for local, small scale manufacturing, largely eliminating supply chains for many types of product. Consumer units for home use will even become feasible, allowing end users to simply download a design for the product they require and print it out. There will be major challenges for the conventional manufacturing industry to adapt to these changes. The opportunities for technology and engineering are clearly huge, however, and the creative possibilities in product design and printing material formulation are nearly endless.

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