Design and Development of FDM Based Portable 3D Printer

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Abstract— **Additive manufacturing process or 3d printing process is now becoming more popular because of its advantages over conventional processes. A 3d printer is a machine that create objects out of plastic, nylon like many other materials.3D printers now days available are not so portable and also they are very costly. By analyzing this problem, we are trying to make a portable 3D printer which we can take anywhere easily because of it's briefcase like design. The cost of this printer will be very less compared to other 3D printers. In this printer we are also providing more interfacing options like we can control it through computer or we can send G-codes directly from SD card.**

Keywords—FDM,G-Code,STL File

I. INTRODUCTION

3D printing or additive manufacturing (AM) is any of various processes for making a three-dimensional object of almost any shape from a 3D model or other electronic data source primarily through additive processes in which successive layers of material are laid down under computer control. A 3D printer is a type of industrial robot.

Early AM equipment and materials were developed in the 1980s. In 1984, Chuck Hull of 3D Systems Corporation invented a process known as stereo lithography employing UV lasers to cure photopolymers. Hull also developed the STL file format widely accepted by 3D printing software, as well as the digital slicing and infill strategies common to many processes today. Also during the 1980s, the metal sintering forms of AM were being developed (such as selective laser sintering and direct metal laser sintering), although they were not yet called

3D printing or AM at the time. In 1990, the plastic extrusion technology most widely associated with the term "3D printing" was commercialized by Stratasys under the name fused deposition modelling (FDM). In 1995, Z Corporation Commercialized an MIT-developed additive process under the trademark 3D printing (3DP), referring at that time to a Proprietary process inkjet deposition of liquid binder on powder.

A. 3d-Printer:

3D-Printer is a machine reminiscent of the Star Trek Replicator, something magical that can create objects out of thin air. It can "print" in plastic, metal, nylon, and over a hundred other materials. It can be used for making nonsensical little models like the over- printed Yoda, yet it can also print manufacturing prototypes, end user products, quasi-legal guns, aircraft engine parts and even human organs using a person's own cells.

3D printers use a variety of very different types of additive manufacturing technologies, but they all share one core thing in common: they create a three dimensional object by building it layer by successive layer, until the entire object is complete. It's much like printing in two dimensions on a sheet of paper, but with an added third dimension: UP.

Each of these printed layers is a thinly-sliced, horizontal cross-section of the eventual object. Imagine a multi-layer cake, with the baker laying down each layer one at a time until the entire cake is formed. 3D printing is somewhat similar, but just a bit more precise than 3D baking.

In the 3D world, a 3D printer also needs to have instructions for what to print. It needs a file as well. The file, a Computer Aided Design (CAD) file is created with the use of a 3D modelling program, either from scratch or beginning

with a 3D model created by a 3D scanner. Either way, the program creates a file that is sent to the 3D printer. Along the way, software slices the design into hundreds, or more likely thousands, of horizontal layers. These layers will be printed one atop the other until the 3D object is done.

Fig.1.Typical 3D printer

B. Architecture & Structure:
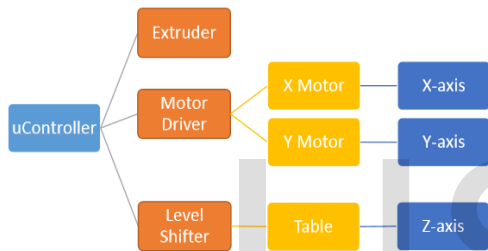
Fig.2. Flow Diagram of Control

The extruder is the most important part of a 3D-Printer. As the extruders in the normal paper printers, this extruder is also used to pour ink for printing. The movement of extruder in various dimensions create the 3D print. For printing a 3d object, the extruder has to access X, Y and Z coordinates. For achieving this, many techniques are used according to the printer specification required for various applications.

If the 3D-Printer is a desktop printer, the Z axis movement of the extruder can be avoided and that function can be transferred to the print table. This will avoid complexity in 3D printing as well as time consumption.

When the STL file is input to the printer, the microcontroller extracts each layer from it and also extracts each line segment from each layer. Then it gives controls to the movement of the extruder at required rate. The X-direction movement of extruder is made possible by the X-motor. When the X motor rotates, the shaft also rotates and the extruder moves in X direction. The Y-direction movement of extruder is made possible by the Y-motor. When the Y motor rotates, the shaft also rotates and the extruder moves in Y direction. The X direction movement is made by the print table.

Consider printing larger objects like house using 3D printer. There will not be any X motor or Y motor in that case.

An extruder which can pour concrete mix is fixed on the tip of a crane. The crane is programmed for the movement of extruder in X, Y and Z axis. The concept and structure of 3d printer changes according to the type, size, accuracy and material of the object that has to be printed.
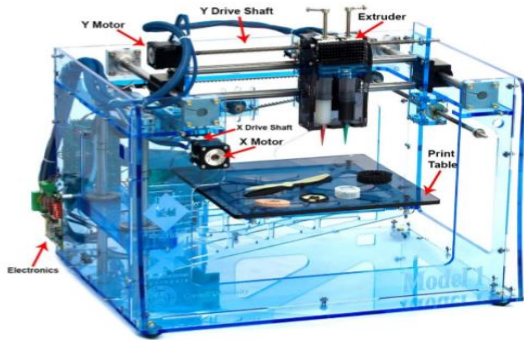
C. Extrusion Deposition

In extrusion deposition, Fused Deposition technique is used. Fused Deposition Modelling (FDM) was developed by Stratasys in Eden Prairie, Minnesota. In this process, a plastic or wax material is extruded through a nozzle that traces the part's cross sectional geometry layer by layer. The build material is usually supplied in filament form, but some setups utilize plastic pellets fed from a hopper instead. The nozzle contains resistive heaters that keep the plastic at a temperature just above its melting point so that it flows easily through the nozzle and forms the layer. The plastic hardens immediately after flowing from the nozzle and bonds to the layer below. Once a layer is built, the platform lowers, and the extrusion nozzle deposits another layer. The layer thickness and vertical dimensional accuracy is determined by the extruder die diameter, which ranges from 0.013 to 0.005 inches. In the X-Y plane, 0.001 inch resolution is achievable. A range of materials are available including ABS, polyamide, polycarbonate, polyethylene, polypropylene, and investment casting wax.
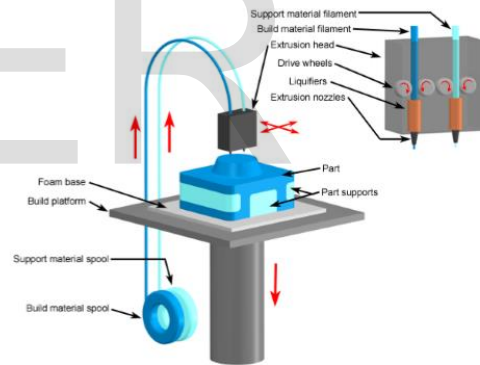

Fig.3. Fused Deposition Method

II. LITERATURE SURVEY

Devised Analysis of 25 review paper is as follows

Jee & Sachs[1],studied A visual simulation technique for careful examination of model before actual fabrication to minimize unwanted design iteration in 3D printing ,which helps to realize a manufactual design with minimum iteration by fabrication process rule for 3D printing.Barry Bermon[2], examine the characteristics and application of 3d printing and compares it with mass customization and other manufacturing process. Stephens[3],studied two different type of 3D printer on basis of Ultrafine article emission rate and conclude UFP emission rate higher for 3D printer utilizing an ABS thermoplastic feedstock relative to PLA feedstock. Leuven Belgium[4], present a software solution for data management &quality assurance in 3D printing as well as explain unique benefits & compared to traditional manufacturing process. This shows how 3d printing is maturing &attracting much attention from main media stream. Santolaria[5], Proposes volumetric error compensation technique based on pattern artefacts and for materialize the point conical sockets are used that are measured automatically by self-centering probing system.

Galantucci[6],do Analysis of dimensional performance for 3D printer based on FDM technique. which shows Proper control of process parameter improving the product quality. Belter[7], Investigate the F.C.T technique for increasing the strength of the product. which result product strength and stiffness improved by 45% . Ostrout[8], investigating the effect of printer parameter on dimensional accuracy of product and mention adequate fan speed nozzle temperature & platen temperature. Ensure the validity & accuracy of product. Rayna[9],studied the effect of each phase on the key business model component and noted that the increase the affordability of 3d printer could significantly increasing the competition. Zhu[10], For 3D shape recognition, they convert 3D shape in 2D space and uses auto encoder for feature learning on the 3D images.

Eric Goselin[11], introducing a large scale 3d printer which uses a six -degree of freedom cable suspended robot for positioning with polyurethane foam as the object material & sharing foom as the support material. That enhancing ,the system robustness & accuracy. Szkiedans[12] quantifies the basic tensile strength & elastic modulus of printed product produced with application of FDM & SLA printer, which Show a strong anisotropy of 3D printed part and posses wide scope of application. Weng[13], introduces surface of nanofilters were modified using organic modifier of (γ-mps) and (C 16 -DMAAC) characterized by FTRI and small XRD analysis that increased the curing speed of SLR while the addition of OMMT and ATP decreased the curing speed. Tian[14],shows how Temperature and pressure are critical parameters to forming process, which determines the mechanicals property of composites. Gosselin[15], Introducing a new additive manufacturing processing route is introducer for ultra -high performance concrete.so it indicate that large scale 3D printing of ultra -high performance concrete – a new processing route for architects & builder.

Weng[16], Introduces melt intercalation technique for preparation of ABS nanocomposites with organic modified montmorillonite(OMMT).so it increase the mechanical properties of FDM 3D printed samples more than the increase of mechanical properties for the sample prepared by injection moulding. Kumar[17], Propose the gray relation grade method for comparing two different rapid prototyping system and obtain optimum factor level of each dimensional characteristic simultaneously. Mardani[18], Develop a unique modular distillation column using 3D printer. which means Small and complex parts can be manufactured with the help of 3D printer like hearing aids human organ. Burcin[19],He investigate the 3D printed Savonius rotor performance. The static and Dynamic analysis is done experimentally via 3D printer, Junk[20],do Review of Open Source and Freeware CAD Systems for Use with 3D-Printing ,that mean specification of CAD system has been explained with particular consideration to the requirements of inexperienced users in the area of 3D printing M.

Despeisse[21],show that 3D printer can enable more sustainable modes of production and consumption by adoption of circular economy by utilising circular economy method instead of linear method . Rodriguez[22],doing Finite element analysis of the Thermal behaviour Of a RepRap 3D. Anthony[23], analyses the ability of an adversary to "weaponize" compromised additive manufacturing equipment in order to cause kinetic, nuclear, or cyber damage by using 3D printing and prove 3D printers that could produce physical impact. Miek Mitchell[24],it utilises 3D printer for successfully make functional tissue that performed the metabolic activity of livers and other organs.Yao[25], A redundant parallel six -component force with spoke structure combining parallel mechanism with flexible mechanism is proposed.

From studying all this we found a considerable gap in synopsis of Design and Development of FDM Based Portable 3d Printer.

III. METHODOLOGY

Following methodology shows how design and development of 3D printer
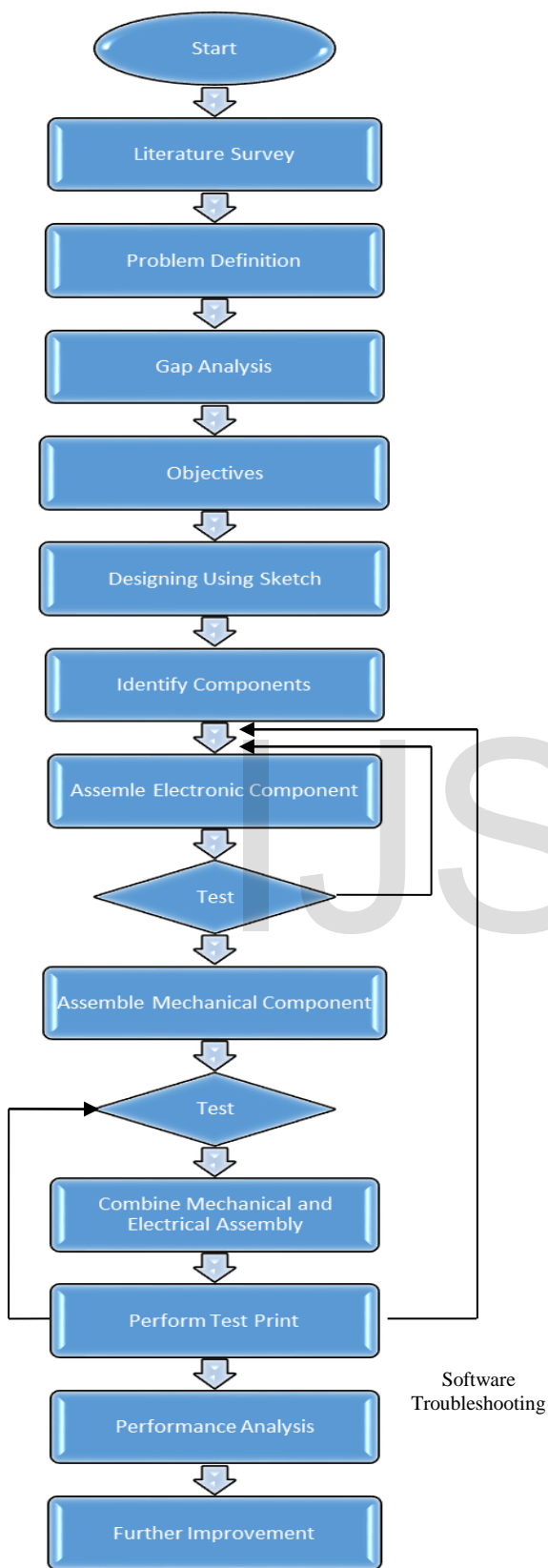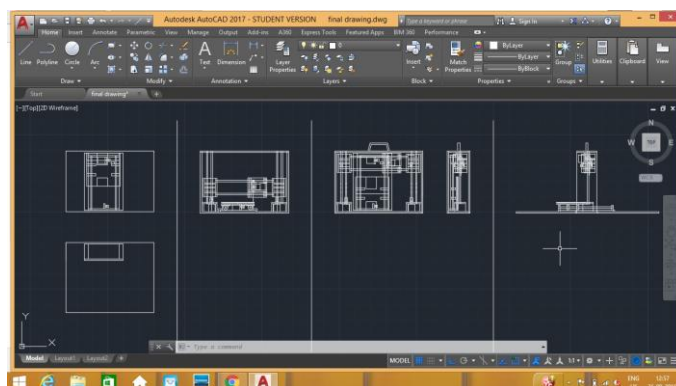
IV. DESIGN

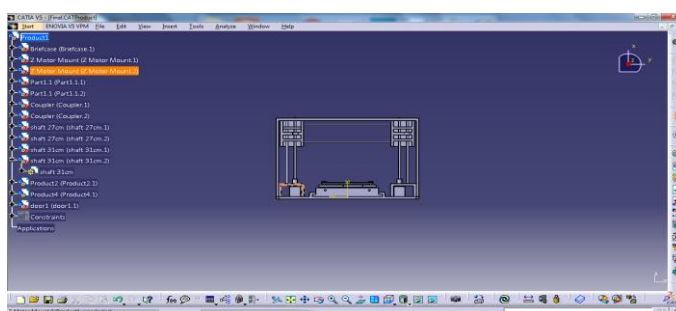*A. 2D Design*:

Fig. All Views
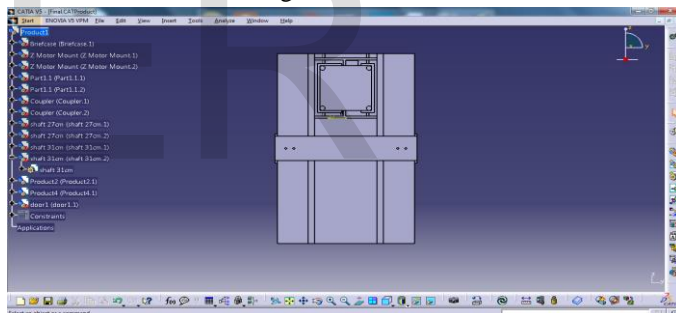
B. 3D Design

Fig. Front View

Fig. Top View

Fig. Prospective View.

Start

Literature Survey

Problem Definition

Gap Analysis

Objectives

Designing Using Sketch

Identify Components

Assemle Electronic Component

Test

Assemble Mechanical Component

Test

Combine Mechanical and Electrical Assembly

Perform Test Print

Software Troubleshooting

Performance Analysis

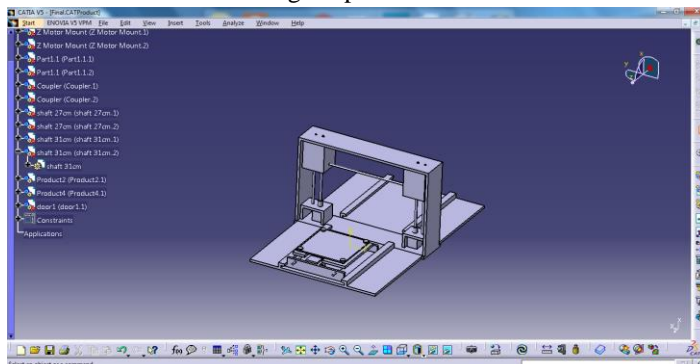Further Improvement

CONCLUSION

As by referring many references here the working of portable 3D printer not yet reported with such design in any literature till now.

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