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Additive Cum Electronic (ACE) – 3D Printer

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Abstract - *In the world of developing technologies, 3d printing has been replaced the entire manufacturing firm or system with its improved version of building parts layer by layer using additive approach and new trends. 3D printing technology is extremely versatile and rapid process, accelerate innovation and reduce energy usage, minimize material and compress supply chains. Actually, it is the process of making 3D physical objects from a 3D CAD file by successively adding materials layer by layer. The main technique used in 3D printing technology is Rapid Prototyping. It is a group of technique used to quickly fabricate of a scale model of a part or assembly using 3D CAD data. The proposed project indents to expand the application of 3D printer to a level where the machine capable of printing electronic object/material which contain both insulating part and electronic parts. This integrates both parts of an electronic object into a single unit. This project also includes the extension of Robotic arm system which is capable of drawing the circuit path and prints the model along with this path.*

Key Words: **3D printer, Additive Manufacturing, Rapid Prototyping, Robotic Arm.**

1. INTRODUCTION

3-D printing or additive manufacturing (AM) is any of various processes for making a 3-dimentional object of almost any shape from a 3-D model or other electronic data source primarily through additive processes in which successive layers of materials are laid down under computer control. A 3-D printer is a type of industrial robot. The modeling is basically of two types as parametric modeling and mesh modeling. In which fusion 360, solid works, catia, auto cad etc comes under parametric modeling and mesh mixture, blender, maya etc.

This technology has been substantially improved and has evolved into a useful tool for many fields like researchers, manufacturers, designers, engineers and scientists. Collaborating different fields in single package formed 3D printer as it includes Design, manufacturing, electronics, materials and business. The difference between traditional manufacturing and 3D printing is that the 3d printer involves additive approach but most of the traditional manufacturing processes involve subtractive approach that includes a combination of grinding, bending, forging, moulding, cutting, gluing, welding and assembling. At the beginning 3D printing was mostly seen as a tool to shape and bring it to the artistic or different designs, but in the last few years this technology is developing to a point where mechanical components and some required parts can be printed. It completely changes not only the industrial/manufacturing field, but also our entire way of life in the future as 3D printer makes possible to complete model in a single process.

For consumer level additive manufacturing, currently two main techniques to 3D print objects: Fused Deposition Modeling and Stereo lithography. Both processes add material, layer by layer, to create an object's. Stereo lithography (SLA) uses a Ultra-Violet light source to particular cure resin while Fused Deposition Modeling (FDM) extrudes semi-liquid plastic in a required layout to create objects. The fast growth of this technology has allowed great inventions and 3D printing (mainly Fused Deposition Modeling or FDM technique). This is most prominent method is Fused Deposition modeling.

The reduced cost of manufacturing, the build time, and the weight of the object, reduction of waste compared to some traditional manufacturing processes therefore making 3D printings attainable to the average consumer. 3D printer has made ripples through various industries. The industries can be mapped based on their current level of applying 3D printer, compared to the future potential shown in fig 1.

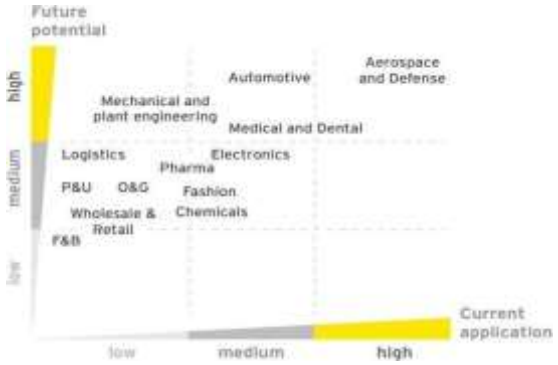

Fig-1: Current application and future potential of 3D printing by industry

Since the start of the 21st century there has been a large growth in the sales of AM machines, and their price has dropped substantially. Applications are many, including architecture, construction (AEC), industrial design, automotive, aerospace, military, engineering, dental and medical industries, biotech (human tissue replacement),

fashion, footwear, jewellery, eyewear, education, geographic information systems, food, and many other fields.

3-D printing called as desktop fabrication. It is a rapid prototyping process whereby a real object can be created from a 3D design. A 3D printer machine uses a CAD model for rapid prototyping process. 3D printing is called as desktop fabrication which is a process of prototyping where by a structure is synthesized from its 3D model. The 3D design is stored in as a STL format and after that forwarded to the 3D printer. It can use a wide range of materials such as ABS, PLA, and composites as well.3D printing is one kind of rapidly developing and cost optimized form which is used for rapid prototyping. The 3D printer prints the CAD design layer by layer forming a real object.

3D printing process is derived from inkjet desktop printers layer by layer derived from the CAD 3D data. 3D printing is diversifying and accelerating our life, letting various qualities of products to be synthesized easier and faster.

2. FDM PRINTER

Presently 3-D printing uses various technologies for its manufacturing operation. Some of the technologies used are:

- Fused deposition modelling (FDM)
- Stereolithography(SLA)
- Digital Light Processing(DLP)
- Selective Laser Sintering (SLS)
- Selective laser melting (SLM)
- Laminated object manufacturing (LOM)
- Digital Beam Melting (EBM)

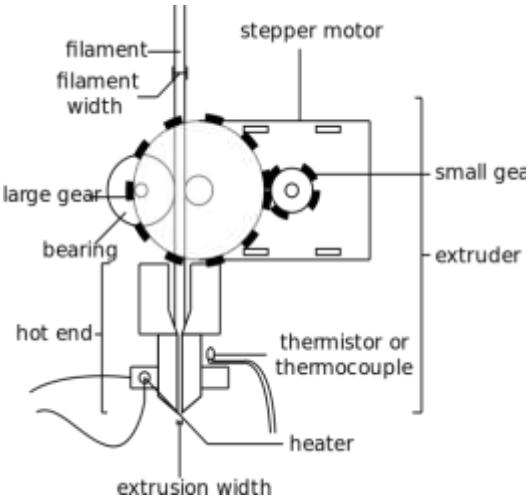

Fig-2: Methodology of FDM printer

Fusion Deposition Modeling is one of the prominently used technologies in the 3-d printing technology. This technology is more familiar with its operating advantages. In this section the various parts of FDM printer is explained. The proposed project is based on this FDM technology.

The various parts of the above mentioned figure are described below:

2.1 Nozzle

The line width of the print directly proportional to the nozzle diameter. The material comes out from the nozzle by a required amount that a printer needs to complete its printing operation.

2.2 Heating coil

It is used to heat a filament to the print temperature or the nozzle temperature. It is one of the important part of FDM printer for its stable operation.

2.3 Thermistor

The main functions of thermistor are to detect the temperature and also to maintain the nozzle temperature to a given temperature. The other function is there is a linkage between heating coil and thermistor. When temperature decreases thermistor detects and gives signals to the heating coil to increase the temperature up to required temperature.

2.4 Heat Breaker

The main function of heat breaker is to prevent the transfer of heat from the heating coil to feeder mechanism to an extent. It also prevents clogging and ensures smooth flow of material.

2.5 Feeder Mechanism

It feed or pushes material to the nozzle in the required flow rate. Flow rate directly depends on layer height that given to it. Feeder mechanism consists of two rollers and a stepper motor. One roller is powered by stepper motor and it give some grip to feeder mechanism.

2.6 Filament

Filament is usually bundled in spools, but some is also sold by the meter (ideal for test prints). Before making any purchase of filament, it is essential to know what filament diameter at which printer works with. It will be either 1,75mm or 3mm, which are the two standard sizes.

2.7 End stoppers

They prevent X, Y, Z movement of printer to particular limits. They are the other form of mechanical type of switches

used to detect the end of line and for the pointing of object in the heat bed according to the printer input.

3. ROBOTIC ARM OF PROPOSED PROJECT

A robot is a virtually intelligent agent capable of carrying out tasks robotically with the help of some supervision. Practically, a robot is basically an electromechanical machine that is guided by means of computer and electronic programming.

A robotic arm is a robotic manipulator, usually programmable, with similar functions to a human arm. For the robotic arm, it is expected to see applications of linkage and gear systems to realize at least 3 degrees of freedom in 3D dimension. Also, it is expected using of electric motors to power the robotic arm and realize rotation of the arm. Linkage systems can be used to transfer rotational motion from the electric motor into specific motions that wanted. The main advantage of a robotic arm comparing to manpower is its high endurance of long time operation, its efficiency of working and precision of each action.

This robotic arm is programmable in nature and it can be manipulated. Humans today do all the tasks involved in the manufacturing industry by them. However, a robotic arm can be used for various tasks such as welding, drilling, spraying and many more. A self sufficient robotic arm is fabricated by using components like micro controllers and motors. This increases their speed of operation and reduces the complexity.

Fig -3: Proposed Robotic Arm

Fig 3 shows the robotic arm for the proposed project. This are intended to make electrical conduction path. The proposed project has a implementation of two nozzles; with one nozzle is used in the robotic arm itself for the drawing of path for the electrical conduction. The robotic arm is worked based on the servo motors installed on it and has programmed that is uploaded on it via the arduino. The robotic arm consists of a nozzle through which the melted form of the conducting material extrudes out.

Here the diameter of the material used is basically of 1.75mm and 2.85mm. The melting temperature of the conducting material is about to be 185 to 200 degree celsius. The proper setting of thermistor helps to detect and maintain the nozzle temperature to the given temperature. The arm may be sum total of the mechanism or may be part of a more complex robot.

4. ACE 3-D PRINTER

Currently, in manufacturing sectors the mode of production for an electronic product consists of two different sections. The former sector consist essential circuits for its purpose and latter includes the insulation part, outer body or enclosure. The product made has to follow a set of standards regarding the size, shape, complexity etc. Therefore the proposed project intends to implement most advanced method of product manufacturing for an electronic device. By the introduction of this product any circuit can be printed along with the insulation part by minimizing its complexity, reducing the space, enhancing compatibility. The main feature of this machine is that it can be printed in any angle with ease and reliability. This method uses the principle of additive manufacturing with extensive use of robotics and coding.

The proposed project has similar characteristics to FDM model and the two nozzle extruder is suggested in which one for insulation or body construction and another for conductive pathway drawing for the proper conduction of the circuit obtained through the printer. The proceedings of the conductive pathway drawing through the nozzle extruder are obtained by the implementation of the robotic arm which is explained in former section. Fig 4 represents the proposed ACE 3-D printer.

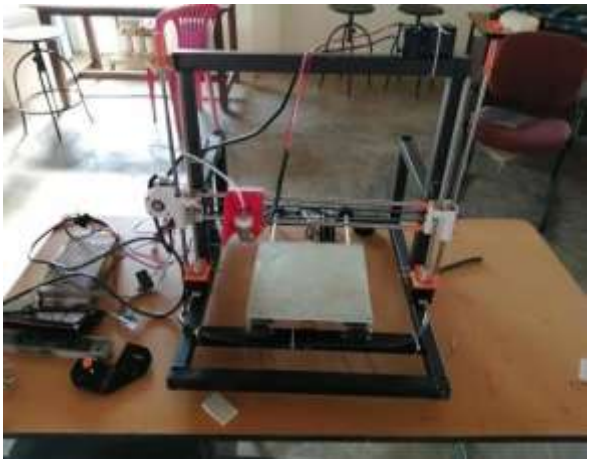

Fig -4: Proposed ACE 3-D Printer

4.1 Architecture

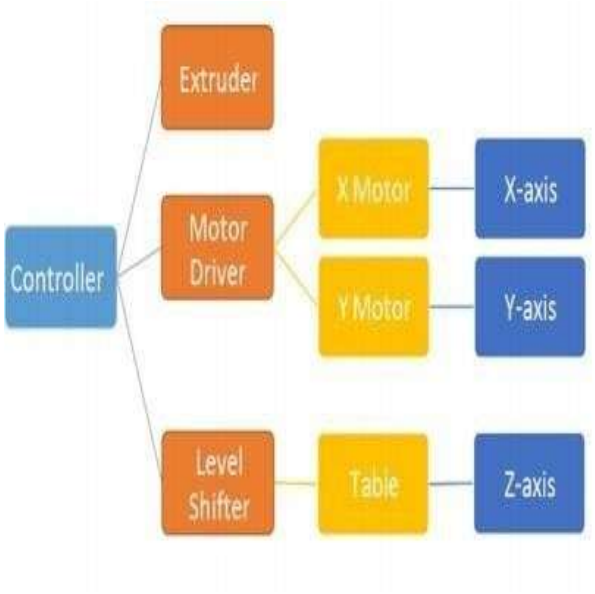

Fig- 5: Architecture of 3-D Printer

The above figure 5 shows the architecture of 3-D printer. The print table is the platform where the objects for printing have been situated. It provides the basic support for manufacturing objects layer by layer. The movement of extruder in various dimensions creates 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.

4.2 Significance of the project

By the implementation of the proposed project the following benefits can be obtained:

1. Design the electronic / electrical circuits without the use of PCB and breadboard.
2. Space constraints can be removed whereas in PCB only rectangular space can be achieved.
3. Design any complicated shape / structure.
4. If any slots needed, 3-D printer itself produces it, so no need of extra components.

4.3 Methodology

This method consists of two nozzles. The descriptions of these two nozzles are under the following:

1. One nozzle fixed within the printer for the making of the insulation part by extruding the insulating materials, mainly thermoplastic materials such as PLA, ABS, PP etc.
2. Another nozzle provided within the robotic arm for the drawing of the electrical conduction path by extruding the conductive material. This is obtained by the operation of the robotic arm installed on the 3- D printer.

The nozzle with extruding the filament is done its extruding operation with the help of stepper motor that is installed on the 3-D printer and the latter nozzle extrudes the conducting material with the help of robotic arm. The X, Y, Z movement of machine is obtained with the help of the stepper motor that is installed on these X, Y, Z axis of the printer.

5. CONCLUSIONS

The ACE 3D printer is modifying with the help of several set up. Here the proper checking of nozzle, heating coil, heat breaker, feeder mechanism, end stopper, filament etc... should be continuously checked for proper working. Here all the protective devices are placed inside a system known as print head and consist of an insulated sleeve. The manufacturing technique if focused on to the additive manufacturing so that it will lead to the less wastage from production and provide better customization with the lower fixed cost. The materials used for printing the insulating part are either PLA or ABS. Here the PLA is flexible and more eco-friendly/biodegradable, easy to print, made from corn and sugarcane starch but it Is less stable due to low strength. ABS is chemically derived so that it is harmful to the environment but stronger enough and is durable, impact resistance, thermoplastic. Here the materials mentioned above are loaded to the machine in the form of spool. The both material are non- abrasive in nature. This material is extruded with the help feeder mechanism that has stepper motor on it.

The robotic arm in the machine helps to draw the electric pathway for the circuits and heat element extrudes the melted form of conducting material to complete the circuit along with insulating part of object. The movement of arm is based on servomotor installed on the arm and controlled via arduino programming. Then the machine capable to print both insulating and conducting parts of an electronic object.

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