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Construction of 3D printer and programming it to print solid objects

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Abstract:

This is a research paper on 3D printing which has become a notable topic in today's technological discussion. In this paper, we will look at additive manufacturing or which is commonly known as 3D printing. first of all we will define what we mean by term "Additive Manufacturing" and what is so significant about it. We will delve a bit into the additive manufacturing history. We will look into the various types of additive manufacturing.Then we shall see about the process of 3D printing and the materials used in the manufacture of 3D printed objects. Finally the various process to achieve a good print quality in the current technology outlined.

Keyword: **3D printing, 3D printers, polymers, Stereolithography, Additive manufacturing, RepRap, contour craft.**

I. INTRODUCTION

3D printing is also known as desktop fabrication or additive manufacturing; it is a prototyping process whereby a real object is created from a 3D design. The digital 3D-model is saved in STL format and then sent to a 3D printer. The 3D printer then prints the design layer by layer and forms a real object . 3D printing is a fast developing and cost-effective form of rapid prototyping. 3D Printing technology based upon common inkjet desktop printers where multiple jets deposit the print material layer after layer based on the 3D CAD data. The process of "printing" a three-dimensional object layer-by-layer with equipment. 3D printing makes

it possible to make a part from scratch in just hours. It allows designers and developers to go from flat screen to exact part. 3D printing can provide great savings on assembly costs because it can print already assembled products. With 3D printing, companies can now experiment with new ideas and numerous design iterations with no extensive time or tooling expense. They can decide if product concepts are worth to allocate additional resources. 3D printing could even challenge mass production method in the future. 3D printing is going to impact so many industries, such as automotive, medical, business & industrial equipment, education, architecture, and consumer-product industries.

II. HISTORY

The inception of 3D printing can be traced back to 1976, when the inkjet printer was invented. In 1984, adaptations and advances on the inkjet concept morphed the technology from printing with ink to printing with materials. In the decades since, a variety of applications of 3D printing technology have been developed across several industries.[2] With all of its recent headlines and technological leaps, additive manufacturing can feel like a very new field. But in fact, 3-D printing has been slowly evolving in labs and in the market since Chuck Hall invented stereo lithography back in 1986 with his company, 3D Systems. In the 27 years since, additive manufacturing has evolved from Hall's original concept into a thriving, diverse collection of techniques and technologies that fall under the "3-D printing" umbrella. These include fused deposition modelling, ink jet printing and laser sintering – technologies that have brought the power of 3-d printing everywhere from the home workshop to the factory floor.[3] In September, 2011 - Vienna University of Technology developed a smaller, lighter and cheaper printing device. This smallest 3D printer weighed around 1.5 kilograms, it costs around 1200 Euros.

II. METHODS AND TECHNOLOGIES OF 3D PRINTING

Not all 3D printers use the same technology to realize their objects. There are several ways to do it and all those available as of 2012 were additive, differing mainly in the way layers are built to create the final object. Some methods are melting or softening Material to produce the layers. Selective Laser Sintering (SLS) and fused deposition modelling (FDM) are the most

common technologies using this way of printing. Another method of printing is a lay liquid materials that are cured with different technologies. The most common technology using this method id called Stereo lithography (SLA).

A. Selective laser sintering (SLS):

This technology uses a high power laser to fuse small particles of plastic, metal ceramic or glass powders into a mass that has the desired three dimensional shapes. The laser selectively fuses the powdered materials by scanning the cross-sections (or layers) generated by the 3D modelling program on the surface of a powder bed. After each cross-section is scanned, the powder bed is lowered by one layer thickness. Then a new layer of material is applied on the top and the repeated until the object is complete. All untouched powder remains as it is and becomes a support structure for the object. Therefore there is no need for any support structures which is an advantage over SLS and SLA. All unused powder can be used for the next printing.

B. ***Fused deposition moulding (FDM)***

The FDM technology works using a plastic filament or metal wire which is unwound from a coil and supplies material to an extrusion nozzle which can turn the flow on and off. The nozzle is heated to melt the material and can be moved in both horizontal and vertical directions by a numerically controlled mechanism, directly controlled by a computer –aided manufacturing (CAM) software package. The object is produced by extruding melted material to form layers as the material hardens immediately after extrusion from the nozzle.

FDM was invented by Scott Crump in the late 80's. After patenting this technology he started the company Stratasys in 1988. The software that comes with this technology automatically generates support structures required. The machine dispenses two materials, one for the model and one from a disposable support structure. The term fused deposition modelling and its abbreviation to FDM are trademarked by Stratasys Inc. The exactly equivalent term, fused filament fabrication (FFF) ,was coined by the members of the RepRap project to give a phrase that would be legally unconstrained in its use.

C. Stereolithography(SLA) :

The main technology in which photo polymerization is used to produce a solid

part from a liquid is SLA. This technology employs vat of liquid ultraviolet curable photopolymer resin and an ultraviolet laser to built the object's layers one at a time. For each layer, the laser beam traces a cross-section of the part pattern on the surface of the liquid resin. Exposure to the ultraviolet laser light cures and solidifies the pattern traced on the resin and joins it to the layer below.

After the pattern has been traced, the SLA's elevator platform descends by a distance equal to the thickness of a single layer, typically 0.05 mm to 0.15 mm (0.002" to 0.006"). Then, a resin-filled blade sweeps across the cross section of the part ,re-coating it with fresh material. On this new liquid surface, the subsequent layer pattern is traced, joining the previous layer. The complete three dimensional object is formed by this project. Stereolithography requires the uses of supporting structures which serve to attach the part the elevator platform .

IV. ISSUES WITH 3D PRINTERS

In most of the low cost 3D printer, users face many problems in printing the objects which case a print failure and poor quality of printed object, there are many ways to avoid those errors,

A. Hotbed leveling

This is first thing which need to be balanced as the print has to stay on its actual place while the print job is on process. Imperfect bed leveling can also result dimensional error. it is easy to find out whether the hotbed is leveled or not. Switch ON the printer hit the auto home command, once the nozzle is near the corner of bed then manually adjust the Z axis threaded rode so that the nozzle is slightly above the edge of the bed, then place a piece of paper between the bed and nozzle. Now try to slide the paper, Adjust the Z-Axis end stop screw also and repeat this step until a sheet of paper can barely pass between the nozzle and the bed. You should feel a slight drag on the paper, but you should be able to move the paper. make sure that all the corners of bed as adjusted using this process.

B. Hotbed sticking

This is a most common issue which most of the user face while printing .There are many reasons which affects the object is not sticking to the Hotbed. It generally happens on long time print object as the bottom layer gets cooled faster and contracts. industrial 3D printers print inside its enclosure which terminates the outside temperature and maintains a constant temperature suitable to

print without contraction of the layers. Even there are few ways by which we can avoid the issue. Need to clean the glass plate with spirit so that there is no oil residue on the glass surface. Apply masking tape or good quality of hair spray can solve the sticking issue.

C. Hotbed power supply

Hotbed is a induction based printed circuit board and which is capable of getting maximum temperature of 110 ºC. The hotbed circuit consumes too much current around 11Amp where many of controller fails to give that much current leading damage in control board. So the avoid that implementing the relay can solve the current issue. Mechanical relay can withstand much current at output side making the controller to be safe.

D. motor driver current limitation

This is a major issue where user need to be very careful about the current transferred to the stepper motors. Less current can cause less torque over the timer belt leading to missing of E-steps.too much of current can heat the motor which will directly affect motor performance. It also affects the motor driver to get heated up too much, by installing small sink on the driver can reduce the heating effect and even placing a cooling fan can also reduce the risk of damage to motor drive.

V. CONCLUSION

In this paper, we have presented and analysed the impact of 3D printing technology on the society and economy. After presenting, in the introduction, a brief history of 3D printing, in the second section we have depicted the additive technology and the materials used in rapid prototyping. In the third section, we have highlighted the main advantages and limitations of the 3D printing technology, while in the fourth section we have made a survey of the most significant existing 3D printing solutions. We have compared these 3D printing solutions, taking into account their technical specifications and prices. One can conclude that the 3-D printing technology's importance and social impact increase gradually day after day and significantly influence the human's life, the economy and modern society.

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