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3D Printing and Its Applications

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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 3D printing. We will firstly define what we mean by this term and what is so significant about it. We will delve a bit into the history. Then we shall see about the process of 3D printing and the materials used in the manufacture of 3D printed objects. We shall also see the advantages of 3D printing as compared to conventional methods of manufacturing. We shall observe the numerous applications it is being out to use today. Finally the future potential of this technology is outlined**

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

I. INTRODUCTION

3D printing, additionally referred to as additive manufacturing, may be a method of basically making a three-dimensional object from a package model. The thing may be of just about any form. The method of making these objects in largely additive. Within the additive method, an object to be written is built from the base-up by in turn adding it to layers of the development material. The additive method may be contrasted with the subtractive process, where material is removed from a block by methods such as sculpting or drilling. The main material utilized in the development of 3D objects is plastic, though recently, there has additionally been a slew of innovation toward using alternative materials like metals of various sorts and additionally organic matter like carbon and its varied derivatives.

Hideo Kodama of Nayoga Municipal Industrial Research Institute is generally regarded to have printed the first solid object from a digital design. However, the credit for the first 3D printer generally goes to Charles Hull, who in 1984 designed it while working for the company he founded, 3D Systems Corp. Charles a Hull was a pioneer of the solid imaging process known as stereolithography and the STL (stereolithographic) file format which is still the most widely used format used today in 3D printing. He is also regarded to have started commercial rapid prototyping that was concurrent with his development of 3D printing. He initially used photopolymers heated by ultraviolet light to achieve the melting and solidification effect.

II. PRINCIPLES OF 3D PRINTING

The main principle of 3D printing is *stereolithography*, outlined by Charles Hull in a 1984 patent as "a system for generating three-dimensional objects by making a cross-sectional pattern of the object to be formed". This means that any 3D object generated using a 3D drawing software is first split into layers and these layers are then successively printed by the machine on top if one another.

Step one of 3D printing is the generation of a 3D printable model. This model is generated using a computer aided design software or via a 3D scanner. A real life object can be set to be 3D printed by scanning it to get a 3D model that is realistically within the bounds of the 3D printer's capability. Then the STL file is generated by running the design through a converting software. You can customize various aspects of the design such as the layer thickness, temperature, and outer finish, etc. Once the STL file is generated, then the object is ready to be printed. After the designing step comes the printing part. The converted STL file is fed into the printer and according to the layers we have obtained, the machine

starts out laying the plastic out layer by layer. The material need not be plastic but it can be anything ranging from liquid, powder, paper or sheet material. The layers are automatically fused to get the final shape. Its advantage over conventional machining techniques is that it can be used to create almost any geometric shape.

The object may take anywhere from several minutes to several hours to complete depending on the size and complexity of the model and also on the type of machine used. Some additive manufacturing techniques are capable of using multiple materials to construct parts. They can also use multiple color combinations simultaneously. In case there are projecting parts in the model, supports are used like scaffolding until the overhanging part sufficiently hardens. These supports can be dissolved in water when the model is printed.

III. 3D PRINTERS

Although most 3D printers are expensive, recently there has been a steep decline in the prices of 3D printers. This has led to it going from being a niche industry novelty to a hobbyist's item. There are many affordable 3D printers that are available for much less than they are worth, if we take all its production capabilities into account. Companies have also realized the potential of a consumer market for 3D printers and as such have been aggressively courting enthusiasts with cheaper and better models. There are many communities formed around these enthusiast groups which are active on the internet set up to share projects and ideas and new possibilities. One of the most popular is known as RepRap. Its goal is to produce a free and open-source hardware (FOSH) 3D printer licensed under GNU Public License. These printers are also intended to be capable of replicating itself printing many of its own plastic parts to create more machines.

IV. UNCONVENTIONAL APPLICATIONS OF 3D PRINTING

3D printing has a wide variety of uses and it can also be put to some unconventional uses. People have tried to make stuff that not only eschews the usual plastic used to make the objects but also makes use of non-traditional and commonly unavailable material to print objects. Scientists have successfully been able to print ears, skin, kidney, blood vessels and bones using 3D printers. Instead on typical plastic, a gel-like substance made of cells is used. For bones, a ceramic powder is used instead. In the future, every patient will have their own matching set of skin for a graft, a bone fragment or an organ. Already, 3D printers are capable of printing prosthetic limbs for people with disabilities. The biggest challenge is the challenge of printing a fully beating human heart that works just as well as a natural one. Bio-engineers at the Cardiovascular Innovation Institute at the University of Louisville have printed a coronary artery some small blood vessels of the heart muscle and are hoping to soon print a functioning heart. Of course, to keep them alive must prove daunting. In the future, we may live in houses that have been 3D printed. A researcher at University of Southern California claims to have designed an enormous 3D printer that is capable of printing a whole house in just a day. This conceptual model uses concrete as its base element in order to replicate computer programs of houses. In order to ensure that the house is compatible with plumbing and electrical apparatuses, it uses a layered fabrication tech called "Contour Craft". A printed house could have far-reaching implications for low-income housing, disaster recovery applications such as creating models of plastic that can serve as a sample or a prototype of a larger-scale version of itself. NASA has been developing technologies to print wood from the printers using 3D bioprinting technology. The basic theory is that the printer will lay out living cells in a specific manner upon a gel. This gel stimulates the cells to start excreting wood. One application could be that astronauts could bring wood to space without actually having to carry any of it. NASA will have the technology ready by the year-end.

Modern Meadow, a company that lies at the intersection of traditional farming and modern cutting-edge 3D printing technologies, is a company that believes we can sustainably 3D print food. According to the company, traditional slaughtering of animals to obtain animal by-products such as meat or leather is unsustainable and that we might be better off trying to 3D print our meat. The company also thinks that there will be a high demand for that sort of meat in the future. Though it may sound like something farfetched, the company has patented techniques to make it happen. This technology, according to their own description, achieves it as follows:

In this technology, conveniently prepared multicellular aggregates (the bio-ink particles) are delivered into a biocompatible support structure according to a design template (compatible with the shape of the desired biological

construct) by a computer-controlled delivery device (the bio-printer).More research is still needed to make it happen but the company evidently has the brains and research to figure it out.

NASA has also jumped on the 3D printed food bandwagon and are said to be extensively funding research in this area in order to feed astronauts in space. In fact, we already can print chocolate confectioneries and desserts from a special printer invented recently called Chocedge. Also, Hershey and 3D Systems have partnered to presumably create all kinds of printable food items. Should the company replace factory workers with 3D printers, it might be able to streamline the process of manufacturing.

Speaking of astronauts, by far the most ambitious of these 3D printed futures is where we set up an entire moon base by printing out the construction blocks to be used to construct the base. Researchers have theorized that in the absence of plastic, we might be able to utilize the abundantly available moon soil to print out building blocks to form a lunar habitat for humans. Researchers at the European Space Agency have been able to create a 1.5 tonne building block make of synthetic lunar soil. The result was a sturdy yet light material that the astronauts can assemble themselves. It should be noted that, so far, these technologies have been tested only on Earth. The real test will occur whenever the ESA decides that it is ready for space launch.

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