

3D Printer

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Abstract:

Digital fabrication technology, also referred to as 3D printing or additive manufacturing, creates physical objects from a geometrical representation by successive addition of materials. 3D printing technology is a fast-emerging technology. Nowadays, 3D printing is widely used in the world. 3D printing technology has been increasingly used for the mass customization, production of any types of open-source designs in the field of agriculture, in healthcare, automotive industry, locomotive industry and aviation industries. 3D printing technology can print an object via layer-by-layer deposition of material directly from Computer Aided Design (CAD) model. This paper presents an overview of the types of 3D printing technologies, the application of 3D printing technology, and the materials used for 3D printing technology in the manufacturing industry.

Keywords: Additive Manufacturing, 3D Printing, manufacturing industry.

1. INTRODUCTION

3D printing can create physical objects from a geometrical representation by successive addition of material. The first commercialization of the 3D printing processes happened in the year 1980 by Charles Hull.

3D printing technology has originated from the layer-by-layer fabrication technology of 3D structures directly from computer-aided design (CAD) model. 3D printing technology is innovative and has emerged as a versatile technology stage. It opens new opportunities and gives hope to many possibilities for companies looking to improve manufacturing efficiency. Conventional thermoplastics, ceramics, graphene-based materials, and metal are the materials that can be printed by using 3D printing technology. 3D printing technology has the potential to revolutionize industries and change the production line. The adoption of 3D printing technology will increase production speed while reducing costs. At the same time, the demand of the consumer will have more influence over production. Consumers can request to have it produced to fit their specifications. At the meantime, the facilities of 3D printing technology will be located closer to the consumer, allowing for a more flexible and responsive manufacturing process, as well as greater quality control.

Nowadays, 3D printing is widely used in the world. 3D printing technology is being increasingly used for the mass customization, production of any types of open-source designs in the field of agriculture, in healthcare, automotive industry, and aerospace industries.

At the same time there are several disadvantages in the adoption of 3D printing technology for manufacturing industry. For instance, the effect of the use of 3D printing technology will reduce the use of manufacturing labour so, it will automatically affect the economy of countries that rely on large number of low skill jobs. This is because the use of 3D printing technology is simple, just sketching, and setting the data in the machine so 3D objects can be generated.

2. OPERATION OF 3D PRINTER

1.1 Step-1

This step contains the drafting of 3D objects which we want to print in CAD software. But we cannot use the 3D objects file as it is. These files need to convert into STL file format. There are many software's available in the market which can be used for drafting and modelling also. Some of these are fusion360, Solid Works, Auto CAD, etc. Now day's 3D scanners are also available for making programmer files. This program sends to the main board of the printer by using computers and by pen drives or memory cards.

1.2 Step-2

1.3 This is the last step of 3D printing. When the program is given to the printer as per requirement material starts to heat in the extruder and the filament starts to melt. This melting material is deposited on the print bed as programmed and the object is made by depositing materials layer by layer on one another. The layers are horizontal, cross, and zig-zag way with each other and in a hexagonal or honeycomb structure.

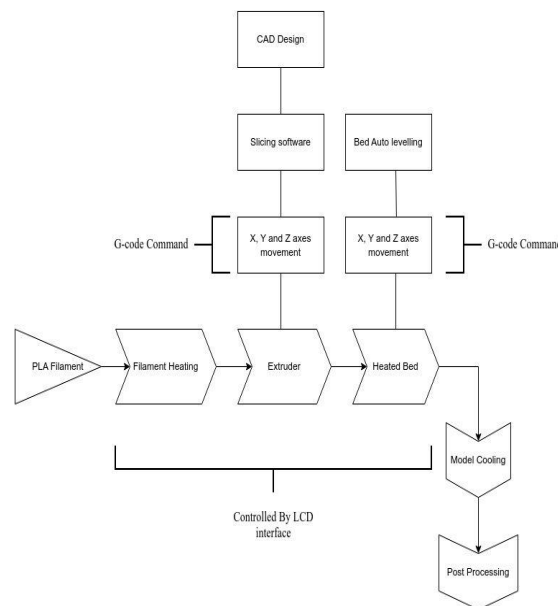


Fig. Flow chart of 3D printing operation

Material Used in 3D printing technology

3D printing needs high-quality materials for making high-quality devices. 3D printing technology can make high-quality devices by using many types of materials like metal ceramics and their combination forms.

1.4 Plastic

This most common material used for 3D printing. This is the most diverse material for 3D-printed toys and household products. This is available in transparent and in colours like green red yellow etc. Plastic is light in weight also highly durability its surface smoothness is very well. The types of plastic used in this process are usually made from one of the following materials.

a) Polylactic acid (PLA)

This is an eco-friendly material. PLA is made up of sugar cane and corn starch therefore biodegradable. This is available in two forms soft and hard. Plastics are made from polylactic acid so it is used in industries hard polylactic acid is stronger and therefore used for making ideal products.

b) Acrylonitrile butadiene styrene (ABS)

ABS is the best option for home-based 3D printers. It is valued for strength and safety. ABS is available in various colours. This makes the material suitable for products like stickers and toys. ABS is also used to make jewellery and vases.

c) Polyvinyl alcohol plastic (PVA)

It is used in low and home printers. It is low cost. This material is used for temporary used items.

d) Polycarbonate (PC)

PC is only used on this printer which feater nozzle is designed and operates at high temperature. This is less frequently used.

1.5 Powders

Today's 3D printers use powdered materials to construct objects or products. This powder is melted inside the printer and distributed in layers unit the preferred thickness and pattern are made. There are many powders used in printers but the most common are;

a) Polyamide (Nylon)

Nylon strength and flexibility are varied therefore it is used for joining pieces and interlocking parts in 3D models.

b) Alumide

This powder makes the strongest products. This is mainly industrial models and prototypes.

1.6 Metal

The second most popular material in the industry of 3D printing is metal. The properties of this material are strong hard more life and long-lasting life. The properties of the metal are good hence we can make complex shapes of human organs and aerospace parts. They also make jewellery. Various metals used for products are below;

a) Stainless steel: printing out utensils cookware and other items that could ultimately encounter water.

b) Bronze: Used for vases and other products.

c) Gold: Printed for jewellery likes ring, earrings, bracelets etc.

d) Nickel: Used for printed coins.

e) Aluminium: Used for printing thin metals objects.

f) Titanium: It is the best option for strong solid fixtures.

1.7 Resin

Resin properties are less flexible and strong. This is generally found in transparent black and white but certain printed items are produced in orange red blue and green. These are less used materials used in 3D printing. There are available in three categories;

- a) High details resins: These are used for small models.
 - b) Paintable resin: Used in smooth surface 3D prints.
 - c) Transparent resins: Used in strongest class and smoother than rough and transparent in appearance.
- 3D printers also use other materials like carbon fibre graphite and graphene nitinol paper.

Applications

There are many sectors where we can use this technology, these are listed below;

1.8 Aerospace Industry

3D printing technology provides unparalleled freedom design in component and production. In the aerospace industry, 3D printing technology has the potential to make lightweight parts and improved and complex geometries, which can reduce energy requirements and resources. Furthermore, 3D printing technology has been widely applied to produce the spare parts of some aerospace components such as engines. The engine's part is easily damaged, which requires regular replacement. Therefore, 3D printing technology is a good solution for the procurement of such spare parts. In the aerospace industry, nickel-based alloys are preferred due to their tensile properties, oxidation/corrosion, resistance, and damage tolerance.

1.9 Automotive Industry

Nowadays, 3D printing technology has rapidly changed our industry to design, develop and manufacture new things. In the automotive industry, 3D printing techniques have made phenomena in bringing new shines, allowing for lighter and more complex structures in a fast time. For instance, Local Motors printed the first 3D-printed electric car in 2014. Furthermore, Ford is the lead user of 3D printing technology and applies 3D printing technology to produce prototype and engine parts. In addition, BMW uses 3D printing technology to produce hand tools for automotive testing and assembly. Meanwhile, in 2017, AUDI collaborated with SLM Solution Group AG to produce spare parts and prototypes.

Consequently, using 3D printing technology in the automotive industry enables companies to try various alternatives and emphasize right in the improvement stages, prompting ideal and effective automotive design. At the same time, 3D printing technology can reduce the wastage and consumption of materials. Moreover, 3D printing technology can reduce costs and time, therefore, it allows testing new designs in a very fast time.

1.10 Food Industry

3D printing technology is a high-energy efficiency technology for food production with environment-friendly, good quality control, and low cost. 3D food printing can be healthy and gives benefits to humans because it creates new processes for food customization and can adjust to individual preferences and needs. By allowing food preparation and ingredients to be automatically adjusted to the consumer's information, it would be possible to have diets that enforce themselves without the need to exercise.

Additive manufacturing of food is being developed by using 3D printing. NASA also worked on this technology which made food on the 3D printer in space. A large no. of variety of foods are made on 3D printers such as chocolates, candies, pizza, and flat food. This technology helps to limit food waste.

1.11 Healthcare and Medical Industry

3D printing technology is being used to print 3D skin, drug and pharmaceutical research, bone and cartilage, replacement tissues, organ, printing for cancer research, and models for visualization, education, and communication. There are several advantages of 3D Printing technology for biomedical products which are;

- a) 3D printing technology can replicate the natural structure of the skin at a lower cost. 3D-printed skin can be used to test pharmaceuticals, cosmetics, and chemical products. Therefore, it is unnecessary to use animal skin to test the products. Consequently, it will help the researcher to get accurate results by creating replica for the skin.
- b) Using 3D printing technology to print drugs can increase efficiency, accurate control of dropped size and dose, high reproducibility, and the ability to produce dosage forms with complex drug-release profiles.
- c) 3D printing technology can print cartilage and bone to replace bony voids in the cartilage or bone caused by trauma or disease. This treatment is different than auto-grafts and allografts because this treatment focuses on generating bone, maintaining, or improving its function by using it in vivo.
- d) 3D printing technology is also used to replace, restore, maintain, or improve tissue function. The replacement tissues produced by 3D printing technology have an interconnected pore network, biocompatible, have appropriate surface chemistry, and have good mechanical properties.
- e) 3D printing technology is also used to print out similar organ failures caused by critical problems such as disease, accidents, and birth defects.
- f) 3D printing technologies can form highly controllable cancer tissues model and shows great potential to accelerate cancer research. By using 3D printing technology, patients can get more reliable and accurate data.
- g) 3D printout models can be used in the learning process to help neurosurgeons practice surgical techniques. Using a 3D model can improve accuracy, can take a short time for the trainer when performing clinical procedures, and provides opportunities for training surgeons hands-on, as the 3D model is a simulation of a real patient's pathological condition.

1.12 Architecture, Building and Construction Industry

3D printing technology can be considered as an environmentally friendly derivative and it gives unlimited possibilities for geometric complexity realization. In the construction industry, 3D printing technology can be used to print entire buildings or can create construction components. The emergence of Building Information Modelling (BIM) will facilitate better use of 3D printing technology. Building Information Modelling is a digital representation of functional and physical characteristics, that can share information and knowledge about 3D building. It can form a reliable source for decisions during its life cycle, from initial conception to demolition for construction or design of the building. This innovative and collaborative technology will support more efficient methods of designing, creating, and maintaining the built environment.

With 3D printing technology, companies can design and create the visual of the building in a fast time and inexpensively, as well as avoid delays and help pinpoint problem areas. At the same time, with 3D printing technology, construction-engineer, and their clients can communicate more efficiently and clearly. Much of a customer's expectations come from an idea, and 3D printing makes it simple to appear that idea beyond the dated method of paper and pencil. Examples of 3D-printed buildings are the Apis Cor Printed House in Russia and Canal House in Amsterdam.

1.13 Fabric and Fashion Industry

When 3D printing technology enters the retail industry, 3D printed shoes, jewellery, consumer goods, and clothing are emerging into the market. The combination of fashion and 3D printing may not seem like the

most natural fit, but it is starting to become an everyday reality across the world. For instance, big companies like Nike, New Balance, and Adidas are striving to develop the mass production of 3D-printed shoes. Nowadays, 3D-printed shoes for athlete's, custom-made shoes, and sneakers.

Besides, 3D printing technology can spread creative possibilities for fashion design. Indeed, it makes it possible to make shapes without moulds. In the fashion industry, by using 3D printing technology, one can design and produce garments by using a mesh system and can print ornaments for traditional textiles. Moreover, the application of 3D printing technology is not limited to the fashion industry 3D printing techniques are being used to print leather goods and accessories. For instance, jewellery, watchmaking, accessories, and so on.

The retailers and designers believe the purpose of creating fashion products by using 3D printing technology is not to duplicate current products, but to improve product design by offering personalized and unique products to customers. The advantages of product development by using 3D printing technology are the product is in demand for custom fit and styling. In the meantime, using 3D printing technology, it can reduce the supply chain cost. Lastly, 3D printing technology can create and deliver products in small quantities in a fast time.

1.14 Electric and Electronic Industry

As 3D printing becomes more and more accessible to science, technology, and manufacturing fields, manufacturers are starting to see its potential realized in all sorts of interesting ways. Nowadays, various 3D printing technologies have already been used broadly for structural electronic devices like active electronic materials, electrodes, and devices with mass customization and adaptive design through embedding the conductors into 3D printed devices.

In addition, active electronic components are any electronic devices or components capable of amplifying and controlling the flow charges of electricity. Besides, active devices also include those that can generate power. Examples of active electronic components include silicon-controlled rectifiers, transistors, diodes, operational amplifiers, light-emitting diodes (LEDs), batteries, and so on. These components require highly elaborate fabrication processes compared to those used for passive components due to their complex functionalities. 3D printing technology provides advantages for processing products along with its electronics. With multi-material printing technology, the efficiency of electronic systems may be adopted in Industry Revolution 4.0, enabling more innovative designs created in just one process. The development of a green electronic device with low-manufacturing cost, good safety, high reliability, and rapid production is urgently in demand to address environmental pollution today.

Conclusion & Future Scope

3D printing has large-scale industrial areas where we can develop new things. New 3D printing technologies take less time for making products. This product makes highly precise products in less time and less cost without any big equipment and machine, so 3D printing technology plays a very important role in our industrial areas. This research paper is helpful for studies on the future scope of 3D printing and new technologies and their applications. Worldwide, a big market is available for this type of technology.

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