Analysis of 3D printing technology research status

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Abstract. Three dimensional printing (3DP) is a kind of rapid prototyping technology, also known as additive manufacturing, it is a digital model file based on the use of powder metal or plastic and other adhesive materials, through layer by layer printing to construct the object technology. The complicated process can also be a problem. For products with complex structure, it is necessary to collect various structural information and correct printing equipment. And the material needs to be proved too. Nowadays its material is too normal. The high cost and non-replicability are also one of the important reasons for the cost increase. 3D printing technology has a wide range of application prospects and great significance, it can make personalized products, fast original manufacturing, reduce material waste. At the same time, it has a good design curve, and has far-reaching influence in many fields such as industry, medical care, education, and architecture. Through searching the data, this article understands the definition, principle, main process, application in different fields, significance and future development of 3D printing technology to understand 3D printing technology.

Keywords: 3D printing, Additive manufacturing, adhesive materials.

1. Introduction

Our thesis is about analysis and prospect of the development status of 3D printing technology in mechanical manufacturing [1]. Due to the advantages of direct molding, low cost, short development cycle, green manufacturing, flexible manufacturing, etc., 3D printing technology will be used in the design and manufacturing of mechanical prototype products to shorten the development cycle, reduce development costs, and improve design efficiency. So that the application of 3D printing technology in mechanical product innovation and digital design and manufacturing has become an inevitable trend [2]. There are some problems in this technology. 3D products are difficult to replicate in bulk. 3D is unique in personalized and even small-scale production, but it is not possible in mass production. The complicated process can also be a problem. For products with complex structure, it is necessary to collect various structural information and correct printing equipment. And the material needs to be proved too. Nowadays its material is too normal [3]. The high cost and non-replicability are also one of the important reasons for the cost increase. Technical standards and policy systems are not perfect, education and training systems need to be strengthened urgently, and professional personnel are scarce. The poor practicability could also be a problem. For some products, it is often only possible to print the shell or prototype, and it cannot have all the functions of the product like the prototype [4].

3D printing technology, as an advanced mechanical manufacturing technology, has great application prospects and market, which is in line with the current demand for green development. This article will analyze the working principle and current application status of 3D printing technology, providing technical guidance and reference for its future development.

2. The principle of 3D printing technology

The core principle of 3D printing technology is to add materials layer by layer, transforming digital designs into a solid object. Firstly, a digital model or CAD file is required. Then, the 3D printer overlays the materials layer by layer based on this model until the final object is formed. This process is similar to the principle of printing a piece of paper with an inkjet printer, except that ink is used instead, and various types of raw materials such as plastic, metal, ceramics, etc. are used [5].

3D printing technology typically involves three main steps: preprocessing, manufacturing, and post-processing. In the preprocessing stage, the digital model needs to be sliced and divided into layers suitable for 3D printers. During the manufacturing phase, the printer generates stacked objects based on the data from each layer. Finally, in the post-processing stage, the completed object needs to be processed and trimmed to achieve the desired appearance and performance [6].

Different 3D printing methods have their own characteristics:

Some of them use a technique called "melt deposition molding", which melts plastic inside its nozzle and then forms a thin layer of these deposited plastic fibers; In addition, other systems also use a "laser sintering" technique that uses powder particles as printing media. By spraying powder particles onto the tray of the mold, an extremely thin powder layer is formed, which then melts into a specific shape and solidifies through the sprayed liquid adhesive; some also melt powder particles by using electron flow in vacuum. When encountering more complex structures such as holes and cantilevers, it is necessary to add an appropriate amount of gel or other filling materials to the medium to support or occupy the required space. This part of the powder will not melt, and in the end, simply rinse off the support with water or air flow to form pores. Figure 1 shows the structure of a thermoplastic 3D printer.

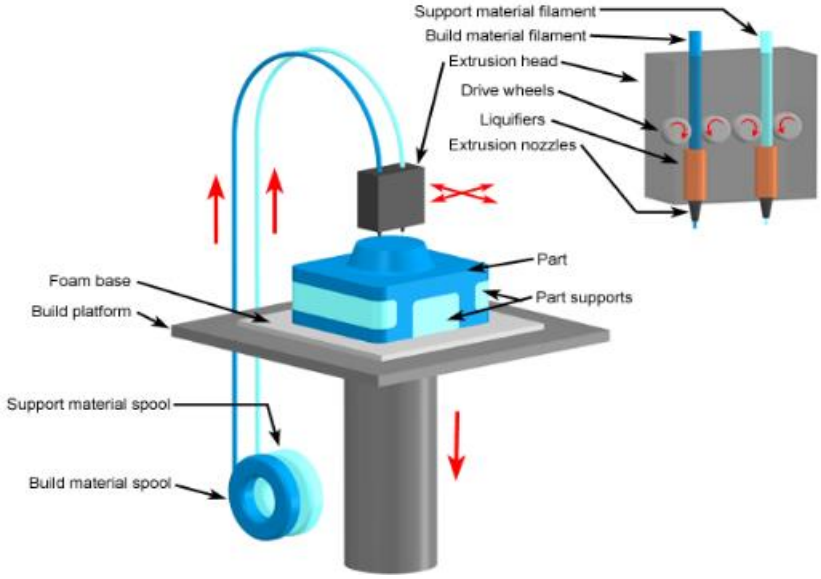

Figure 1. The structure of a thermoplastic 3D printer [7].

3. The application of 3d printing in various fields

3.1. Medical

With the rapid development of 3D printing technology, various fields have begun to introduce and apply 3D printing. 3D printing technology has been frequently applied in the biomedical field. In orthopedic surgery, hospitals can print implants and prostheses. Traditional implants and prostheses are made in batches by factories, and their sizes are only a few fixed, but each patient's bones and limbs are all different sizes and may have specific structures, so traditional implants, and prostheses are often mismatched or not ideally matched to the patient. 3D printing technology can quickly and accurately print personalized implants and prostheses that match patients, thereby reducing hidden dangers and providing patients with better rehabilitation effects. At present, 3D printing heads, vertebral bodies, maxillofacial parts, joints, and prostheses have been used in clinical practice [8].

Another application of 3D printing in the medical field is called bioprinting. 3D bioprinting is a technology that prints living tissue from living cells and other biological agents on the basis of 3D printing. By using this technology, not only can human or animal liver tissue, kidney tissue, muscle tissue, skin tissue, bone tissue, heart tissue, cartilage tissue be printed, but also organs such as blood

vessels and tracheal splints can be printed. Bioprinting is suitable for drug testing, organ transplantation, etc. important meaning. Taking 3D-printed blood vessels as an example, this technology can customize personalized blood vessels for patients to replace necrotic blood vessels and solve the current problems of insufficient blood vessel sources and poor tissue compatibility. In addition, there are researchers trying to print organs, because organs have been in a state of short supply, and there will be immune rejection after transplantation, requiring lifelong medication.3D printed organs promise to solve this problem. Researchers have used 3D printing technology to develop a completely air-driven silicone rubber artificial heart that can beat about 3,000 times and generate blood flow and pressure signals. It can be seen that 3D printing has opened up a new path for the medical field. Figure 2 is the 3D printed organs [9].

Figure 2. The 3D printed organs [3, 9]

3.2. Architecture

3D printing technology also plays a crucial role in the field of architecture. Starting from the design drawing, the traditional design should not be too complicated due to the difficulty of construction. If the 3D printing model is used to assist the design, any complex spatial surface can be produced. Compared with the traditional design, it saves a lot of manpower, Material, and time costs, and this model is fast, environmentally friendly, low-cost, and beautifully modeled. At the same time, compared with the exaggeration caused by the deliberate creation of aesthetic effects in the 3D renderings, the 3D printing models are much more realistic and intuitive [10]. At the same time, when communicating with Party A, the display of a model is more intuitive than several design drawings, and the designer does not need to consider the difficulty of construction and can design the building he wants with confidence and 3D printing. Put into practice. No matter how complex the structural design is, as long as the drawings can be designed, 3D printing technology can be used to form it at one time, which solves the problems that traditional construction methods cannot break through. Figure 3 is the 3D printed building model.

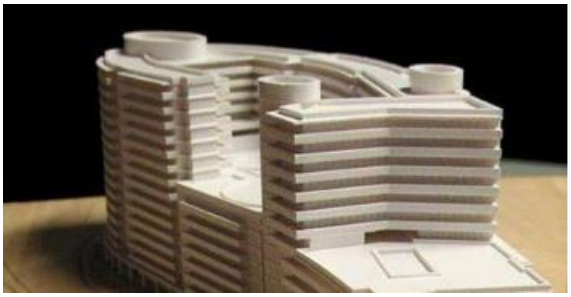

Figure 3. The 3D printed building model [5].

3D printing technology can be used to combine traditional drawings with electronic data such as geographic information and architectural scanning, and present them in physical form. At present, 3D printing technology is widely spreading, but people have not yet discovered its full potential. If it proves that this technology is as useful as expected, then compared to other construction techniques, it will be a very advantageous technology in terms of production efficiency. It will rely more on

robotics technology, thus saving a lot of labor. If the various safety aspects of this technology are ensured, the amount will ultimately be greatly reduced in terms of construction costs. However, at present, architects mostly use 3D printing technology to create their building models, and 3D printing can produce almost anything. Any complex form that may have seemed impossible before can be achieved or printed using CAD software and 3D scanners [5].

3.3. Aerospace

The first industry to benefit from the development of 3D printing technology to the ability to manufacture finished parts is undoubtedly the aerospace sector. The benefits of reducing component weight by manufacturing complex structures are obvious, such as shortening the development cycle of new aerospace equipment and improving material utilization, saving expensive strategic materials, and reducing manufacturing costs. With 3D printing technology becoming a key technology for improving the design and manufacturing capabilities of aerospace, its application scope in the aerospace field is constantly expanding, and there is a trend of expanding from component to whole machine manufacturing. At present, the application of 3D printing in the aviation industry mainly focuses on the processing of materials such as titanium alloys, aluminum lithium alloys, and ultra-high strength steel, and high-temperature alloys. These materials basically have the characteristics of high strength, stable chemical properties, difficult forming and processing, and high cost of traditional processing techniques. In addition, domestic and foreign enterprises and research institutions have used 3D printing not only to print components of aircraft, missiles, satellites, manned and cargo spacecraft, but also to print complete machines in the aerospace field such as engines, drones, and microsatellites, achieving significant benefits in some aspects, fully demonstrating the application prospects of 3D printing technology in this field.

With 3D printing technology becoming a key technology for improving the design and manufacturing capabilities of aerospace, its application scope in the aerospace field is constantly expanding, and there is a trend of expanding from component to whole machine manufacturing. At present, domestic and foreign enterprises and research institutions have used 3D printing not only to print components of aircraft, missiles, satellites, manned and cargo spacecraft, but also to print complete machines in the aerospace field such as engines, drones, and microsatellites. Significant benefits have been achieved in terms of cost, cycle, weight, etc., fully demonstrating the application prospects of 3D printing technology in this field.

4. Conclusion

3D printing can automatically convert the 3D design in the design drawings into actual models in reality, and even directly convert them into parts that do not require processing, effectively shortening the product development and manufacturing cycle and efficiently using new materials. But this seemingly convenient technology is not without its shortcomings. In terms of technology, some common modeling techniques for molten deposition not only have poor accuracy, but also have slow speeds; UV cured consumables have very high costs, low strength, and low material strength and durability; In terms of environmental protection and energy consumption, commonly used 3D printers require continuous operation for 28 hours to print irregular 3D plastic models with a size of about 30 centimeters, which is time-consuming and costly. Layer by layer scanning consumes a large amount of energy continuously, and the consumed materials cannot be recycled, resulting in great waste. In order to solve these shortcomings, I think it can continue to develop new materials and new printing methods.

There are many high-quality alloy materials, composite materials, and nanomaterials on the market now, and it will undoubtedly be a huge improvement if these materials can also be shaped by 3D printing. This paper introduces the principle of 3D printing, reduces several common printing methods, and the application of 3D printing in three fields. Recommendations were also made. At present, 3D printing technology seems to face many difficulties in its promotion and development,

but it is an emerging technology. In the near future, with the progress and development of society and science, 3D printing technology will continue to improve.

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