Research on the Progress in Process Control of 3D Printing Technology

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Abstract: With the rapid development of 3D printing technology, it has been applied in more and more fields and products, so the research on 3D printing technology control process has important practical significance. This paper first analyzes the current development of 3D printing technology, and then introduces the classification of 3D printing technology, as well as the classification of control process system. Finally, several control process systems of 3D printing technology are analyzed and studied.

1. Introduction
As a rapid prototyping technology, 3D technology is based on modern digital model and applied in the field of machining. Compared with the traditional machining technology, 3D printing has many advantages, such as short time limit, no need of traditional mold, complex structure manufacturing and production process simplification. Due to the advantages of 3D printing, its application is more and more extensive, so it is of great practical significance to study the process control of 3D printing technology.

2. Analysis of the development of 3D printing technology

2.1 Definition of 3D printing technology
3D printing technology is based on modern digital technology, through the agreed terminal accumulation and control of printing materials, the final design into a physical object. Compared with the traditional technology, 3D printing technology reduces the production capital, reduces the waste of resources, and can produce complex contours. In addition, 3D printing technology based on good design concept and design process can shorten the production cycle and quickly produce parts.

2.2 Development status of 3D printing technology
With the rapid development of 3D printing, China's 3D printing has grown at a double-digit rate in the past four years. At present, 3D printing technology is mainly used in household appliances, consumer electronics, automobile, aerospace and other industries. Figure 1 shows the scale of China's 3D printing market in 2014-2018. With the gradual maturity of 3D printing technology, its demand in all walks of life will continue to grow rapidly.
At present, in the application field structure of China's 3D printing industry, industrial machinery accounts for the highest proportion, followed by aerospace, automobile, consumer goods / electronics and other related fields, as shown in Figure 2 below. At present, 3D printing industry is developing in the direction of automation, data threading and digitization.

3. Research status of 3D printing process control

3.1 Classification of 3D printing technology
According to the state and forming method of materials used in 3D printing, 3D printing technology can be divided into several categories as shown in Figure 3 below. The characteristics of various technologies are shown in Table 1 below.
3D printing technology categories

Table 1. Characteristics of various 3D printing technologies

| 3D printing technology | Advantages                          | Disadvantages                          |
|------------------------|-------------------------------------|----------------------------------------|
| FDM                    | Low cost and mature technology      | Less materials available               |
| SLA                    | High accuracy and material utilization | High process cost                      |
| LOM                    | Faster                              | Waste of materials                     |
| EBM                    | Complex structure available         | Limited molding size                   |
| SLM                    | Complex structure available         | Limited shaping size                   |
| LDMD                   | Large size metal parts available    | Not suitable for complicated parts     |
| EBF                    | Efficient                           | Not suitable for poor plasticity parts |

3.2 Research status of 3D printing process control
With the rapid development of control technology, 3D printing technology is becoming more and more complex and intelligent, the difference of 3D printing process control system results in the difference of 3D printing forming technology. At present, the process control system of 3D printing technology mainly includes three kinds of control systems: melting deposition forming control system, photo-polymerization forming control system and laser powder forming technology control system.

4. Analyse of 3D printing process control

4.1 Control system of fused deposition forming
With the rapid development of electronic control equipment, fused deposition control technology and new algorithms are constantly applied to meet the requirements of 3D printing in terms of higher and higher precision, intelligence and speed. The control system is needed to complete the extrusion of materials after hot melting. The control subsystem of FDM includes hot melt nozzle, wire feeding mechanism, moving mechanism, heating forming room and related parts of equipment movement, so the control of the system is mainly the control of these parts.

4.2 Photo-polymerization control system
Each subsystem of the control system of photo-polymerization molding mainly includes the following parts: table lifting, photosensitive resin level detection and control, photosensitive resin coating, laser scanning, temperature control and computer detection. During the molding, the liquid level is detected and controlled to a certain height, and the laser scanning system scans point by point and solidifies layer by layer according to the instructions of the computer. After each layer is completed, the photosensitive resin level detection and control system will descend again, and the scanning of the next layer will be carried out again, and then repeat layer by layer, and finally print the 3D solid model.
4.3 Control system of laser powder forming technology

Laser powder forming technology includes SLS, DMLS, SLM and EBM. The subsystem of laser powder forming technology system usually includes laser scanning, galvanometer scanning, forming cylinder lifting, powder spreading control, preheating control and drive, etc. During molding, the powder is spread on the lifting system of the molding cylinder by the powder spreading control system and compacted. Then, the powder is preheated to a predetermined temperature, and the computer system then performs a trajectory scanning to form a layer of the sintered solid powder material. After finishing the first layer, the system descends again, the control system spreads the powder again, and then the laser beam scans the new layer. Then the sintering process of each layer circulates layer by layer until the parts are formed.

5. Conclusions

In recent years, the rapid development of 3D printing technology has led to the rapid expansion of its application. However, there are still many unsolved problems in 3D printing technology, especially in the process control of 3D printing technology. In the future, 3D printing technology has great development opportunities. With the new breakthroughs in process control, overall control, experimental design, simulation analysis and industrialization of the control system, 3D printing technology will have more and broader application prospects. At the same time, 3D printing also needs a technology accumulation and verification process, only through long-term and large amount of application research, the existing problems of 3D printing technology process control can be found and solved, and the application of 3D printing technology can be developed continuously.

Acknowledgement

Production, Learning and Research in Wuhan Universities: Research on Key Technologies of Intelligent Equipment for Digital Additional Material Manufacturing Technology. Project No. CXY201611.

References

[1] Zhong Xiaomin, Wang Juan, Guo Zhou. Future development trend of 3D printing technology in China [J]. Industry and Technology Forum. 2016 (22).
[2] Wang Xiaofei. Application of 3D printing technology in the field of Architecture [J]. Engineering technology research. 2017 (12).
[3] Yang Yu. Application prospect of 3D printing technology in civil engineering [J]. Modern decoration. 2014 (11)
[4] Wang Weichen. Discussion on the application and Prospect of 3D printing technology in civil engineering [J]. Value engineering. 2017 (05).
[5] Wu Chunyan, Jiao Hongtao. 3D printing technology development and patent law response [J]. Technology and law. 2014 (04).
[6] Li Guangya, Wang yuzeng, Han Jingru, Liu Shuangyuan. Geometric algorithm of galvanometer system correction in mechanical parts RP. machine tool and hydraulic, 2014, 42 (19).