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Recent 3D printing technologies: A comparative review and future perspective

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Abstract : *Additive manufacturing (AM) is generally recognized as three-dimensional (3D) printing or rapid prototyping, which has evolved rapidly in numerous applications. In this review paper, recent major fundamentals and technology development in 3DP are reviewed, including its features and latest findings. Moreover, some potential applications in 3D printing are involved, followed by its typical applications, advance trend, and future perspective.*

Keywords – *AM, Rapid prototyping, 3DP*

I. INTRODUCTION

Nowadays, manufacturing technology plays a vital role in economic growth, industrial application, scientific and technological progress. As technology rapidly advances, manufacturing technology has developed from the era of traditional manufacturing to an era of intelligent, high-efficient, sustainable manufacturing industry. 3D printing technology was invented in the late 1980s, which is generally known as 'additive manufacturing' (AM) or 'rapid prototyping' (RP). 3D printing has rapidly garnered extensive focus and developed as an emerging manufacturing technology. Therefore, 3D printing has widely adopted in various fields, such as fashion jewelry, polymer printed textiles, robotics and automation, tissue and scaffolds, electronics, and end-use products. 3D printing has boosted the application fields according to its several characteristics, such as short-time process, low-cost, customization, and material reduction. Furthermore, 3D printing technology is still in the active stage of industrial innovation, which could advance the manufacturing production mode and manufacturing maturity as revolution technology. From a structural design perspective, 3D printing provides a high-efficient and more significant platform for designers to manufacture complex structures using this new technology, which is mainly used for engineering and fashion purposes.

II. TECHNOLOGY FUNDAMENTAL

The 3D printing technology is known as additive manufacturing, which is used for fabricating products in a consecutive layering sequence. 3D printing is mainly classified into solid, liquid, and power-based method, which is based on its input material. The solid-based pattern is comprised of fused deposition modeling (FDM), and the power-based pattern is comprised of selective laser sintering (SLS) and selective laser melting (SLM). The liquid- based pattern is comprised of stereolithography (SLA), digital light processing (DLP), direct ink writing (DIW), and inkjet.

Currently, there are almost 100 different available 3D printers in the market, which are small and affordable desktop 3D printers, respectively. There are several additive manufacturing methods, which use different input materials and functions. In order to deeply understand its characteristics of relevant methods, a brief overview, and a summary of relevant 3D printing methods are provided in Table 1.

Table 1: The brief overview of relevant 3D printing methods

Methods	Status	Layer printing	Key features	Materials
FDM	Solid	Deposition of solid material	Low cost. clean condition	Thermoplastics (PLA, ABS, PU), composites
SLS	Power	Layer of powder	Softening particles, sintering	Metals and alloys, ceramics, polymers (PP), composites
SLM		Layer of metallic powder	Fully melting	Metals and alloys, ceramics, composites
SLA		Liquid layer curing	Ultraviolet curing, high-resolution	Polymers, ceramics, composites
DLP		Liquid layer curing	No support structure, high-speed	Elastomers, metamaterials
DIW	Liquid	Fluid layer curing	Self-supporting, thixotropic ink	Polymers, ceramics, waxes, polyelectrolytes, composites
Inkiet		Liquid layer solidifying	Multiple print abilities, complex structure, high-resolution	Werowhite, max, visijet M3, crystal, MED620, MED625FLX

III. COMPARATIVE ANALYSIS THODOLOGY

3D printing offers a cost-effective technology to manufacture products, and 3D printing is an advanced technology, which has the capability to achieve multi-functionality, self-assembly, and self-repair. 3D printing, which adds one more dimension of transformation procedure over time. It is a new and advanced technology, which rapidly applied to numerous engineering fields.

It is significant to analyze and compare between the 3D printing and conventional technologies, which obtains characteristics of two technologies and market future. On the other hand, it is also shown the evolution trend of 3D printing. 3D printing has significantly grown in recent years that could indirectly increase the market demands of 4D printing in the next decade. With the emergence of 3D printing and smart materials, it will have a significant impact on industrial sectors.

IV. 3D PRINTING APPLICATION

3D printing technology has widely applied in various areas due to it is low-cost, short processing time, highly efficient, customization and personalization characteristics, which refers to infrastructure, military & defense, building & construction, etc. According to its applied fields, it is directly indicated that 3D printing technology and its products have commonly used in our daily life. Some typical examples are introduced as follows. For example, high-quality 3D printed replicas of cadaveric material were printed for teaching resources in education. Recently, several findings have studied the use of 3D printing to produce bones, stem cells, blood vessels, tissues, organs, and drug delivery devices in the medical area.

Furthermore, the 3D printing technology has significant application potential in the military and defense sector, such as arms and weaponry parts, which provides much more self-dependent. A brief description of the typical application in building and construction has been carried out by Skanska company and Win Sun company. Currently, 3D printing is being applied in the food areas such as military and space food, sweet food, which was firstly introduced in the food sector by researchers from Cornell University. 3D printing is also used for sensor packaging, which is designed for infrastructure health monitoring as a new piezoelectric sensor.

V. FUTURE PERSPECTIVE

Intelligent printing, although as a novel technology, has the potential to use in many potential areas. For 3D printing technology, it is limited in terms of materials for specific applications under extreme external conditions or environment such as biomaterials in medical application, which is still required further development of novel materials. Currently, available 3D printers of novel materials have challenged with the limited industrial application using single material.

Therefore, there are several challenges to advance the next generation of 3D printing technology, which is mainly listed as follows:

- Advance printing speed and resolution and reduce energy consumption and costs.

- Improve the printed product dimension accuracy, and scale size (e.g., nanoscale)
- Develop new 3D printing materials with superior properties
- Integrated 3D printing with other traditional process or multi-process technology (e.g., additive + subtractive technology) as hybrid or triple technology

VI. CONCLUSION

Intelligent printing manufacturing is developed as an advanced technology compared to conventional manufacturing technology, which is known as 3D printing technologies. 3D printing technology has used to produce static structure in 3D coordinates. In recent years, 3D printing has emerged and gained attention according to its structural response over time under environmental stimuli. This review paper provides a basic understanding of the fundamentals of 3D printing technologies, which involves its concept, development trend, and recent research findings. 3D printing technologies are comparatively analyzed using SWOT method, which presents its strength, weakness, opportunity, and threat.

REFERENCES

Journal Papers:

[1] Liu, Z., Zhang, M., Bhandari, B., & Wang, Y. (2017) "3D printing: Printing precision and application in food sector" Trends in Food Science & Technology 69: 83-94.

[2] López-Valdeolivas, M., Liu, D., Broer, D. J., & Sánchez-Somolinos, C. (2018) "4D Printed Actuators with Soft-Robotic Functions" Macromolecular rapid communications 39 (5): 1700710.

[3] Chua, C. K. and K. F. Leong (2014) 3D Printing and Additive Manufacturing: Principles and Applications (with Companion Media Pack) of Rapid Prototyping Fourth Edition. World Scientific Publishing Company.

[4] Rastogi, P. and B. Kandasubramanian (2019) "Breakthrough in the printing tactics for stimuli-responsive materials: 4D printing" *Chemical Engineering Journal.*