Dogo Rangsang Research Journal
ISSN : 2347-7180

UGC Care Group I Journal
Vol-08 Issue-14 No. 04, April 2021

3D Printing Technology: A Future Perspective

[1] T. N. Mishra*, [2] M. K. Khamari, [3] P. Barla

[1][2][3] Department of Mechanical Engineering, Gandhi Institute for Education and Technology, Bhubaneswar

***Abstract*--- 3D printers have drawn attention of hobbyists, engineers, students and researchers in last few years. More specific areas explored are types of 3D Printers and use of 3D Printers for various applications and R&D in 3D Printers. Presently, 3D Printers are showing a prospective future in process, medicine, food, building-construction, jewelry design industries. Rapid prototyping and 3D Printing have drastically reduced the time and cost of the process of making new industrial objects. Present work describes, how 3D printing technology would be proven revolutionary as well as blissful in the field of manufacturing process.**

***Keywords*--- 3D Printing technology; 3D Printer; CAD**

I. INTRODUCTION

The 3D Printing Technology is additive manufacturing process realizing 3-dimensional objects from the digital 3D models. In this manufacturing process the 3D object builds up by the solidification of the material layer by layer using computerized control. In 1980 Hideo Kodama invented the additive manufacturing device [1]. Alain Le Mehaute filed a patent on stereo lithography process in 1984. After some time, in 1984 Chuck Hull filed a patent on stereo lithography fabrication system. STL (stereo lithography) file format is used to make digital 3D model [2]. 3D printing technology can be divided into Fused Deposition Modelling (FDM), Stereolithography (SAL), Digital Light Processing (DLP), Selective Laser Sintering (SLS), Material Jetting (MJ), Drop on Demand (DOD), Direct Metal Laser Sintering (DMLS), Electron Beam Melting (EBM) [3]. As we know, in the process of manufacturing generally injection molding and die casting methods are used for making any object made of either plastic or metal. 3D printing can print far more complex parts as finished product than traditional molding and casting processes of manufacturing. For 3D modeling of any object, many software packages are available like: Autocad, SIEMENS NX, 3D Max, etc. These software generate CAD file that can be converted into the "gcode" file using available slicer software like: Cura, Matter control, etc. Further, this "gcode" file can be fed to the 3D printer which prints the 3D object using plastic, metal, bio-material, paper, etc. The process is shown in Fig. 1. Due to large variety of material support in different types of 3D printers, this technology has been proven revolutionary in diverse sectors [4].

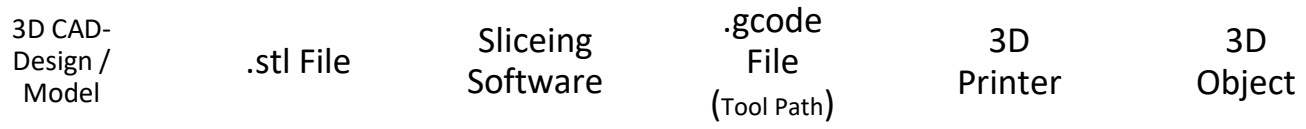

Fig.1 3D printing Process

II. 3D PRINTING TECHNOLOGY IN VARIOUS SECTORS AND THEIR FUTURE

A. Prototype making

For prototyping FDM technique is mostly used and has proven to be cost-effective. This technique is specifically for hardcore hobbyist, researchers and innovators. Traditional techniques like die casting and molding for object making is expensive as well as time consuming process for prototyping. 3D printing technology saves the money of companies and helps in improvement of the end product. Higher accuracy and finishing in the 3D object at the level of making prototype is generally not mandatory. The FDM 3D printers available in the market are

affordable for the stakeholders. People, who have sufficient primary knowledge of 3D modeling, can print their custom designed 3D models to 3D objects using FDM 3D printer [4].

- *Future:*

The developments in this sector make this field fast, cost effective, user-friendly, flexible and result oriented [5]. The author envisages an exponential rise in prototyping activities using 3D printing technology looking into the versatility of the technology and its adaptability to various types of material.

B. Medical field

Researches and innovations tremendously are available and in the pipeline for the better health of the human being. Recently 3D printing technology has been introduced in this sector as well. As shown in Fig.2, using 3D printers the Prosthetic limb, jaw, crowns, bones, hearing aids of the human body can be printed exactly as the size of the relevant person and can be fitted to the individual [6]. Using 3D printer and with some knowledge of 3D modeling dentists can design denture (Fig.2) for the patient as per the size of the individual jaw.

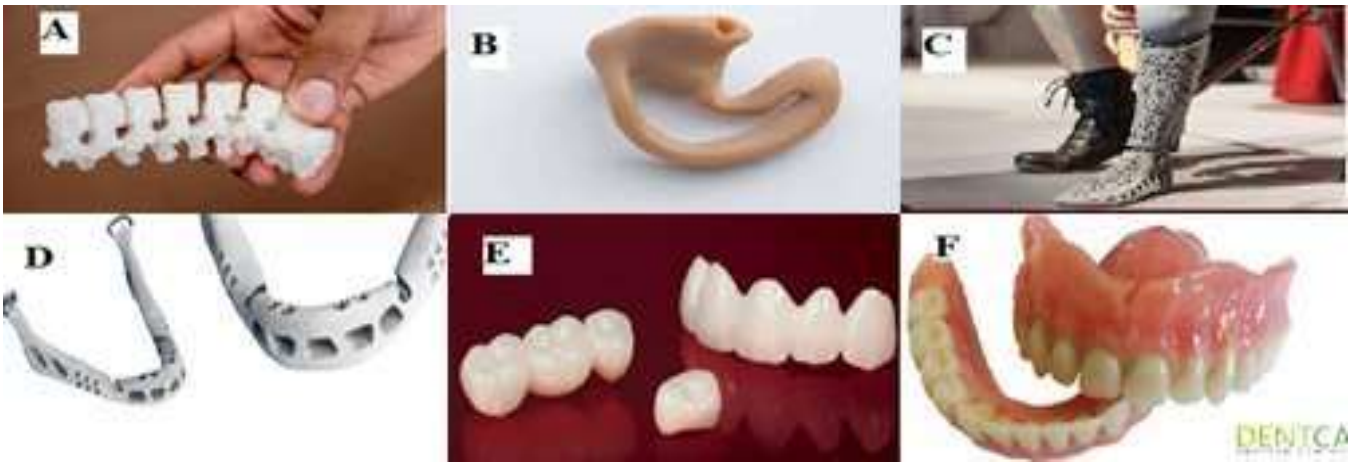

Fig. 2. (A) Bones [8], (B) Hearing Aids [9], (C) Prosthetic Limb [10], (D) Jaw [11], (E) Crowns [12], (F) Denture [13].

A 3D printer can also print human organs like kidney, liver, heart, ears using biomaterial (fig.3). It is envisaged that, in future tailor-made 3D printed organs will be able to replace human organs with same efficacy of natural organs [13].

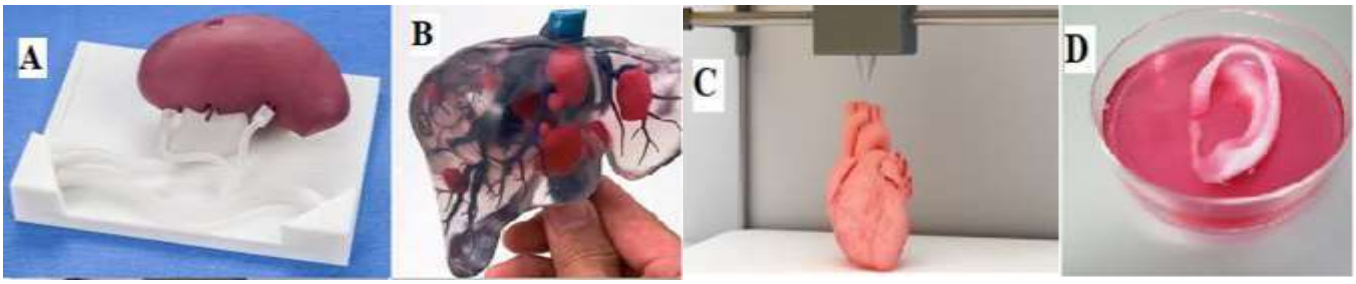

Fig.3. (A) Kidney [14], (B) Liver [15], (C) Heart [16], (D) Ear [13]

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Although the printing of body parts/organs is under experimentation stage and is not available for medical practices. But with maturing technology and development in biomaterials available for such applications, it's not impossible to predict that such 3D printed parts or organs will be key players in the healthcare sector.

C. Housing and construction

Huge 3D printers are employed to construct a house from the base. This technology will provide a good alternative against the traditional method of construction in future. Construction of 10 houses in a day using 3D printing has been reported from China [17]. Various 3D printing techniques are employed for the building construction like:

Big Area Additive Manufacturing (BAAM), 3D Curve Printing and Scaffold technique [18]. All these techniques help to construct building for time and cost saving [18]. Using 3D printing technology in this sector, large number of houses can be constructed for the needy people, in short period of time and reduced cost. An example of 3D printed house is shown in Fig. 4. Economically, it is a faster and more accurate construction method for complex members and low labor costs and has zero generated waste.[19]

Fig.4. 3D Printed House [19,20] (Courtesy: The Verge)

- *Future:*

Being economic and fast, the process of 3D printing of homes will soon be a general view even in our Indian context. Actually this can boost up the mission of the Government to provide shelter to every individual Indian citizen.

D. Parts manufacturing for industries

With large varieties of available 3D printers and materials, it will be a miracle in the sector of manufacturing. 3D printers are able to design complex geometrical parts with better accuracy and finishing. 3D printed aerospace and automobile parts are already available in the market [17]. Industries use 3D printing according to their specific requirements. Object manufacturing without using tooling and fixing, accuracy of the shape of the object, design freedom of the parts, easy material handling, are few of many advantages of this technique [21]. 3D printing technology is maturing with time and will become more adaptable in the industrial manufacturing sector in near future. 3D printed Turbine and Drill component are shown in Fig.5.

- *Future:*

In small scale industries (specifically in the Saurashtra region of India) the manufacturing process is still carried out using traditional methods like sand and investment casting due to some hurdles in using this technology. Once the hurdles are resolved, 3D printer will change the entire scenario of manufacturing industry. Also entire machinery process and materials will change.

Fig. 5. 3D printed Turbine (left) and Drill component (right) [22]

E. Domestic Applications

People can print their own custom designed 3D object at home using 3D printer. Toys and other small things (Convenience like: Hangers, Key chain, Key holder, Mobile phone stand, etc.) useful in the home can be made easily [17]. People can make profitable print jobs and sell, in this way they can earn money using the 3D printer [23]. Some 3D printed parts for domestic use are shown in Fig. 6.

- *Future:*

The technology is yet not sufficiently economic to be housed domestically and people are unaware about its possible implications. With an economic 3D printer in home, the concept of repair and maintenance will be transformed thoroughly.

Fig. 6. (A) Planter, (B) Juicer, (C) Ball pen Stand, (D) Tube Squeezer [24]

F. Educational purpose

Demonstration is one of the best ways to inculcate and disseminate concepts in process of education. Use of models has shown improvement in learning ability of the students [25]. The technology helps students to understand the concepts of various subjects with help of 3D printed models. Students may create their own designs according to their field of interest [26]. A 3D printed Airboat model is shown in Fig.7

- *Future:*

The technology is going to be boon for education field. Educationist can create and explain complex structures while students can give wings to their creativity. Prototyping will be easy and less time consuming.

Fig.7. Airboat Model [26]

G. Jewellery designing

Traditional technique for jewelry design requires good technical knowledge of casting, mold making, grinding, cutting, engraving, etc. Nowadays, 3D printer is able to make any complex jewelry design and eliminates some steps from traditional process. Presently, 3D printers are used by the jewelry manufacturers [27]. 3D printed Rings are shown in Fig.8. Minute, precise design and manufacturing is controlled by this technology.

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An age of blended design and jewelry made of different materials may emerge as new fashion. Apart from jewelry, the technology may showcase its importance and footprints in other art sectors too.

Fig. 8. 3D printed Ring [28]

H. Food printing

Food printing is a novel application of 3D printing technology. Food items can be printed with help of 3D printer using semisolid, powder and viscous liquid form of food material. Specially formed cartridges for food printing with the food stuff have longer life and controlled amount of nutrients, making it very suitable option for providing fresh food to astronauts.

Fig.9. Chocolate 3D printer [29]

This concept is distant in our market [30]. To control the diseases for human, food customization is required and for that the food printing is better option [31]. The chocolate 3D printer is shown in Fig. 9.

- *Future:*

With 3d printing decorative, designer dishes will be possible. This technology will enable no-touch preparation of food enhancing hygiene standards. Food making will have new dimensions in terms of test, textures and presentation.

III. CONCLUSION

3D Printing technology has many pros-cons and challenges in case of adaptation of this technology in variety of sectors. The continuous research and development in the 3D printing lead to drastic change in the manufacturing and will increase the 3D printing technology adoption. Most desirable thing for a human being is health and 3D printing plays a fantastic role in this sector. In case of food printing, the diet control and personalized food can be provided using this technology is another health beneficiary part. The best alternates of traditional manufacturing and designing process are being provided by the 3D printing technology for the jewelry making, housing and construction. 3D printing is also helpful in education for the students and teachers. So, this technology contributes in each and every manufacturing process.

Authors had planned to compile information available regarding this technology in various aspects of practical applications that can improve human life. Hence, we have confined ourselves to some specific applications only, not spanning to enormous range of applications.

REFERENCES

[1] Hideo Kodama, "A Scheme for Three-Dimensional Display by Automatic Fabrication of Three- Dimensional Model," IEICE Transactions on Electronics (Japanese Edition), vol. J64-C, No. 4, pp. 237–41, April 1981

[2] U.S. Patent 4,575,330 "Apparatus for Production of Three-Dimensional Objects by Stereolithography"

[3] https://all3dp.com/1/types-of-3d-printers-3d-printing-technology/

[4] Christopher Barnatt "3D printing Third Edition" Published 9th November 2016 by ExplainingTheFuture.com ISBN-13: 978-1539655466.

[5] Sudhir Kumar, Rupinder Singh, TP Singh, Ajay Batish: "Flexural, pull-out, and fractured surface characterization for multi-material 3D printed functionally graded prototype"; Journal of Composite Materials, Volume: 54 issue: 16, page(s): 2087-2099

[6] https://www.ucsf.edu/news/2018/10/412026/3-d- printing-helping-doctors-patients-prepare-opening- you-surgery

[7] https://www.audicus.com/hearing-aids-3d-printing/

[8] https://www.forbes.com/sites/tjmccue/2014/08/31/3d-printed-prosthetics/#3e04a01633b4

[9] https://www.xilloc.com/patients/stories/total-mandibular-implant/

[10] https://www.3ders.org/articles/20180110-porimy-launches-new-3d-ceramic-printer-and-first certified- 3d-printed-ceramic-dental-fixtures-in-china.html

[11] https://www.cellular3d.com/index.php/dental-3d-printing/178-fda-clears-first-sla-resin-for-permanent-contact-dental-use

[12] Hyun-Wook Kang, Sang Jin Lee, In Kap Ko, Carlos Kengla, James J Yoo & Anthony Atala, "A 3D bioprinting system to produce human-scale tissue constructs with structural integrity", Nature Biotechnology volume 34, pages312–319(2016)

[13] https://www.3printr.com/3d-printed-kidney-better-cheaper-training-tool-4943349/

[14] http://cysticfibrosis.com/ucsds-3d-printed-liver-cells- most-liver-like-yet/

[15] https://transmitter.ieee.org/first-3d-printed-soft-artificial-heart/

[16] Thabiso Peter Mpofu, Cephas Mawere, Macdonald Mukosera, "The Impact and Application of 3D Printing Technology", International Journal of Science and Research (IJSR) ISSN (Online): 2319- 7064, Impact Factor (2012): 3.358, Volume 3 Issue 6, June 2014, www.ijsr.net

[17] Yin Hongxi, Qu Ming, Zhang Haiyan & LimYeChan. 3D Printing and Buildings: A Technology Review and Future Outlook. Technology|Architecture + Design, 2:1, 94-111. ISSN: 2475-1448 (Print) 2475-143X (Online) Journal homepage: http://www.tandfonline.com/loi/utad20

[18] https://all3dp.com/2/how-much-does-a-3d-printed- house-cost-in-2018/

[19] Rawan Allouzi, Wael Al-Azhari, Rabab Allouzi, "Conventional Construction and 3D Printing: A Comparison Study on Material Cost in Jordan", Journal of Engineering, vol. 2020, Article ID 1424682, 14 pages, 2020.

[20] Manoj Gupta, "3D Printing of Metals. Metals" 2017, 7, 403; doi:10.3390/met7100403, www.mdpi.com/journal/metals

[21] https://www.protolabs.com/resources/design-tips/industrial-3d-printing-for-production-parts/

[22] https://all3dp.com/1/why-buy-a-3d-printer-reasons/

[23] https://www.digitaltrends.com/cool-tech/useful-3d-printed-household-items/

[24] Gebhardt, Andreas; Fateri, Miranda. "3D printing and its applications", http://www.dipp.nrw.de/service/dppl/ URN: urn:nbn:de:0009-2-35626

[25] Ye, Z., Dun, A., Jiang, H. et al. The role of 3D printed models in the teaching of human anatomy: a systematic review and meta-analysis. BMC Med Educ 20, 335 (2020).