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An Over View On 3d Printing Technologies-A literature review

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ABSTRACT:

Digital fabrication technology, commonly referred to as 3D printing or additive manufacturing, creates tangible objects from a digital model through the sequential addition of materials. This technology is rapidly advancing and is being adopted globally. 3D printing is increasingly utilized for mass customization and the production of various open-source designs across multiple sectors, including agriculture, healthcare, automotive, locomotive, and aviation industries. The process involves the layer-by-layer deposition of material directly from a computer-aided design (CAD) model. Presently, 3D printing finds applications in food sectors such as military and space food, elderly nutrition, and confectionery. Achieving accurate and precise printing is essential for successful outcomes. This paper presents an overview of the different types of 3D printing technologies, their applications, and the materials employed in the manufacturing industry.

Keywords: Additive manufacturing, 3D Printing, manufacturing industry

Introduction:

3D printing has undergone significant advancements since its inception in the late 1970s. The fundamental principle involves the layering of materials based on a digital model generated from CAD software to produce a three-dimensional object, a method commonly referred to as Additive Manufacturing. Currently, 3D printing encompasses a wide array of applications across various sectors, including medicine, manufacturing, aerospace, automotive, construction, architecture, jewelry, and food, among others. The diversity of technologies and materials available in 3D printing offers limitless opportunities, particularly in the realm of geometrically intricate models that require high precision and reliability. This paper will present and compare some of the most prevalent 3D printing technologies based on specific criteria related to accuracy, functionality, and usability. A comprehensive examination of printing materials, along with their respective advantages, disadvantages, and various applications, will also be included. As a global leader, Nike faced significant challenges regarding its reputation in Vietnam during the 1990s, prompting the company to address these tensions. In addition to reputation management, various production systems have been introduced within the research domain, emphasizing the importance of environmental sustainability and social equity in response to past controversies. Conversely, the future of advanced manufacturing is increasingly centered on technological innovations within advanced production systems. To sustain market presence and conserve resources for future generations, it is essential to integrate technology with other critical requirements.

Methodology:

The basic principle of additive manufacturing (AM), also known as 3D printing, is to create objects layer by layer from digital models, rather than by traditional subtractive methods like machining [2]. In additive manufacturing, a 3D design is sliced into thin cross-sectional layers, which are successively built up to form the final object [5].

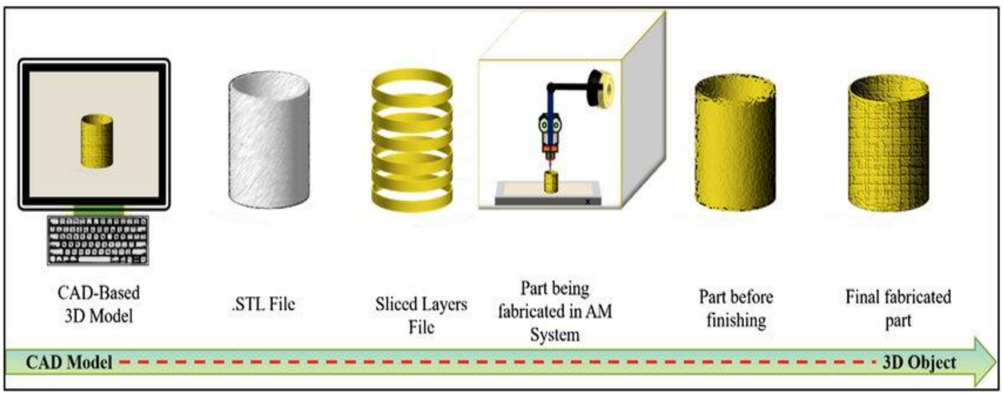
Digital Design Creation: A 3D model is created using computer-aided design (CAD) software. This model serves as the blueprint for the object. [3]

Slicing and Layering: The digital model is "sliced" into thin layers. Each layer is essentially a 2D cross-section of the object, which will be built sequentially from the bottom up [4].

Layer-by-Layer Fabrication: Using various AM technologies (e.g., Fused Deposition Modelling, Selective Laser Sintering, or Stereolithography), the printer deposits or solidifies material in each layer according to the digital design, gradually creating the full 3D object.

Material Deposition or Solidification: Depending on the method, material can be deposited as a melted filament, resin, powder, or metal that then solidifies to form each layer [6].

Fig1:Basic principle of 3D printing



Stereo lithography

This procedure employs liquid photopolymer resin and ultraviolet (UV) light, which solidifies the material upon exposure to UV radiation, thereby creating the model. As illustrated in Fig. 3, stereolithography represents a 3D printing method that constructs models and prototypes layer by layer through photopolymerization. This technique involves the use of light to link molecular chains, resulting in the formation of polymers that ultimately create a three-dimensional solid structure. Research in this field began in the 1970s, but it was Charles (Chuck) W. Hull who coined the term and secured a copyright for the process in 1986. Subsequently, 3D Systems Inc. was founded to commercialize his patent. Stereolithography (SLA) is a precise 3D printing technology that utilizes liquid photopolymer resin. In this method, the model material is cured using a UV laser beam to achieve the desired geometry. The liquid resin required for SLA printing is contained in a tank, where the working platform is gradually submerged and selectively illuminated by a UV laser in the areas designated for model creation. This curing process is repeated until the part is fully formed, after which it is cleaned with isopropyl alcohol to eliminate any uncured polymer. Finally, the printed model is placed in a specialized light-setting device to enhance its final properties.

Fused Deposition Modelling

The system comprises a filament roller that supplies filament to two additional rollers, subsequently directing it into a product in a semi-liquid form. This component is produced through a process that involves the extrusion of small material pearls, which solidify in layers, as depicted in Fig. 4. An extruder features a head that receives thermoplastic filament or wire coiled in a spiral configuration. The dust head is responsible for heating the material to a predetermined temperature and controlling the flow by turning it on and off. Typically, step motors are employed to maneuver the extrusion head in the Z-direction and to adjust the flow according to requirements. A computer-aided manufacturing (CAM) software application, operating on a microcontroller, can control the head's movement in both vertical and horizontal directions and manage the mechanism. Generally, the tolerance for Fused Deposition Modeling (FDM) printing ranges from 0.15 mm to 0.25 mm[2][6].

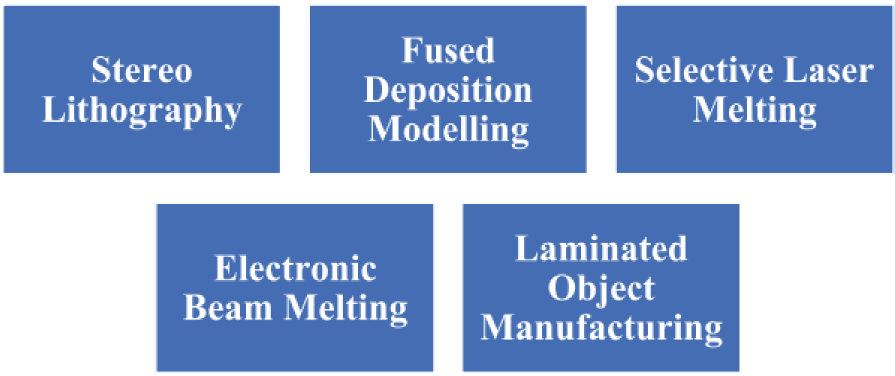
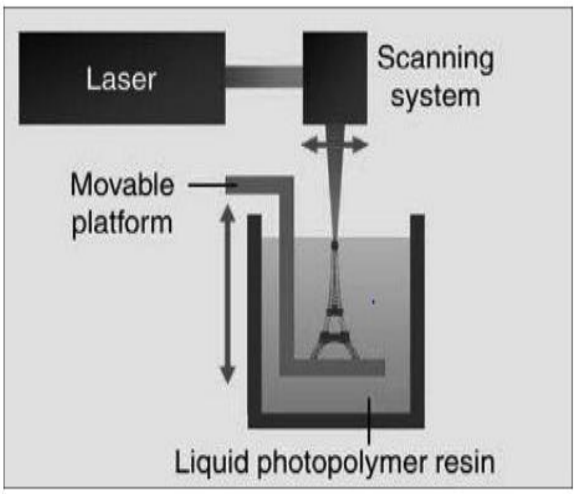


Fig.2- Basic Principles of 3D Printing

The primary advantages of FDM include the rapid adjustment of the filling in printed 3D models, facilitating the easy production of prototypes for verification and refinement. By utilizing low internal filling or even a hollow core, material costs can be reduced. Once the design phase is complete, final inspections can be conducted, or small to medium production runs can be initiated with the finalized filling of the respective 3D print[5]..



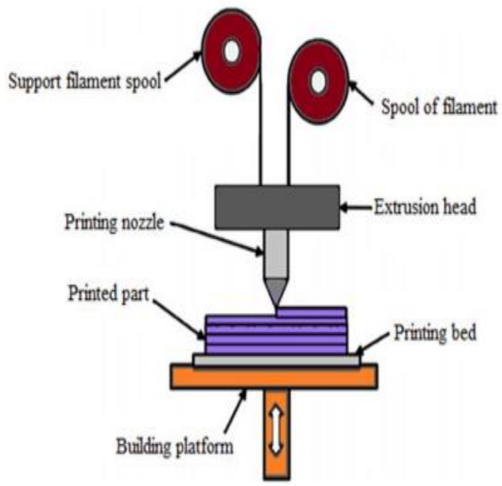
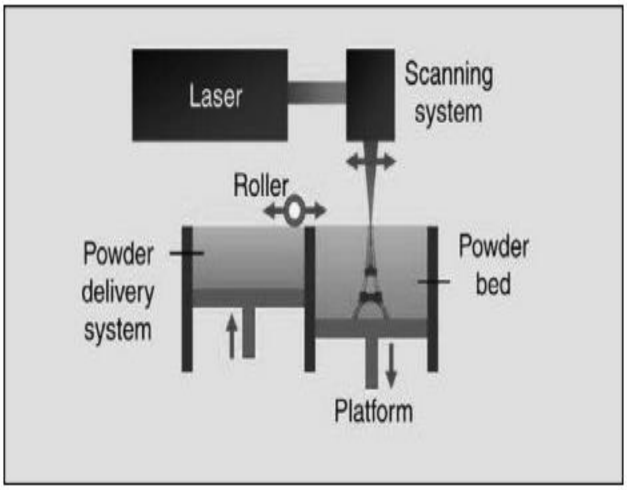


Fig.3- StereolithographyFig.4-Fused Deposition Modelling

Electronic Beam Melting

Instead of UV radiation, 3D printers employ electron beams. In the EBM process, the layer-by layer of metal powder that is shaped by a strong electron beam is built up completely dense metal components as shown in Fig. 6. The precise geometry of the 3D CAD model is melted into each layer. Great energy may be employed with great melting capacity and high productivity thanks to the EBM technique. Components are created in vacuum at high temperatures and are better than cast and equivalent to wrapped material, leading to stress-relieving parts. The electron beam scans the powder bed for each powder layer to keep the high temperature specific to different alloys. The electron beam then melts the outlines of the component and the bulk. [2]



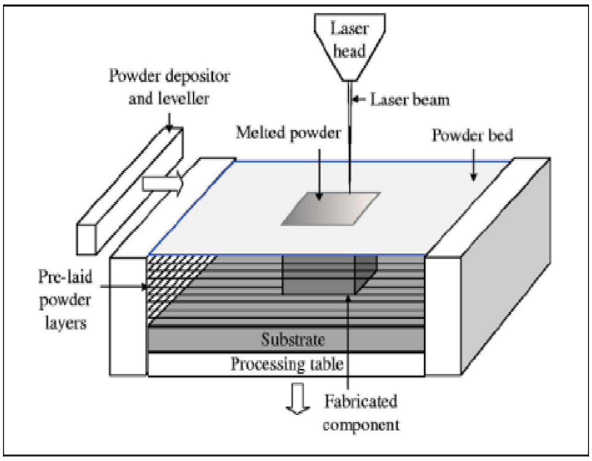


Fig.5- Selective Laser MeltingFig.6- Electronic Beam Melting

Laminated Object Manufacturing

The plastic, paper, or metal is then bonded together and then sliced to the required shape with laser. In it, sticky coated layers Laminates of paper, plastic or metal are gradually assembled and sliced into suitable form by laser cutters as shown in Fig. 7. The printed objects may be adjusted after the printing process by machining. This method' typical layer resolution is dictated by material feedstock and is typically one-to-a-number of many thick sheets.

RESULTS AND DISCUSSIONS :

3D printing is employed in the production of hearing instruments and some of the automotive components that demand more precision. In the car, the crane buckets. Components of the aviation now consist of 3D printers for a day since they are robust enough and light in weight. Fig. 8 shows detailing of Automobile 3D Printed partszThe report of the Commission. They are also utilized to make artificial eyes, jaws, faces and ore. 3D printing technology is widely used in AI. They are also employed in the production of 3Dprinter handguns. And a 3D printer is constructed from separate components of a gun. With the use of 3D printers, Nike makes several sports shoes. Fig. 9 shows 3D Printed hand for orthopedic applications [12]. The technology also makes patterns for the downstream metal casting of dental crowns and for manufacturing tools for the formation of plastic to build.[2]
3D printing can be used to create patient-specific implants that nearly replicate the anatomical attributes of the damaged tissues by combining medical images from technologies such as X-ray, CT, MRI, or ultrasonic scanning. Custom implants have already been the subject of many clinical studies.

FIG.10- 3D PRINTED DENTAL PART

CONCLUSIONS :

The initial chapter elucidates the 3D printing methodology employed in the manufacturing process. It also provides insights into the rapid prototyping techniques associated with additive manufacturing. Subsequently, we explore the various fundamental methods utilized in 3D printing, including stereolithography, fused deposition modeling, and selective laser melting, among others. The applications of these technologies span across multiple sectors, including medical, automotive, and aerospace industries. Furthermore, the chapter evaluates the advantages and disadvantages of 3D printers. Recent advancements in 3D technology are transforming the production landscape, facilitating global manufacturing and significantly improving processes. A computer-aided design (CAD) program is utilized to either scan or create an object, which is then divided into thin layers, allowing for the subsequent printing of a solid 3D item. It is widely recognized that 3D printing plays a crucial role in addressing various human needs.

The incorporation of augmented reality (AR) into Building Information Modelling (BIM) signifies a notable progression in the architecture, engineering, and construction (AEC) sector, providing a multitude of advantages throughout the entire project lifecycle, encompassing design, construction, and facility management. This technology fosters improved visualization and collaboration, while also enhancing decision-making, operational efficiency, and client satisfaction, thereby propelling innovation within the AEC industry. This initiative has revealed the substantial potential of AR technology in revolutionizing the interaction of construction professionals with digital models in real-world environments. A critical aspect of this integration involves the energy analysis outcomes produced by Green Building Studio, which take into account various influencing factors such as openings, glazing, and diverse building orientations. By evaluating these elements, the project yields essential insights into energy performance, empowering stakeholders to make well-informed decisions. As we persist in exploring new opportunities and refining current applications, it will be vital to promote collaboration among all stakeholders. The future of AR in the construction sector appears even more promising; with continuous advancements in AR hardware and software, we can expect increasingly immersive experiences and enhanced functionalities, further optimizing building design and performance.

REFERENCES:

1. P.F. Jacobs. Stereo Lithography and other RP&M Technologies: From Rapid Prototyping to Rapid Tooling, Society of Manufacturing Engineers (SME), Dearborn, 1996, p. 450.
2. Tamir, Tariku Sinshaw, et al. "3D printing in materials manufacturing industry: A realm of Industry 4.0." Heliyon (2023).
3. Nizam, Maruf, Rajesh Purohit, and Mohammad Taufik. "3D printing in healthcare: a review on drug printing, challenges and future perspectives." Materials Today Communications (2024): 110199.
4. Pathak, Kalyani, et al. "3D printing in biomedicine: Advancing personalized care through additive manufacturing." Exploration of Medicine 4.6 (2023): 1135-1167.
5. Jeong, Min, et al. "Materials and Applications of 3D Printing Technology in Dentistry: An Overview." Dentistry Journal 12.1 (2023): 1.
6. Song, Yongzhi, et al. "An overview of selective laser sintering 3D printing technology for biomedical and sports device applications: Processes, materials, and applications." Optics & Laser Technology 171 (2024): Ntousia, Margarita, and Ioannis Fudos. "3D printing technologies & applications: an overview." Proceedings of the CAD 2020 Conference, Singapore. Vol. 243. 2019.Ganesh Kumar and P.Vasanth Sena, "Novel Artificial Neural Networks and Logistic Approach for Detecting Credit Card Deceit," International Journal of Computer Science and Network Security, Vol. 15, issue 9, Sep. 2015, pp. 222-234
7. Sun, Jie, et al. "An overview of 3D printing technologies for food fabrication." Food and bioprocess technology 8 (2015): 1605-1615
8. Jadhav, Aniket, and Vijay S. Jadhav. "A review on 3D printing: An additive manufacturing technology." Materials Today: Proceedings 62 (2022): 2094-2099.
9. Srinivasan, D., et al. "3D printing manufacturing techniques, materials, and applications: an overview." Advances in Materials Science and Engineering 2021.1 (2021): 5756563.
10. Gebler, Malte, Anton JM SchootUiterkamp, and Cindy Visser. "A global sustainability perspective on 3D printing technologies." Energy policy 74 (2014): 158-167.
11. Pshtiwan Shakor, Jay Sanjayan, Ali Nazari, Shami Nejadi. Modified 3D printed powder to cement-based material and mechanical properties of cement scaffold used in 3D printing, Science Direct.