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MEDICAL APPLICATION FOR 3D PRINTING

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Abstract: One of the innovations brought forth by the industrial period is 3D printing technology. It has been a part of our life for a long time. It is quickly evolving and employed in a variety of industries, including the aviation and defence sectors. In recent years, the medical industry has frequently preferred this miraculous production technique. This paper introduces 3D printer technology, discusses various 3D printing techniques, and refers to the usage of this technology in biomedical applications. The applications of 3D printing in surgery, the pharmaceutical industry, disease modelling, the creation of custom implants and prostheses, organ printing, veterinary medicine, and tissue engineering have been discussed, and this new technique has been contrasted with conventional methods that are currently used in the biomedical field. Additionally, this paper explores potential future directions.

Keywords: Anatomical models, pharmacologic at model, Prostheses, implants, surgical devices, auxiliary medical equipment

I. INTRODUCTION

The phrase"additive manufacturing"(AM)refer to processes that create physical products from three-dimensional (3D) digital data by "process of joining materials to make objects from 3D model data, typically using computer-aided design (CAD) software" (ASTM International Committee F42).as opposed to subtractive manufacturing techniques, layer after layer.1 This is a collection of industrial AM procedures, often known as 3D printing, that use computer-assisted manufacturing (CAM) techniques to layer-by-layer create real-world 3D items from computer-aided design (CAD) models. As a result, additive manufacturing, also referred to as 3D printing, is a manufacturing process that allows for the creation of items by melting or depositing materials onto or into a substrate.

1.1 Surgical Planning

One of the possible applications of 3D printing that have emerged is surgical planning. This involves studying the anatomy and physiology of defects in complex organs such as the brain or the heart, or anatomical specimens such as the pelvis or the spinal cord, and using the information for surgical planning. 3D models can assist surgeons to study the impaired organs before the operation, explore various approaches and acquire hands-on experience before entering the operating room. This process shortens operation time significantly, and ultimately improves the outcome of the operation for the patients, the surgeons, and the patients' care providers.

1.2 Prostheses

A variety of disabled people who have been injured by an accident or a genetic defect can now lead normal lives because to recent advancements in 3D printed patient-specific prosthesis. using powerful high A precise anatomic prosthesis can be produced using 3D printing, a high-quality imaging technology, for use in a variety of medical procedures. The area of dentistry has also been significantly impacted by this.

1.3 medical training and education

The use of cadaveric training materials to instruct new medical doctors has generated debate. This is brought on by both moral concerns and the expense of the procedures. In many situations, including those where using a cadaver is not an option, 3D printing technology may provide an innovative and efficient alternative by accurately replicating complicated anatomical organs using high resolution CT imaging. Additionally, training facilities greatly benefit from 3D printing's capacity to generate numerous replicas of any anatomical subject in various sizes.

1.4 Health-Related Studies

The creation of innovative treatments for various diseases and tumours as well as the automated manufacturing of cell structures for toxicity testing have all been made possible by the development of printers soft enough to print cells directly. Up to 50% of medications that pass preclinical testing are later discovered to be hazardous to people, while other drugs that tested toxic in animal testing may turn out to be safe for people. Researchers can therefore expedite their work since they can reproducibly print tissues that closely mimic the cellular organisation found in real tissues and organs. Here, we discuss some recent developments in medical research that are relevant to these application

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1.5 Organ printing

Although less developed than the other technologies discussed in this article, this one has the potential to revolutionise medicine and render synthetic artificial organs and organ transplants obsolete.

1.6 Delivery of drugs

Undoubtedly, when 3D printing becomes a part of pharmaceuticals, drug delivery will change. Drugs can be printed with different sustained release and quick release layers, allowing the dosage profile to be changed, in addition to doses that are specifically calculated for each individual. This assists patients who are taking a lot of medication, as they may be able to take fewer tablets as a result of personalised therapy. Devices for 3D printing drugs that precisely match a patient's anatomy are also in development.

The variety of industries covered in this introduction demonstrates how 3D printing technology is transforming medicine. In fact, there are currently so many uses for 3D printing in medicine that a thorough investigation would be necessary.

II. LITERATURE SURVERY

Paper 1: Recent developments in 3D printing's use in medicine
Gordon M. Paul, Amin Rezaienia, and Pihua Wen are the authors.

ABSTRACT: This article reviews some recent advancements in the use of 3D printing to medicine. A quick description of how and why 3D is altering medical practise, instruction, and research serves as an introduction to the subject. Then, using recent developments in the industry as examples, we demonstrate the state of the art. This article's conclusion assesses the present 3D printing for medical applications limits and identifies potential areas for further development.

Paper 2: Future Opportunities and Trends in Biochemical Applications of 3D Printing Technology
Turkish authors Kadikoy and Istanbul

ABSTRACT: One of the innovations brought forth by the industrial period is 3D printing technology. There have in our life for a very long time. It is quickly evolving and employed in a variety of industries, including the aviation and defence sectors. In recent years, the medical industry has frequently preferred this miraculous production technique. This paper introduces 3D printer technology, discusses various 3D printing techniques, and refers to the usage of this technology in biomedical applications. It has been discussed how 3D printing is used in veterinary medicine, surgery, the pharmaceutical sector, illness models, the creation of customised implants and prostheses, organ printing, and tissue engineering applications.

Paper 3: THE FUTURE OF 3D PRINTING IN MEDICINE, Al Mughiah, Salahaldin Ebrabim, and Meena Mekhael Fahem are the authors.

ABSTRACT: A technology to bring ideas to reality has been made available to people in a variety of industries thanks to three-dimensional The use of 3D printing in the medical industry is not new. used since its creation in a variety of applications. We will briefly explore the various additive technologies that are now on the market in order to clarify their distinctions. The present uses of 3D printing in medicine can be broken down into four categories: research, equipment modification or manufacturing, patient care, and medical education. Examples of upcoming research and technology that might become accessible in the near future are used to illustrate the different applications in these areas. Despite 3D's advantages

PAPER 5: Advanced 3D printing technology and its use for medical supplies
Daoyang, FanYanLi, and Hang Cai

ABSTRACT: Patient-specific anatomical level productions are made possible by three-dimensional (3D) printing.with excellent microstructure resolution and flexibility. 3D printing has emerged as a top healthcare and pharmaceutical manufacturing technology with cost-effective manufacturing for high productivity. It is suitable for a wide range of applications, including tissue engineering models, anatomical models, pharmacological design and validation models, medical apparatus and instruments.

Today, 3D printing offers clinically viable medical items and platforms appropriate for developing research domains, such as manufacturing organs and tissues. The purpose of this review is to discuss cutting-edge 3D printing technology and its use in medical materials. Additionally, the additive overview offers manufacturing methods and printable materials.

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III. TECHNOLOGIES

There are roughly twenty AM techniques, however only a few of them are used often in the medical sector. The primary cause is the unique fabrication procedure and raw materials needed to achieve the rigorous standards for medical devices. The four most popular AM methods are: powder-based printing Vat-based polymerization printing Extrusion-based printing and printing using droplets

Power based printing

A promising method for creating unique objects with a variety of outward shapes, interior structures, and porosities is powder-based 3D printing. Direct metal laser sintering (DMLS), selective laser melting (SLM), selective laser sintering (SLS), and electron beam melting (EBM) are the four most popular powder-based printing processes. Each method relies on localised heating to produce melted metallic powder, which is then used to create the unique products.

These four powder-based printing methods clearly differ from one another in terms of both the printing process and the characteristics of the final output. Powder particles are bound with laser rather than spray solution for SLS and DMLS. During printing, a layer of the powder bed is covered with a laser to create precise designs.

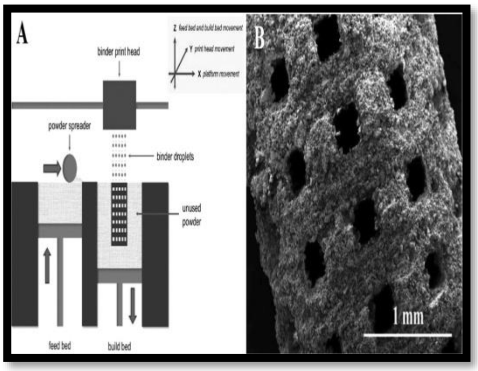

Fig -1 power based printing[2]

Droplet Based printing

With the help of hundreds of jets, liquid material droplets are ejected and polymerized in the material jetting technology process. Only for specifically designed structures does directed UV polymerization take place. Aerosol jet printing (AJP), binder jet printing (BJP), and poly jet printing (PJP) are all examples of material jetting technology (Figure 4). Layers of composite in aerosol suspension are discharged onto the substrate during AJP while being transported by N2 gas. With AJP's low printing temperature, a variety of materials, including metals, polymers, and ceramics, can be employed, which is advantageous for bio manufacturing. In contrast to SLS, binder jet printing (BJP) does not require a thermoplastic excipient. Specific ranges of surface tension (35–40 mJ/N) and viscosity must be met by the binder in BJP.

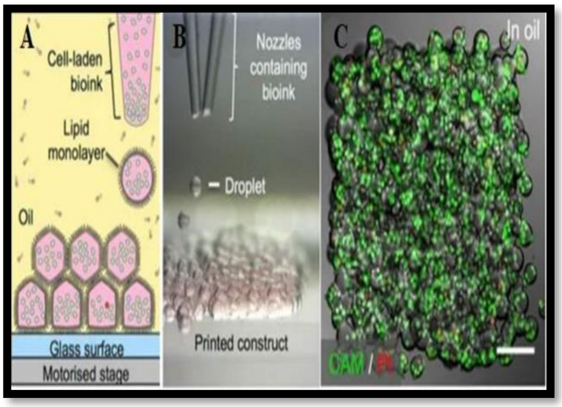

Fig -2 droplet based printing [4]

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Extrusion based printing

S. Scott Crump invented extrusion-based printing, also known as fused deposition modelling (FDM) or fused filament fabrication (FFF), in 1988. The extrusion of thermoplastic or composite materials drawn through the hot extrusion head (with one or several extrusion nodes) is the foundation of the established technology known as FDM. Layer by layer, fused materials were deposited using nozzles that were moved horizontally and vertically by a machine tool under numerical control. Metal, polymer, and bioprinting all use extrusion-based printing extensively.

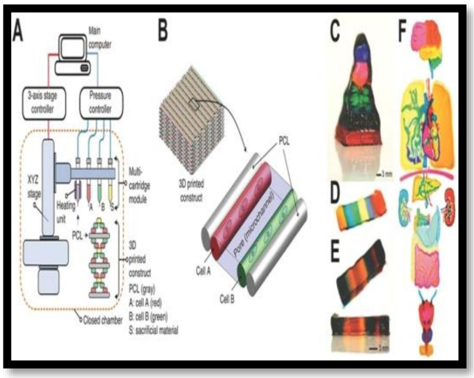

Fig -3 extrusion based printing[5]

IV. WORKING PRINCIPLE

Real anatomical structures of a patient must first be digitally captured in order to create a 3D print that is unique to that patient. In order to create a volumetric image of the anatomy, this technique makes use of 3D scanning technologies like MRI, X-ray CT, or 3D ultrasound. To identify structures of interest and create a 3D computer model, the photos must be segmented and tagged. Depending on the scanning mode, anatomical subject, and image quality, a wide range of procedures are used here. Traditional methods take a lot of time and knowledge, however programme with sophisticated segmentation capabilities, like Simple ware software, can speed up this procedure.

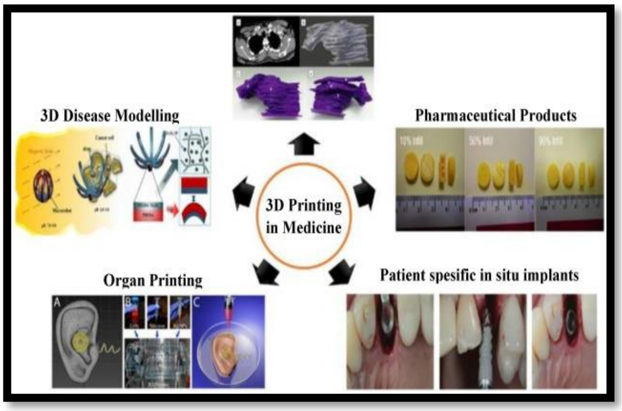

Fig-4 working principle of 3D printing

The potentially multi-part 3D models are reduced to a collection of surface meshes and made ready for 3D printing by the addition of connections and surface colour data. In order to disassemble the resulting print and more easily view diseases or interesting features, the surfaces may also be partitioned. Finally, the surfaces are exported to the 3D printer, often as STL files, where the printer software will understand them and add support material as well as compute and execute the printer head paths required to layer material and create a physical replicate of the computer model.

APPLICATION

- Medical Industry 3D Printing Software for Detailed Visualizations.
- Create Custom 3D-Printing Tools for Medical Industry.
- Prostheses Tailor-Made for patients.

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- Bone and Joint Reconstruction.
- Bioprinting Artificial Organ and Tissue

ADVANTAGES

- Flexible Design
- Rapaid Prototyping
- Print on Demand
- The most durable and light-weight parts
- Rapid Design and Production
- Depth of focus
- Minimising waste
- Cost-effective
- Advanced Healthcare

FUTURE SCOPE

The use of 3D printing in medical applications holds out a lot of hope for the future; despite this, there are still a lot of obstacles in the way of its implementation. Research aims to successfully 3D print organs for transplant, and soon there might be advancements that permit autologous 3D printed organs made from a patient's cells.

However, it is still challenging to 3D print the intricate cytoarchitecture of organs. Additionally, 3D printing could be employed more as a teaching tool. For medical businesses, research explores adapting current products to enable 3DIt makes sense for research to focus on printing and increasing the types of materials that can be 3D printed, as well as enhancing the effectiveness and speed of 3D

CONCLUSION

In order to transform healthcare, 3D printing in the medical industry and design needs to look beyond the box. The capacity to treat more individuals where it was previously impractical, achieving patient results, and requiring less time in the direct care of medical specialists are the three key foundations of this innovative technology. In a nutshell, 3D printing allows doctors to treat more patients without compromising quality of care.

As a result, 3D printing has opened up many benefits and opportunities in the medical industry. This is illustrated by each single instance of 3D printing's use that is presented in this examination. However, in order to ensure its accuracy, it must be complemented with modern legislation.

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