

Bioengineering in the Development of Artificial Hips, Knees, and other joints. Ultrasound, MRI, and other Medical Imaging Techniques

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Abstract

The bioengineering technique is developed as a method that is essential to combine different dead and inorganic materials with a living elements. Artificial organs are human-made organs that are helpful for providing a specific function for the patients to reach normal life soon. Improvement in healthcare can be possible to reach with properly aligned different artificial organs that are helping to overcome serious situations in life. In this research, the secondary qualitative method is used which is beneficial for completing the study in an effective way. Different previous published research in different journals, articles, and books are referred to for completing the research which is important for gaining proper growth for the research. Different aspects of bioengineering in the field of providing artificial body parts for humans are discussed in this research which is helping them to recover from any disease or impact of an accident. The overall impact on society and growth in the life developed due to artificial organs are also discussed in this research. Medical imaging techniques are helpful to create growth for research by providing the right track to growth. A proper understanding of diseases can be possible with the help of these technological advancements that are able to eliminate difficulties that are growing in human health.

Keywords

artificial organs, Bioengineering, biomedical engineering development, MRI, prosthetics, replacing organs.

INTRODUCTION

Different application principles are developed with engineering principles that are beneficial for different designs and analyses for biological systems and development in biological technologies. Biomechanics, systems physiology, bioinstrumentation, and rehabilitation engineering are the specialist areas of biomedical engineering. Different diagnostic and therapeutic medical devices are used as clinical equipment for micro-implants. The imaging techniques used for bioengineering, MRI, and EEG, the common method that is used for diagnosing and monitoring different issues in the body, help to understand the difficulties. The problem-solving techniques for engineering in biology and medicine are referred to as biomedical engineering. Artificial Organs, kidney dialysis, Surgical robots, different advanced prosthetics, and new pharmaceutical drugs are commonly used for biomedical engineering. With the help of different latest innovations in the bioengineering field, BME is developed for understanding tissue engineering. Biomedical engineering is helping to improve human health and bioengineering is focusing on a broader scope in pharmaceuticals, natural resources, and agriculture. MRI machines and dialysis machines are commonly used machines for bioengineering processes that are beneficial for ensuring human health by finding difficulties. Biomedical engineering is ensuring a better way for the future as it is beneficial for completing operations with robots that are helping surgeons to perform the operations efficiently. Pharmacogenomics, genetic

testing (prenatal diagnosis), and gene therapy are the applications that are using biotechnology for health purposes.

In this study bioengineering development in different medical fields is explained, including the development of artificial hips, knees, and medical imaging techniques used for understanding issues for people's health. Secondary qualitative research methods are used for completing this study which is beneficial for ensuring proper growth in this research. Different sectors of artificial bioengineering and its development are properly explained in this research which is essential for the improvement of the medical field.

LITERATURE REVIEW

Evaluation of artificial bioengineering in developing different artificial organs for humans

The importance of artificial organs is an essential part of ensuring growth for humans. These are also playing an important role in gaining strength for humans by replacing or repairing the damage to the organs and tissues of a human. Connection is developed with human cells, tissues, and organs without being rejected by the body, the special feature of biomaterials that are used for developing different artificial body parts. Transplantation is helping to save the life of humans and able to restore any defective or failed organs on a temporary or permanent basis. Facilitating humans from any injury and damage is developed with the help of biological functions that are beneficial for different organs in humans. Artificial hearts and pacemakers, providing dialysis for ensuring kidney performance are

important artificial organs that are available for humans to replace missing limbs [1]. In modern times scientists are continuously developing different ways for creating a newer, cheaper, and safer pathway for providing new life for humans to survive by providing artificial hips, knees, and other joints. Those are able to reduce the risk of losing their life or being in a disabled condition.

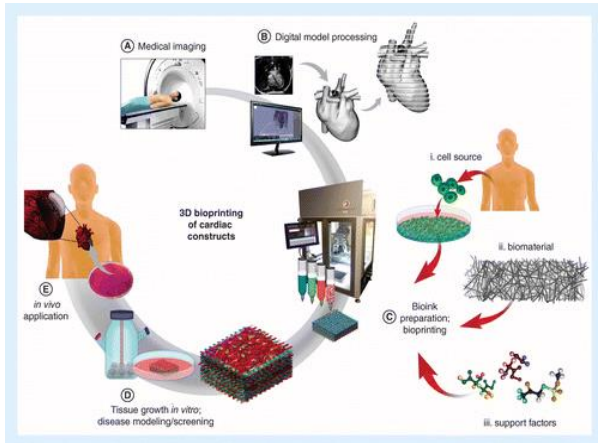


Figure 1: Artificial bioengineering for developing different organs
(Source: 2)

The future of humanity is able to ensure growth with artificial intelligence with the help of different emerging technological advancements such as big data, robotics, and IoT. The effective success rate for developing artificial organs is increasing in a viable way that is gaining the trust in artificial organ replacement. The re-establishment of the human body's fundamental needs is ensured by providing proper bioengineering development to replace the organs [2]. Replacement and development of different functional human tissues, like bones, retina, kidney, blood vessels, nerves, and pancreas are gaining attention by encouraging bioengineering development. Different nano and micro-structured membranes that are combined with functional cells are helping to ensure the cell microenvironmental growth.

Different bionic principles are providing techniques that are aiming toward an effective way of manufacturing various organs on the basis of bioengineering principles. The artificial organs are helping to ensure a translational effect for the human organs leading towards a better way for development. The brain is a valuable organ that cannot be developed with the help of any artificial organ.

Importance of bioengineering for developing artificial parts of the body

Bioengineering is a process that applies all kinds of engineering principles of analysis and design to biomedical technologies and biomedical systems. Biomedical and bioengineers generally install, provide and maintain all kinds of technical support for biomedical equipment. This engineering process has the power for translating biological knowledge into cost-effective, economically viable products, processes and practices, and usable products to “real world” issues. Nowadays bioengineering is one of the major

platforms that make artificial equipment and other organs to improve treatment procedures[3]. In the modern era, people are able to replace organs and tissues with the lab-generated equivalent by TE or tissue engineering process. On the other hand, this process can generate and create various kinds of devices, systems, and procedures that will assist in medical health care. This process also includes devices and design equipment such as diagnostic medicine, replacements of body parts, internal organs, and many more[4]. There are various artificial organs such as artificial hearts, artificial hips, knees, and other joints that help to make a huge impact on modern medical science and treatment processes. On the other hand, bioengineering provides opportunities for medical practitioners and individuals to get rid of their difficulties earlier. Artificial organs help to save lives and are also able to replace damaged and bad genes to cure diseases. There are various factors that are interconnected with the bioengineering process such as maintenance, cost, and demands. The engineer needs to maintain all the factors before creating a device or organ[5]. All devices have some significant values and those help to improve the well-being of people and develop their daily lifestyles as well. Nowadays people who are suffering from orthopedic issues are trying to use artificial joints, artificial knees, hips, and other substances. It helps to provide relief from pain and also improves mobility also. Between 15 to 20 years they will need to change their artificial knees. Through the surgical procedure, professionals are able to replace the organ, and after recovery, individuals are able to engage in some low-impact activities such as swimming, walking, biking, and others.



Figure 2: The artificial body parts development
(Source: 5)

After that during the hip replacement process, a medical practitioner removes the portions of the damaged hip and also replaces those parts in the body. Generally, those parts are made of ceramic, metal, and hard plastics. These prosthetics also assist to decrease the pain that is associated with arthritis and also restore mobility. Every hip transplant system has some unique design and features such as shape, size, method, dimensions, and material. Apart From this cartilage or articular cartilage can be weakened and damaged over time. Joint replacement surgery is one of the innovative treatment procedures used to improve the physical condition and helps to get back the individuals to normal life. In medical science

artificial heart, artificial valve, and strain replacement is the common surgical process that provides a secure lifespan to patients and it plays a major role in the health care system [6]. Some people use a pacemaker which is a small device that is placed in the chest of a human. It helps control the heartbeat and this device prevents the slow beating of the heart. In order to implant, a pacemaker in the chest requires a surgical process and this device is also known as a cardiac pacing device. The artificial hands and legs can provide mental strength for humans to rejoining in the workplace which is beneficial for gaining growth in society and aiming towards a better way of development in the modern world.

Medical imaging techniques make an impact on the treatment process

Medical imaging is the process that refers to several different kinds of technologies that help to monitor, diagnose, and treat medical conditions. In this context, each type of technology provides different kinds of information about the body or organ. These technologies also help to detect the disease, treatment effectiveness, and injury as well. It can be said that bioimaging is one of the attractive parts of medical science and it is also highly connected with bio or biomedical engineering [7]. It provides clear views of organs and provides high-definition images that assist the professionals to provide better suggestions to the patients. On the other hand, this technical facility is used as a decision-making tool for medical professionals. through the digital report, they can able to create a map of their treatment process that also helps to begin the treatment in an easy way. These technologies use various sensor, devices, magnets, cameras, and AI that allows capturing the image of a body part. On the other hand bioimaging technologies also provide some essential information about the body that can not be get by the manual process. These kinds of technologies use circuits and electrodes that can able to check the frequencies and waves of the brain and heart. In modern days several hospitals use these technologies for providing better services to their patients. Basically, the bioimaging process improves the entire concept of the medical industry. Through these technologies, professionals provide the proper treatment very fast that makes an impact on the individual psychological aspect [8].



Figure 3: The artificial organs for human
(Source: 9)

Magnetic resonance imaging or MRI uses computer-based radio waves and a magnetic field that is able to create a description of organs or tissues. Accordingly, a CT scan is one of the updated versions of XRAY and it helps to create the images of the scan portion of the body. There are various kinds of imaging techniques such as PET, and MRS. X-ray and ultrasound pictures can reveal the anatomical structures and the functional ideas that help to measure the transformations or changes in the physiological functions such as blood flow, biochemical process, metabolism, and local chemical compositions [9]. This technique basically provides the structures of bone, cavities of soft tissues, and metal implants. MRI provides high-resolution pictures and it has 3d and 2d facilities that assist to guide professionals and patients to diagnose diseases and treatments. Artificial intelligence is also used in those techniques. From several studies, it has been seen that AI and deep learning develop the medical sectors and play a significant role in drug development, patient monitoring, diagnosis and imaging also. It provides benefits to storing huge amounts of data in memory and also gives suggestions in emergency conditions.

Difficulties in using the bioengineering imaging technique

In the modern era, the Bioengineering sector successfully introduced modern technical facilities to the world. These kinds of technologies provide effective solutions for treatment and diagnostic processes. From several studies, it has been seen that individuals also show interest to take advantage of technology. Though this technology has various problems and issues that can be considered a major difficulty for individuals and hospitals authority.

Price: budget or price is one of the major difficulties due to all hospitals can not afford these facilities. The machines are costly and in order to implement them in the hospital, the authority needs to recruit the technical staff. On the other hand, individuals need to pay a big amount for the imaging

test which is not possible for all people. Accordingly, maintenance cost is one of the external expenses for the organizations.

Technical issues: technical issues is another big issue and sometimes it may face technical issues. This situation is highly responsible for the wrong treatment of individuals and its impact on the individuals. Scientists are continuously trying to develop different solutions for providing a smooth and hassle-free way to provide different artificial organs to humans for aiming towards a better life.

Impact on the body: technical process uses various kinds of sensors, electrodes, and rays to capture the pictures from the body. Medical practitioners place those sensors on the body with some glue-type substance that can be the reason for rashes and itching[10]. Frequently using rays makes an impact on the body and affects the cells of the body as well. Those factors can make a little negative impact on the hospital industry.

METHODOLOGY

Research methodology is the essential part of every study and each study follows the step of methodology. The methodology part has some sub-parts such as research philosophy, research design research approach, data collection, and analysis. All are essential for the study and guide to reach the objective of the study. Researchers choose the research philosophy based on the knowledge and assumption of the topic. This study has selected positivism as a research philosophy that helps to provide exact guidance in the research work. On the other hand, this study focused on the inductive approaches that assist to increase the value of research. Many researchers used the deductive approach to examine the hypotheses. This study has not used any kind of hypotheses which is why the deductive approach is one of the best approaches for the research work[11]. Accordingly, the research design is also an essential part of the research study. Several sources and data have been used in this research study that is recommended to select the case study research design method. The secondary qualitative process has the provision to get the data from various sources and use the data as necessary[12]. In this study, data has been utilized as per the requirements of the study. The medical industry of one of the biggest industries in the world and it makes a renaissance in the health sector.

In order to complete the research secondary qualitative methods are used. This research methodology is used for ensuring a better outcome of the research that is beneficial for gaining a better pathway for the research. In the field of biomedical engineering different latest growths and innovations are gained from the internet, books, journals, and other sources[13]. These published researches are beneficial for helping to promote a better way in the research as different new elements in the field of artificial organs and other medical fields are ensured. Different reliable sources from the internet are used for completing the secondary research that are providing authentic information about the

research topic helping to understand the issues and different new innovative ways in the field of biomedical engineering field. In the field of biomedical engineering innovative ways are important for achieving the desired growth that is the essential material for understanding the research process in modern times [14]. Google scholar, google search engines are used for finding the appropriate articles linked with biomedical engineering development in the field of artificial hips, knees, and other joints also helping to observe any difficulties in the body with medical imaging techniques [15]. The proper and easy way of data collection is helping to complete the research within the time limit and in a cost-effective way that is promoting growth for the researchers. Secondary qualitative research is also helping to understand any difficulties that previously affected the completion of the research in the field of bioengineering which is helpful for gaining overall strength [16]. The easily collected data with the help of different articles, and journals are helping to find out different advancements that are developed throughout the world in the field of bioengineering.

DISCUSSION

From this study, it has been that bioengineering is the biggest platform for the medical field and it provides the opportunity to analyze and designs the entire biological system. In biological and medical development bioengineering process plays a significant role and it develops the process and procedure of treatment. There are various kinds of artificial prosthetics that help to improve the daily life of the individual. On the other hand, there are different kinds of devices that improve the entire healthcare system. Basically, bioengineering focus on the wide scope of pharmaceutical and natural resources, and this technique is also considered a decision-making tool for professionals.

From this study, it can be observed that artificial body parts make a big revolution in the medical industry. This helps the individual to get rid of pain and other difficulties. These also get them back into their daily and natural life [17]. Many people have been suffering from joint, and knee issues for several years. Medicine cannot provide relief and those medicines cause other side effects in the body. The bioengineering process gives the replacement opportunity and in this case, medical professionals place the artificial organs in the body and also remove the damaged organ from the body. In the modern era, some people are using artificial arms and legs who have lost their organs in accidents or other issues. These prosthetics are mainly made of metal, ceramic, and other kinds of materials, and for up to 15 -20 years, patients are able to carry these organs safely.

It also has been observed in this study, that medical imaging is one of the other essential parts of medical science and these processes change the whole structure of the medical industry. MRI, SC SCAN, PET, ECG, EEG X-ray, and Ultrasound technologies have the capability to capture pictures from the internal part of the body[18]. X-ray and

ultrasound provide a clear picture of the bone that detects the issues in an effective manner. These kinds of technology used various kinds of sensor or ray that helps to get a high-resolution and clear picture of the body part or organ. Accordingly, it can be stated that imaging material has the capability to detect the earlier with zero error. These facilities are able to reduce the rate of disease and difficulties. On the other hand, there are various kinds of limitations to using technologies in the medical sector. Budget can be considered a major issue due to these innovative machines are much more costly and all hospitals are not capable of main the facilities due to high maintenance costs [19]. Hospital authorities need to appoint the technician getting and provide the service. On the other hand, technical issues are common factors in the issues that can make some effects on the treatment process. Different failed organs are replaced with artificial organs that gains growth for the medical industry for overcoming different issues in human health. Artificial hips, knees, and joints are replaced with the help of bioengineering are aiming towards better growth in the future which is also helping to encourage the progression of providing better health for humans [20]. The imaging techniques are also helping to make life easier for humans by providing an exact way of understanding the difficulties that are growing. Biomedical growth is aiming towards an effective way to overcome difficulties that are developing different elements that are used for designing and creating equipment, devices, computer systems, and different essential software for healthcare purposes [21]. Expenditures in healthcare are increasing in a way that is focusing towards growth for engineering and sciences are helping to overcome these issues and provide different cost-saving materials that are able to gain growth for the future. Organ manufacturing is developed into different parts which are divided on the basis of automation. These parts are fully automated, semi-automated, and manual. Organ failure is leading towards a leading cause for mortality that is ensuing mortality of a person. Interfacing with the living tissues the artificial organ development is interfacing with living tissue is associated. Transplant shortage can be solved by artificial organs helping to save the life of humans which is gaining developing growth in medical history. Advanced 3-D printing and tissue engineering are developed for completing the research that is organs in physical and physiological functions that are increasing nurturing vasculature, hormones, and growth and modeling as the individual grows. The artificial organs are developing an orthopedic device and neurological support, and visual support is helping to ensure blood cell and tissue replacement that are developing autoimmune and metabolic therapy treatments. The evaluation that is aiming toward better growth in the sector of bioengineering is helping different medical equipment providing a way of encouragement in the field of medicine. Artificial organs, kidney dialysis, advanced prosthetics, surgical robots, and new pharmaceutical drugs are developed with the help of biomedical engineering. Different designing

processes are helping towards for providing health care materials that are essential for ensuring the growth process in the medical field. Patients are able to get help with different technological advancements that are aimed toward better growth and development in the healthcare process these are contributing to life-saving elements. In the modern world, bioengineering development in the medical field is aimed toward visible difference in life by saving patients from critical conditions.

CONCLUSION

From the above study, it can be concluded that bioengineering is gaining an important part in human health. This is beneficial for providing a better opportunity for humans to ensure benefits in health-related issues. Artificial hips, knees, and other joints are providing a better way of living for patients suffering from serious issues or getting damaged by these organs due to accidents. Imaging techniques like MRI and EEG are helping to produce an exact result of abnormalities in human health. The secondary qualitative research methodology used to complete this research is beneficial for gaining progress to complete the research more efficiently, fluently, and in a cost-effective manner. Understanding the use of artificial body parts are providing better knowledge for getting a cure for different diseases temporarily or permanently. Problem-solving of different difficult situations that are arrived due to accidents or diseases can be solved with the help of artificial organs. Prosthetics are used to solve different issues of patients suffering from problems of losing hand legs and other replaceable artificial organs. Surgical robots are also used to complete the process of replacing organs that are beneficial for providing a better opportunity for humans suffering from difficulties. This study has shed light on the technologies that make a huge impact on the medical world. The imaging process has the capability to detect issues from the body and artificial intelligence also provides huge opportunities to save all previous data on cloud storage. This data helps to get a suggestion in the emergency condition and also suggests to provides the solution to the major difficulties. Nowadays Medical professionals can diagnose the disease quickly and start the treatment as; per their priority. The bioimaging process also can able to read the entire biological system in humans and it has the provision to monitor the patient regularly. ECG and EEG machines have high-power sensors that are able to create and measure the frequencies of waves. There are some robotics devices that can help to activate the nerve movement of individuals. At last, it can be said that bioengineering is a blessing for the world's medical sector.

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