Bmed-H
e-ISSN: 2582-7405
Transaction on Biomedical Engineering Applications and Healthcare
Vol-2 Issue-2, October 2021

An Overview of Biomedical Imaging and Image Processing that Mirror Breakthroughs in Medical Science

Suresh B[1*], S.Santhosh Kumar[2]

[1] Bapuji Institute of Engineering and Technology, India
[2] St. Xaviers Catholic College of Engineering, Anna University, India
*Corresponding Author Email: drbssmg@gmail.com

Abstract

This study mirrors an idea about biomedical imaging and image processing and its importance in developing entire field of medical science. In recent period, health situations of human beings have improved due to the evolution in medical science and one of those precious factors that bring this vast change is biomedical imaging. Optical microscopy, MRI, and infrared sensor technology play an essential part in identifying and mitigating several health issues faced by individuals. In this study, secondary data related to notion of biomedical imaging and image processing has been gathered. The application of technological advancement leads to the major effects within medical science. Biomedical images and major imagery have been getting popular in the meantime which make easy access to toughest diseases within a less time bound. The major objectives of this imagery are: clarify the body structure, make perfection on certain medical observations. CT scan, PET and USG machines are used by a hospital for maintaining biomedical imaging and image processing. Importance of these machines is to provide proper treatments and services to patients. 3D images of a body play an essential role to identify problems.

Keywords

Biomedical imaging, CT scan, Image processing, Medical science.

INTRODUCTION

Biomedical image processing includes the purchase and examination of images and in biology and medicine such as “computed tomography (CT)”, “magnetic resonance imaging (MRI)”, “infrared sensor technology”, “nuclear medicine”, and “optical microscopy”. One of the most important advantages of medical image processing is, it permits for in-depth, however non-interfering investigation of internal analysis. Biomedical imaging is based on improving and estimating new picturing processes and approaches, development of systems and surrounding devices [1]. Apart from this, novel methods of signal purchase and re-erection, combination of imaging difference and healing agents, technique design, image refining and computational investigation are also included. Central research areas involve MRI, ultrasound, PET, optical imaging molecular and functional probes, developed picture examination process and decision support of clinics.

Instrumentation research and biomedical imaging performs as a bridge between the basic science and clinical studies and engineering work. For prenatal monitoring, the usage of unique picturing technologies can ensure quick detection of diseases and malfunctions [2]. The system of biomedical picturing for management and diagnosis of lifestyle persuade disease will assist to ignore infection development by lifestyle changes. Four most important medical imaging types are medical X-ray imaging, paediatric X-ray imaging, ultrasound imaging and magnetic resonance imaging or popularly known as MRI. The main capabilities of biomedical images are image guided therapy and diagnostic imaging, imaging methods involving optics, MRI, ultrasound. Apart from this, it includes developed ways for image examination, modelling, and data informatics and data science.

Biomedical imaging provides exact tracing of metabolites that can be utilized as biomarkers for disease recognition, improvement and treatment response. CT scan is extremely important equipment in medical imaging to additive X-rays and medical USG or ultrasonography [3]. In recent days, biomedical imaging is improving immensely. Doctors can easily understand the issue or problem by seeing the image and can start the treatment process as soon as possible. Few years back, doctors had to understand or guess where the problem was happening. Currently doctors can easily see the exact position of the disease inside the human body.

MATERIALS AND METHODS

Research design

A researcher chooses some specific techniques to complete a study and the framework related to these research procedures are considered as research design. In this study, a qualitative research design has been chosen and main reason behind this selection is that this framework aids the researcher to interpret the main subject matter in a proper way. The researcher has been capable of gaining an appropriate understanding of the study with the help of qualitative research design.

Research type

In every study, there are specifically two kinds of research types such as primary and secondary. In this particular case,

the secondary research type is selected as only secondary has been collected in the field of accomplishing this study. Data, information and facts related to this study are gathered from peer-reviewed journals which have been published after the year 2019. Therefore, it is clear that only current information related to the importance of the biomedical imaging process is collected by the researcher. Hence, there is no confusion about the validity and reliability of data.

Data management

In this article, secondary data is interpreted by developing certain points related to the significance of biomedical image processing in medical science and this study portrays several objectives of biomedical image analysis. It also showcases some challenges related to biomedical imaging and image processing and at the end, the future of biomedical imaging and image processing is represented explicitly.

Choice of subject

Present subject has been chosen as this study provides an idea about biomedical imaging and image processing and their importance in the development of medical science. In recent days, biomedical images and imaging techniques including ultrasound and MRI play a significant part in detection of diseases. This subject helps to develop knowledge on the importance of biomedical imaging in bringing certain positive changes in the overall medical science.

Inclusion and exclusion criteria

Journals that are published after the year 2019 have only been accepted by the researcher for the collection of information associated with the subject matter. On the other hand, peer-reviewed journals and articles that were published before the year 2019 have been excluded by the researcher. Only, secondary research type has been selected for the completion of the study; however, primary type has been excluded in this study. Despite this, quantitative research design is excluded and qualitative design is included in the present article.

RESULTS

Depiction of Biomedical Imaging and Image Processing

Biomedical imaging is basically a method of image genesis focused on the picture's multimodality and tissue properties. The main motto and technological instalment of nuclear medicine, X-ray, magnetic resonance imaging known as MRI and many other imaging methods utilized in the medical process. Picture processing ways used for biomedical images. Biomedical images have started from simple uses of X-rays to cure fractures or to detect foreign bodies into a collection of string techniques [4]. It was used not only for sufferer or patient care, however for the study of biological function and structure. Technological improvement in X-ray, CT, digital radiography, CT or computed tomography, PET, magnetic resonance imaging or MRI, ultrasound have constructed a range of ways or methods for cross questioning intact three bodies non-intruding.

X-ray in medical industry

An X-ray is a painless and fast process of testing which provides pictures of the shape or construction of a body, mostly the bones of the human body or animal body. X-ray beams move into the body and they are sucked up in several amounts based on the solidity of the substances the X-ray beams move through [5]. The X-ray process is mostly used to check the joints and bones; however, sometimes it is also used to see the issues affecting different organs or soft tissues. Issues such as bone breaks or fractures, dental issues or tooth problems or loose teeth.

Figure 1: X-ray

CT scans in medical industry

CT scan also known as computed tomography is a medical imaging method that utilizes a compound of computer technologies and X-rays to provide pictures or images of the inside of the body. CT scan conveys detailed and an accurate image of every part of the body including the muscles, organs, fat, blood vessels and bones [6]. This process does not hurt, one may feel a fast pinch or string while the intravenous is started. In case the dye is used, the patient may feel a metallic taste in the mouth. It is rare that some people get headaches or feel sick after this test. Generally, a CT scan test lasts roughly fifteen to twenty minutes. It can take up to an hour and even more in case of oral disease

Ultrasonography or USG in medical science

Sonography which is also known as ultrasound is an imaging or picturing method that utilizes sound waves to create images or pictures of body structure of human body or animal body. These pictures or images of the sonography give important data for doing best treatment and diagnosing properly for several conditions and diseases.

Figure 2: Ultrasound image

MRI in medical industry

Magnetic resonance imaging which is also known as MRI is a type of a scan that utilises some powerful radio waves and magnetic fields to build detailed pictures or images of the inside of the human body or any kind of animal body. It is a huge machine that looks like a tube that accommodates strong magnets. During MRI, a patient has to lie inside the machine or tube while the scan [7]. This machine sees inside the body or organs and structures. Health care workers utilize MRI scan machines to cure several types of diseases or conditions. MRI tests are extremely important or useful for testing the spinal cord and brain.

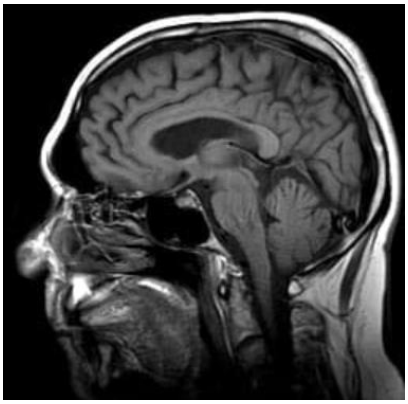

Figure 3: MRI

Objectives of biomedical image analysis

The biomedical image analysis insteps to describe the advantages which have been reaped from the implementation of digital image processing, vision of computation and paradigms examination strategies to the biomedical images like, adding objectives and potentiality and developing diagnostic confidence with the help of quantitative analysis. Medical imaging intends to reveal internal infrastructure which has been hidden by the skin and bones as well to examine and treat any sort of disease in a quick manner [8]. Also, medical imaging constructs a database of normal anatomy and physiology to create an evident identification of abnormalities of any sort of disease.

Biomedical image analysis has a significant role in the field of medical science that is mainly used in non-invasive treatment and within the clinical study. There are several problems in medical image analysis and interpretation which need computer-based processes to understand every image [9]. There are some basic objectives in biomedical imaging that visualize evaluating various issues and any disputes in this processing. There are some methods that are mainly determined to the major applications that can easily collaborate on the ability to analyse data of biomedical systems. Biomedical imaging and image processing allow every doctor to conduct proper study and observation of internal issues related to health [10]. This identification can make possibilities of having a better chance to diagnose a particular disease.

The biomedical engineering referred to as the various digital based treatments that is mainly conducted on the basis of understanding internal diagnostics systems that can make a debut in medical science. Major treatment in the modern era is especially based on several testing and analysis of internal body parts; this is especially done with MRI, X-Ray, USG and CT scan [11]. These tests help in clarifying many diseases in the internal organs of humans. These all testing has a different process and mechanical ability that happens worth extraction of various rays from related machines to help in taking images of internal body parts. These scans help to get a clear picture of the internal body part allowing doctors to diagnose the main disease.

Object identification and object segmentation can help in maintaining better image processing through sections such as: technological positivity, engineering works and potential aspects of engineering activity. This allows popularity in displaying better images with 2D or 3D slices that create important possibilities with difficult diseases [12]. 3D displays allow us to create particular indications of different types of disease that doctors recommend after checking the condition of health. All imaging with high ultrasound, radio wave or any resolution makes a proper approach in medical science and this is also a better creation of biomedical engineering. Infrared sensor technology is mainly used in cardiovascular disease diagnostics and this creates a possibility of having a proper diagnostic facility [13]. On the other hand, these technological aspects mainly proceed with the help of sensor touch which can easily make a connection on any device.

Importance of biomedical imaging and image processing in medical science

New imaging methods are developed and evaluated by this biomedical imaging and instrumentation research process. This particular approach is immensely beneficial for maintaining system and device development in an organised manner. Image processing, therapeutic agents, synthesis of imaging contrast and computational analysis are controlled properly with help of this biomedical imaging and instrumentation process [14]. Ultrasound, MRI, USG. CT Scan, PET and optimal imaging are included in this biomedical imaging framework. A relationship among engineering, basic science and clinical study is maintained by this biomedical imaging and instrumentation. Diagnostic

ultrasound refers to a framework by which a sound wave is used for producing images of structures within a body. This image is helpful for a surgeon to understand size and structure of cells, bones and muscles. In case structure of cells and bones are not proper for a person, this individual cannot be able to maintain a healthy lifestyle on a daily basis [15]. Sometimes morning work, daily exercise and a healthy diet is helpful for a person to maintain their health condition in a simple manner.

Three types of ultrasounds are ultrasound-uterus, saline infusion sonography, and son hysterography. These types of ultrasounds help a surgeon to indemnify proper disease of a person. Magnetic resonance imaging (MRI) refers to a medical imaging process by which a doctor can easily understand condition of a patient. Computer generated radio waves and magnetic fields are used to generate a clear picture of tissues and organs of a human body [16]. MRI process is non-invasive and radiation is not required for this particular process. A clear picture of tissues and muscles is gained by this process. Hence MRI is immensely expensive for a person to identify their diseases. This process cannot be able to find cancer in a human body. Sometimes magnetic fields of this particular machine create a negative impact on human body. CT Scan is used to understand bone tumours and fractures of a person. Proper diagnosis is managed with help of this particular process [17]. A surgeon can easily understand damage of bones, injuries to internal organs, stroke and cancer by this CT Scan imaging process.

Detailed information of diagnosis framework, plan for treatment and evaluation of health conditions of adults and children are known by this particular process. CT scan process needs radiation to get a proper image of bones and tissues. This radiation is not good for health of a person, this creates a negative impact on health and mental condition of a patient [18]. USG is mainly used for monitoring ovaries and uterus during pregnancy time. Gynaecologists always try to understand development of a baby's health. This particular process is effectively beneficial to identify gender of a baby during pregnancy time. A gynaecologist can see position, hands, legs and other body parts of a baby with help of this USG framework.

Figure 4: Positron emission tomography

A positron emission tomography (PET) scan is used to reveal biochemical and metabolic functions of a human body. Work process and functions of soft tissues and organs are known to a surgeon with help of this PET framework. Every image process provides a 2D image of inner body parts, tissues and bones. Hence this particular process provides a 3D image of a human body to identify proper diseases [19]. In case a surgeon understands accurate disease of a person, this individual can easily provide better suggestions and diagnosis to patients. For this reason, a patient can easily recover from any disease with help of proper treatment.

Challenges for implementing biomedical imaging and image processing within a hospital

Biomedical imaging process is immensely beneficial for meeting healthcare demands in an organised manner. Several types of machines are required for maintaining this particular process. However, every hospital and diagnostic centre cannot be able to implement modern technology machines for providing better images of human body [20]. A huge amount of money is required for implementing a machine. Usage of those machines are unknown to users and technicians. For this reason, a person may not be able to get proper images of their inner parts of body. Skills and knowledge related to machines and technologies are unknown to those individuals. As a result, a diagnostic centre and a hospital cannot be able to maintain a proper process and strategy of work. Every hospital has a responsibility to develop new disease specific and image guided therapies for providing better treatments and services to patients [21]. Imaging technology is not used by a technician properly to monitor a therapy. For this reason, development of image guided therapies process is hampered within a hospital.

A diagnostic centre has a responsibility to contribute to a healthy start by providing accurate information on prenatal growth and foetal health. Development process of these health conditions is maintained with help of advanced imaging technologies [22]. Biomedical imaging process plays an indispensable role in accessing prenatal health and foetal health in a simple manner. Lack of experienced technicians creates a negative impact on this particular process and strategy. Genetic, infectious and environmental influences for disease prevention are included in this prenatal health and foetal health. Diagnostic accuracy of ultrasound may not be able to be managed by this biomedical imaging process. Sometimes a surgeon may not be able to understand the accurate position of bones and tissues by this process due to lack of modern machines. Clinical engineers cannot be able to maintain their proper process of work to provide better treatments and services to patients [23]. These biomedical imaging tools may not be able to use properly to make various types of images related to tissues and bones.

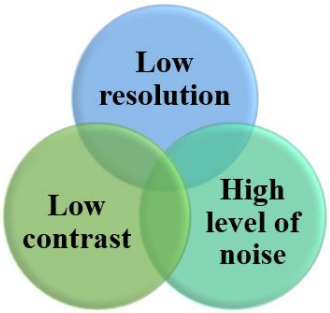

Figure 5: Challenges for implementing biomedical imaging

Low resolution, high level of noise and low contrast are major challenges of a hospital to implement a biomedical imaging process for a person. Low contrast and low resolution of modern machines and technologies creates a negative impact on medical science [24]. A diagnostic centre and a hospital may not be able to provide better services and treatments to patients. A high level of noise is created to maintain biomedical images significantly. Sometimes patients cannot be able to hear high levels of noise from a machine. For this reason, these individuals avoid to use those machines to maintain routine check-ups. Size of medical images creates a negative impact on medical imaging and medical image analysis. Large datasets of medical images are required for this particular medical process. Segmentation process is also an essential challenge for biomedical imaging and image processing [25]. Problem of extracting anatomical structures for a human body shape is analysed with help of this segmentation process. These challenges should be considered by a hospital and diagnostic centre to enhance their performance in an organised manner.

DISCUSSION

Biomedical imaging is mainly a process of image generalization that leads to the multimodality property to make a better approach to medical science. Medical science is getting more advice as there is a facility on application of technological development. Technological implementation is possible with proper processing of various images and high yielding variety of major imaging [26]. This imaging is specialty started with the scanning of the body thigh using an X-Ray machine which allows certain cultural and advanced variety to get perfect impact within the method of technological development. In the direction of biomedical imaging and image processing, the image genesis is focused on the picture multimodality and properties to get perfect treatment. These imaging are installed with the improvement of medical processes that is mainly started with construction of different structures with varied ways to get better possibilities with technological improvement.

Major depictions of biomedical engineering are mainly used for complete cure of patients which may lead to huge variations of different aspects that can impact on the medical science. The impact of biomedical engineering can form a high range of methods which construct pet technological advancement and minute engineering works. The technological improvement proceeds with X-rays, CT scan, digital radiography which assist in having a more initiative approach in report [27]. These scan reports make possibilities to diagnose major disease which lead to a higher chance to understand intensity of treatment process. X-ray in the medical industry proceed with testing of bones whether getting fractured or any dispute within the bones. The beams of X-rays move into the body and sucked most amount of solid substance which affect different types of organs mostly they are affected with these rays. However, this is effective in understanding bone structure.

A computed tomography or CT scan is mainly done on the basis of application of computer technology and in this process, X-Ray helps in making a proper image of the internal organ. This also can form major negative effects that can form tooth problems and humans may permanently lose teeth. The application of these medical treatments can make proper touch with clarification of different brain haemorrhages along with proper diagnosis. However, continuation on certain scans can have huge negative consequences on the human body. USG is also a process of biomedical image and image processing which helps in betterment of proper treatment and provides proper image with sonography. MRI on the certain sensor helps to form a full body scan with certain sensor processes and entrance of rays inside the body [28]. This is extremely useful testing that can form a proper diagnostic impact on the spinal cord and brain.

CONCLUSION

Biomedical imagery and image processing that help in the examination of images in biology and medicine. This aspect allows a better perspective in medical science with application of various technological aspects such as: magnetic resonance imaging (MRI), infrared sensor technology and computed tomography (CT), nuclear medicine. These all are vital with sensor touch and usage of high-resolution effects which can form betterment in medical science. The most important importance of usage of image processing is this help in in-depth observations and investigation of medical analysis which can form better facilities in getting improvements that support proper clinical treatment on getting cure from any disease.

The major importance of biomedical image and image processing is to provide a better approach in medical science. The application of a huge range of technological improvement and advanced engineering work highlight the perfect situation to form proper diagnosis. The major vision of biomedical imaging and this processing allows proper computation, observation and finalizing major diseases for proper treatment. Medical imaging constructs data processing that normally can create evidence in assurance of abnormalities which sort out any type of disease.

Instrumental touch and effective imaging performance can make with the basic activities of advanced medical feasibility

with creativity of havoc engineering appearance. The human body can take these rays at a particular range, though there are some bad effects in these tests. ultrasound rays, X-rays may form a huge negative impact on the body that may impact on health. This article has been clearly mentioned about all the biomedical image processing which is mainly gathered with the help of highlighting some important secondary information on this topic. Hence, this study has clarified the topic with specific evaluation of secondary information based on biomedical image processing.

REFERENCES

[1] Isensee, Fabian, et al. "nnU-Net: a self-configuring method for deep learning-based biomedical image segmentation." *Nature methods* 18.2 (2021): 203-211.
[2] Pradhan, Bikash, Saugat Bhattacharyya, and Kunal Pal. "IoT-based applications in healthcare devices." *Journal of healthcare engineering* 2021 (2021): 1-18.
[3] Singh, Prabhishek, et al. "A Method Noise-Based Convolutional Neural Network Technique for CT Image Denoising." *Electronics* 11.21 (2022): 3535.
[4] Barhoom, Alaa MA, and J. Mohammed Rasheed. "Bone Abnormalities Detection and Classification Using Deep Learning-Vgg16 Algorithm." *Journal of Theoretical and Applied Information Technology* 100.20 (2022): 6173-6184.
[5] Medeiros, André Dantas de, et al. "Machine learning for seed quality classification: An advanced approach using merger data from FT-NIR spectroscopy and X-ray imaging." *Sensors* 20.15 (2020): 4319.
[6] Ponti, Federico, et al. "Aging and imaging assessment of body composition: from fat to facts." *Frontiers in endocrinology* 10 (2020): 861.
[7] Prabhat, Anjali M., et al. "Methodology for low-field, portable magnetic resonance neuroimaging at the bedside." *Frontiers in Neurology* 12 (2021): 760321.
[8] Habuza, Tetiana, et al. "AI applications in robotics, diagnostic image analysis and precision medicine: Current limitations, future trends, guidelines on CAD systems for medicine." *Informatics in Medicine Unlocked* 24 (2021): 100596.
[9] Lucieri, Adriano, et al. "ExAID: A multimodal explanation framework for computer-aided diagnosis of skin lesions." *Computer Methods and Programs in Biomedicine* 215 (2022): 106620.
[10] Farooq, Muhammad Shoaib, et al. "Untangling computer-aided diagnostic system for screening diabetic retinopathy based on deep learning techniques." *Sensors* 22.5 (2022): 1803.
[11] Ghosh, Subhankar, and Saurabh Pal. "MRI, CT, and PETSCAN: Engineer's Perspective." *Cancer Diagnostics and Therapeutics: Current Trends, Challenges, and Future Perspectives*. Singapore: Springer Singapore, 2022. 113-143.
[12] Birlo, Manuel, et al. "Utility of optical see-through head mounted displays in augmented reality-assisted surgery: A systematic review." *Medical Image Analysis* (2022): 102361.
[13] Kędzierski, Kamil, et al. "Telemedicine in Cardiology: Modern Technologies to Improve Cardiovascular Patients' Outcomes—A Narrative Review." *Medicina* 58.2 (2022): 210.
[14] Beyer, Thomas, et al. "What scans we will read: imaging instrumentation trends in clinical oncology." *Cancer Imaging* 20.1 (2020): 1-38.
[15] Hoang, Duc M., et al. "Stem cell-based therapy for human diseases." *Signal Transduction and Targeted Therapy* 7.1 (2022): 272.
[16] Chanana, Priyanka, et al. "The effect of magnetic field gradient and gadolinium-based MRI contrast agent dotarem on mouse macrophages." *Cells* 11.5 (2022): 757.
[17] Kratochwil, Clemens, et al. "EANM procedure guidelines for radionuclide therapy with 177 Lu-labelled PSMA-ligands (177 Lu-PSMA-RLT)." *European journal of nuclear medicine and molecular imaging* 46 (2019): 2536-2544.
[18] Alahmari, Nala, et al. "Musawah: A Data-Driven AI Approach and Tool to Co-Create Healthcare Services with a Case Study on Cancer Disease in Saudi Arabia." *Sustainability* 14.6 (2022): 3313.
[19] Gao, Shuangshuang, and Dimas Lima. "A review of the application of deep learning in the detection of Alzheimer's disease." *International Journal of Cognitive Computing in Engineering* 3 (2022): 1-8.
[20] Benjamens, Stan, Pranavsingh Dhunnoo, and Bertalan Meskó. "The state of artificial intelligence-based FDA-approved medical devices and algorithms: an online database." *NPJ digital medicine* 3.1 (2020): 118.
[21] Maves, Ryan C., et al. "Triage of scarce critical care resources in COVID-19 an implementation guide for regional allocation: an expert panel report of the task force for mass critical care and the American College of Chest Physicians." *Chest* 158.1 (2020): 212-225.
[22] Javaid, Mohd, and Ibrahim Haleem Khan. "Internet of Things (IoT) enabled healthcare helps to take the challenges of COVID-19 Pandemic." *Journal of Oral Biology and Craniofacial Research* 11.2 (2021): 209-214.
[23] El-Sappagh, Shaker, et al. "A mobile health monitoring-and-treatment system based on integration of the SSN sensor ontology and the HL7 FHIR standard." *BMC medical informatics and decision making* 19.1 (2019): 1-36.
[24] Yoganathan, Vignesh, et al. "Check-in at the Robo-desk: Effects of automated social presence on social cognition and service implications." *Tourism Management* 85 (2021): 104309.
[25] Gadosey, Pius Kwao, et al. "SD-UNET: Stripping down U-net for segmentation of biomedical images on platforms with low computational budgets." *Diagnostics* 10.2 (2020): 110.
[26] Azam, Muhammad Adeel, et al. "A review on multimodal medical image fusion: Compendious analysis of medical modalities, multimodal databases, fusion techniques and quality metrics." *Computers in biology and medicine* 144 (2022): 105253.
[27] Haq, Inayatul, et al. "Lung Nodules Localization and Report Analysis from Computerized Tomography (CT) Scan Using a Novel Machine Learning Approach." *Applied Sciences* 12.24 (2022): 12614.
[28] Hampel, Uwe, et al. "A review on fast tomographic imaging techniques and their potential application in industrial process Control." *Sensors* 22.6 (2022): 2309.