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***REVIEW ARTICLE***

# A Review on Image Processing Applications in Medical Field

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## ABSTRACT:
**Objective:** Biomedical signal/image processing and the related imaging modalities is a very vast growing and upcoming field. This paper presents the promising image processing techniques used in medical field.
**Methods:** Application of image processing techniques has played a vital role in assisting the surgeons and physicians in diagnosing the diseases and performing the surgeries for the patients. Clinical medical devices has erupted through combination of hardware and image processing techniques which has a giant leap in medical field.
**Results:** Biomedical signals fetching, image formation, processing of image, and image display for medical/clinical diagnosis based on extracted features from the signal (1D), images (2D) and Video (3D). Image processing has proved its significance in medical analysis and health care.
**Conclusion:** The imaging modalities play a vital role in acquisition of signals and images from human body which involves invasive and non-invasive methods.

**KEYWORDS:** Digital Image Processing, imaging modalities, Diagnosis, human body, signal processing, non-invasive methods.

## INTRODUCTION:
Information Technology had traversed across all aspects of human life, and the previous couple of years have seen the impact of this innovation in the field of healthcare and medical science. Biomedical images are fundamental part of medical science, these images are characterized as the images of human body that assist in the understanding of nature of human biological system. This digital image is represented by a matrix with rows and columns where any algorithm developed for one dimensional can be applied to rows and then to columns. These biomedical pictures are of complete organs, organ system and body parts or might be at the molecular level.

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In understanding and gathering information from these images, the techniques of image processing have most extreme significance. The way toward making visual representation of the inside segments or interior portions of a body for clinical analysis, medicinal intervention and visual representation of function of few organs or tissues is called Medical imaging [1]. These visual representations are processed efficiently, evaluated with specific objective, and made available and communicated to many places with the help of communication networks and protocols namely Picture Archiving and Communication Systems (PACS), Digital Imaging and Communications in Medicine (DICOM). Digital imaging techniques made possible for the physicians to easily diagnose the diseases with the help of digital image processing techniques in the medical field.

There are many techniques and tools are available to analyze the diseases for medical diagnosis. A detailed review on the applications of fuzzy environment for

medical diagnosis is given in [13, 15]. Applications of Bbiomedical engineering include the development of diagnostic and therapeutic medical devices ranging from clinical equipment to micro-implants, common imaging equipment such as MRIs and EEGs, regenerative tissue growth, pharmaceutical drugs and therapeutic biology [16, 17].

Nanotechnology is a new branch of science that studies tools and devices of size 1 to 100 nm with various functions at the cellular, atomic and molecular levels. In recent years, there has been a wide development in the field of nano medicine with the development of new nano particles for the diagnosis and treatment of cancer. Nano particles have unique biological properties given their small size and large surface area-to-volume ratio, which allows them to bind, absorb, and carry compounds such as small molecule drugs, DNA, RNA, proteins, and probes with high efficiency [18-22]. In this paper, we present a review on most popular tools used for analyzing the diseases in the medical field.

**THE CORE STEPS OF IMAGE PROCESSING:**

The digital image processing involves the following steps[2].

- **Image Acquisition:**

It is a basic step which involves capturing images through sensors and various image modalities and is represented by a matrix.

- **Image Enhancement:**

It is a fundamental supporting aid for reviewing atomic region in MRI and Ultrasound in medical field by decreasing noise and used to enhance visual representation of an image.

- **Correction/manipulation of color within an image:**

It can change and correct the color of medical images essentially under the indoor natural light condition.

- **Edge detection:**

It is an essential pre-preparing system in medical image segmentation used of recognition of organs of the human body, for example, lungs and ribs.

- **Smoothing of images:**

It is used to suppressing the noise of medical images.

- **Image restoration:**

It is utilized for reclamation of restorative images like X-ray pictures, ultra sound images, CT filter images.

- **Conversion and construction of 3D images from 2D images:**

3D representation offers plentiful and accurate data than 2D visualization.3D reconstruction of medical images is comprehensively connected to tumor location, surgical arranging and brain electromagnetic and field computation.

- **Artificial/pseudo coloring to the images:**

It is used to enhance and upgrade the visibility of the fracture or any illness which is not obviously noticeable by bare eyes in x-ray image.

**DIGITAL IMAGE PROCESSING ADVANTAGES IN MEDICAL APPLICATIONS:**

- Digital data is non changeable and always retains its originality; irrespective of how many times the data is reproduced.
- Digital processing is a powerful tool to the doctors that moderate the search for representative images.
- Once the image is acquired then immediately it displays.
- Physicians can easily interpret the enhanced/intensified images.
- It quantifying the changes over time.
- Quick comparisons of images can be done.

**APPLICATIONS OF IMAGE PROCESSING IN MEDICAL FIELD:**

Medical Imaging mainly concentrates on uncovering and revealing internal structures which are hidden by the skin and bones. In addition, it is used to analyze, diagnose, recognize and treat the illness or disease. This technique is particularly useful for the specialists to make laparoscopic surgeries for viewing the interior parts without actually opening the body. X-ray imaging uses CT scanner, Ultrasound and Magnetic Resonance Imaging. In this way, specialists can look at the body's obscure or hidden third dimension. By using CT Scanner, inside segments can be exposed and diseased areas can be recognized and spotted very easily. While considering MRI, it gets signal from the magnetic particles of the body and turn its magnetic tune and with the help of Computer, coverts scanned data into images of the internal organs.

**Radiography:**

Radiography is an imaging technique that uses electromagnetic radiation, especially X-ray for viewing the non-transparent object of changing composition and density such as human body. A X-ray generator delivers a heterogeneous beam of X-rays and after which they are projected on the object. The X-rays that penetrates through the object are captured by a detector and provides a superimposed two dimensional representation of all the organs internal structures.


**Fig. 1. X-ray image**

Fig.1. shows a typical X-ray image which provides details of bones in human hand. Radiography is used for examinations like Dental Examination, Orthopedic evaluations etc. Radiography incorporates medical radiography and industrial radiography. When the examined object is living, either human or creature, then it is named as medical radiography and all other radiography is considered as industrial radiographic work. It is also learnt that [14], it is possible to store the patient information on to the X-ray image itself without interfering with the X-ray content.

**Magnetic resonance Imaging (MRI):**

MRI is a medical imaging technique to image the physiological process and anatomy of the human body. MRI scanners form the medically significant images of the body by using magnetic fields and radio waves. Fig. 2 shows the MRI scan image of human head in its cross sectional view.

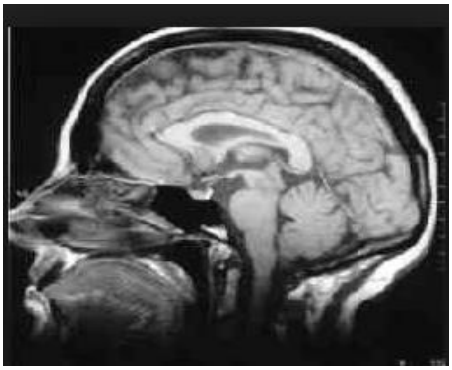

**Fig. 2. MRI Scan of head**

MRI is extensively used for clinical diagnosis, scanners are incorporated that uses radio wave effects, magnetic field effects and field gradients to obtain the images of the human body organs. It is used eminently in diagnostic medicine as well as biomedical research. MRI scans used to produce variety of clinical data additional to digital images. MRI is used to get and follow-up the stages of disease without exposing the body to radiation. As the data produced by MRI is voluminous that avoids manual segmentation. Automatic segmentation is a contemporary problem in the large spatial, structural and variable tumors of the human brain. Convolutional Neural Networks (CNN) plays a prominent role in exploring brain tumors using small 3 ×3 kernels [4].

**Endoscopy:**

The genuine significance of Endoscopy is "looking inside" for medical diagnosis. Unlike other techniques, an instrument is used to inspect and check the interior parts of an empty organ or pit of the body. It permits a specialist to glimpse interior human bodies with the aid of a cutting tool that is attached at the end of the endoscope, and the minor procedures can also performed if necessary. In this way, this surgery is termed as key hole surgery and it leaves a tiny scar on the human body. Fig..3. depicts the endoscopy of abdomen of human body.

**Fig. 3. Endoscopy image.**

In every endoscope, there is couple of fiber bundles in that one fiber is used for enlightening the inward structure of the organ and another is used to collect the light reflection. The endoscope is an optical instrument in tubular shape to analyze body disorders that cannot be viewed through naked eye. Endoscopy is generally used for various procedures in pregnancy, plastic surgery, orthopedic surgery, endoscopic spinal surgery. Endoscopes also used in other fields like bomb disposal personnel and FBI for conducting surveillance via tight spaces [5].

**Stereo Endoscope:**

In Stereo endoscope incorporates two cameras that are mounted on a solitary laparoscope. Images from these cameras are forwarded to a video screen. From these 2D images, few sorts of presentation strategies are used to recognize stereo pictures. When a genuine image is perceived, the cameras transmits images periodically. This gives the impression of 3D perspective of the image. Stereoscopic technology aid the medical and clinical field in improving the accuracy of surgery and operational requirements. with reduction in operation

time and assures patient safety with the help of realistic depth perception of 2D imaging technology [6]. Stereoscopic imaging is also applied to various other fields like digital mammography, teaching of anatomy, diabetic retinopathy, and non invasive surgical operations [7].

**Computer Tomography:**

Computer Tomography is a technique that makes use of digitally processed combinations of number of X-ray images taken from distinct edges. This method produces cross-sectional image of the target object and permits the user to see inside parts without cutting. In medical imaging, CT has turned into an important aid to supplement X-rays and medical ultrasonography. Fig. 4. Represents CT scan image of human brain of various slices.

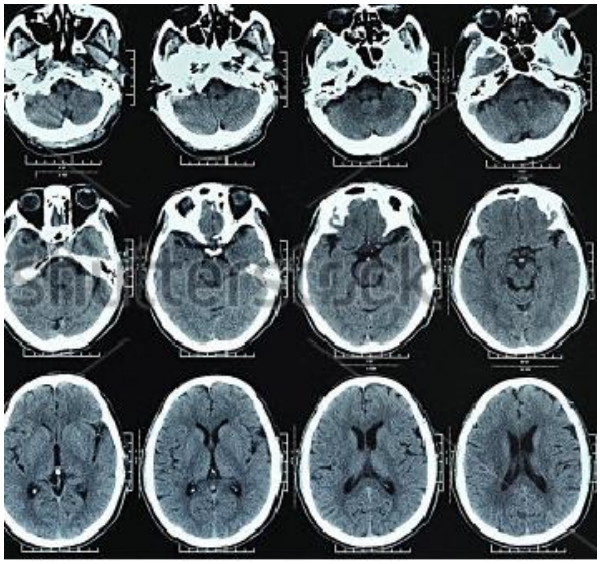

**Fig. 4. CT scan images.**

Normally, CT scanning for head is done to recognize and detect infarction, tumors, calcifications, hemorrhages and bone trauma. A little bore multi-sliced CT scanners are equipped in ambulances for immediate respond to the persons affected by stroke or head trauma. This scan can also done for detecting changing internals of the lungs like acute and chronic. A medical diagnostic test CT Pulmonary Angiogram is used to diagnose Pulmonary Embolism. CT is one sensitive method to diagnose cardiac and abdominal diseases. Four dimensional computed tomography gives new dimension of patient related data for radiation therapy and also provides large volume of data for further processing and analysis [8].

**Electrocardiography (ECG):**

ECG records electrical activity of the heart over a specific period of time with the help of electrodes fixed on the chest and limbs of the body. These electrodes identifies electrical changes on the skin that occurs for every heart beat. The general objective of ECG is to acquire information about the structure and functioning of the heartbeat. A few signs for performing electrocardiography incorporate suspected pulmonary embolism, fainting or collapse, seizures, cardiac stress testing, atrial flutter. Frequent ECG monitoring is used to check critically sick patients, patients experiencing general anesthesia and patients who have an occasionally occurring cardiovascular disorders.

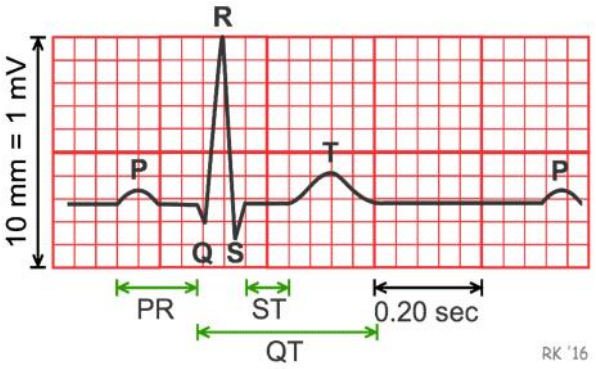


**Fig. 5. Electro Cardio Graphy**

Fig 5. represents time-varying ECG signal. Generally, Fourier transformation does not provide good response. Multi Resolution Analysis and filtering is done to eliminate the accidental troubles by ECG nodes effectively using digital signal processing and efficient filtering effect is obtained by Wavelet Transform [9].

**Medical ultrasound:**

Medical ultrasound is an indicative imaging technique that uses ultrasound. It is generally used to view the inner body structures like tendons, joints, muscles, vessels and inward organs. Its objective is to discover a source of a sickness or to prohibit any pathology.

Sonography (ultrasonography) is broadly used as a part of medicine. It performs diagnosis and therapeutic procedures with the help of ultrasound to direct interventional procedures like biopsies or drainage of fluid collections. Ultrasound has few favorable circumstances compared to other techniques of medical imaging. It gives real-time images that is versatile and is generously lower in expense. It does not use destructive method of ionizing radiation.

Fig. 6. shows the an ultrasound scan of fetus to visualize the condition. An automatic method that uses a class of nonlinear image processing filters like morphological operators to connect and isolate the fetal head and generate a measurement of its diameter [10].

**Fig. 6. Ultrasound Scan of fetus.**

**Positron Emission Tomography (PET) :**

PET is a technique for monitoring the body metabolic processes. The system identifies indirectly emitted gamma rays by a positron emitting tracer introduced into the body on a biologically active molecule [3]. Computer analysis constructs the 3D images of tracer within the body.

**Fig. 7. PET scan image of lung cancer**

Fig. 7. represents PET scan image of lung in which cancer can be easily predicted. The PET-CT images of the brain is segmented into gray, white matter and cerebrospinal fluid. It performs conversion of PET-CT image segments into an optimization process [12]. PET images generally yield quantitative estimates of the concentration of the radiopharmaceutical data at specific locations within the body.

## CONCLUSION:

The conventional image processing methods which require single modality are slowly being replaced by techniques which involve date acquired from multiple modalities .The computational approaches is to integrate the imaging data with non-imaging data. To face this challenge the image processing methods like enhancement, segmentation, restoration morphological systems are integrated with expert systems like neural network and fuzzy logic. The interoperability of necessary integration of algorithms and support to standard techniques should pave way for physicians for future diagnosis.

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