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Multidisciplinary Approach of Artificial Intelligence over Medical Imaging: A Review, Challenges, Recent Opportunities for Research

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Abstract— Multidisciplinary approach of artificial intelligence is revolutionizing the traditional technologies used in medical image computing, radiology imaging, medical diagnoses and features based disease identification [1,2]. In this paper, overview of artificial intelligence and its application over medical images, recent challenges, deeper technological background regarding betterment/innovation healthcare, real life clinical application with parameters of diagnosis, will improve patient health and feature based disease identification. It provides methodologies in the field of medical imaging by developing self driven and intelligent algorithm that manages and extracts meaningful information out of raw data present in the images. It helps in early diagnosis and treatment of the diseases. This paper focuses on various aspects and issues on the growing role of medical image, fundamental technical advantage of AI over traditional patterns for the betterment of human lives. From this research work, reader understands deeper technological aspects for smart algorithms regarding diseases and patient care.

Keywords: medical imaging, convolutional neural network, artificial intelligence, research work, intelligent algorithm, feature based disease identification

I. INTRODUCTION

Imaging is one the fastest growing representations of medical data. The accurate image analysis is now possible with the coming of new algorithms based on technologies such as artificial intelligence, machine learning and deep learning [3, 4]. These technologies have been given a lot of emphasis over past few years because of the efficient results and diagnosis that are produced using the algorithms base on these technologies. Medical imaging is one of the most reliable areas of medical innovation. Different techniques of biomedical imaging such as image segmentation, image registration, image recognition, and image labeling could now be implemented with the help of intelligent and self driven algorithms establishing direct analysis and treatment[5,6]. It is believed that the AI-enabled products will eventually change the way daily diagnosis and treatments are conducted in hospitals and clinics. Medical imaging is often used in routine preventing screenings for cancers, for example breast cancer and colon cancer. An intelligent algorithm based on these new technologies would not only do early diagnosis but would also suggest right treatment of the disease.

II. DEBATE BETWEEN EXISTING LITERATURE: TECHNIQUES OF MEDICAL IMAGING

A. Image segmentation

The rapid adoption of deep learning for image segmentation or semantic segmentation plays a prominent role in biomedical image analysis. The label is assigned to every pixel of an image such that the pixels with the same label share similar characteristics. For example image can be automatically segmented to measure its volume-how big or small it is. CNN (Convolutional Neural Network)[3,8] and FCN (Fully Convolutional Neural Network)[8] is used for the betterment of image segmentation in the field of biomedical imaging[7]. Both of these perform an extensive training for prediction of image segmentation.

B. Image registration

Image registration makes the pixels of two images precisely coincide to the same points in the scene. Registered images are combined together to improve information extraction [8, 10]. The moving image is spatially transformed to line up with the fixed image. For e.g.: we can use image registration to align image to see if a tumor is visible in an MRI or SPECT image [9].

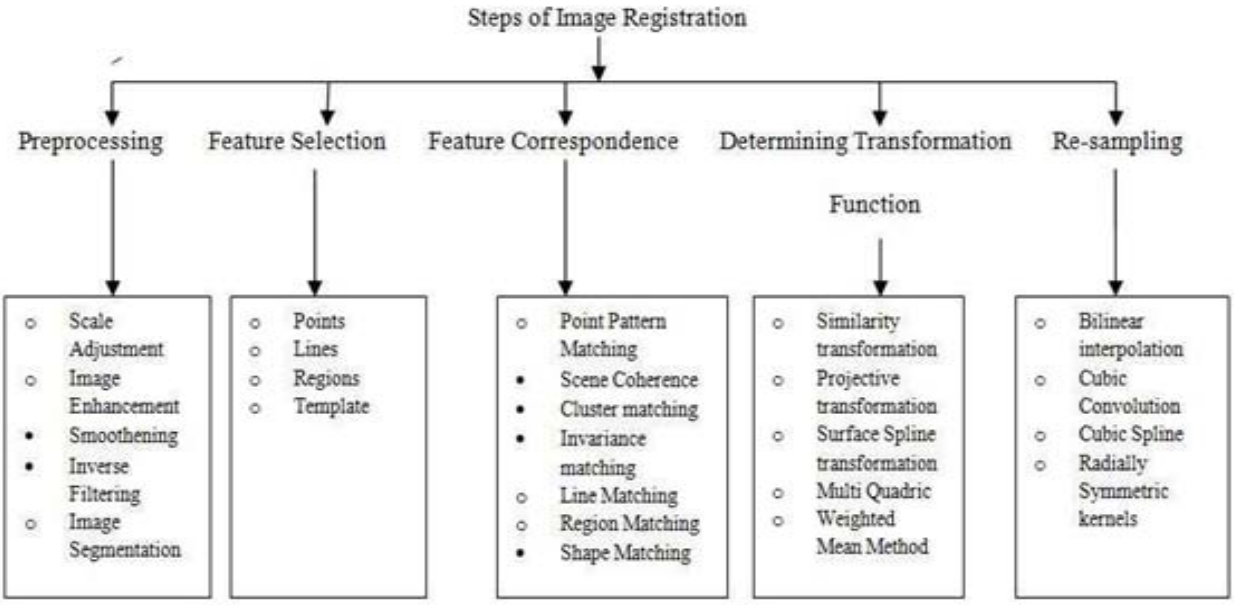


Fig 1 Procedure of Image Registration [11, 12,13,17]

Author and Year	Year	Form of input Dataset	Amendment	Mode	Application	Proposed Strategy
Eppenh et al.[2]	2018	Measured Unit	Reversible/Reconstruct	CAT	Thorax	CNN upto nine panels
Silver, D et al. [15]	2017	Measured Unit	Reversible/Reconstruct	CAT	Lung	Twist Neural Network
Miao, S. et al. [16]	2017	Multiple Augmentation	Robust	X-ray	Spine	Semi-Convolutional Neural Network
Ma, K., Wang, et al.[17]	2017	Augmentation	Robust	Magnetic Resonance Image	Spine	Defuse Network
Cheng, X., et al.[18]	2018	Measured Unit	Robust	computerized tomography	Head	Five panels of DNN
Haskins, G. et al.[19]	2019	Augmentation	Robust	Magnetic Resonance Image	Prostate	CNN upto fourteen panel
Liao, R. et al.[20]	2017	Augmentation	Robust	Cone beam computed tomography	Spine/cardiac	CNN upto eight panels
Matthew, J. et al.[21]	2018	Measured Unit	Robust	Magnetic Resonance Image	Brain	Long short-term memory

Table 1 Recent summary of image registration with respect to medical imaging

C. Image detection

Detecting Image in medical analysis refers to analyzing images through intelligent self driven algorithms and establishing direct analysis and treatment. For an example in the detection model of breast cancer supervised learning algorithms are used for determining the tumor size as benign or malignant[14,15]. CNN techniques are used for image detection in medical imaging because of its high accuracy and reliability .In the CNN technique both 2-d and 3-d organ structure are being studied and being classified into normal or abnormal [16].

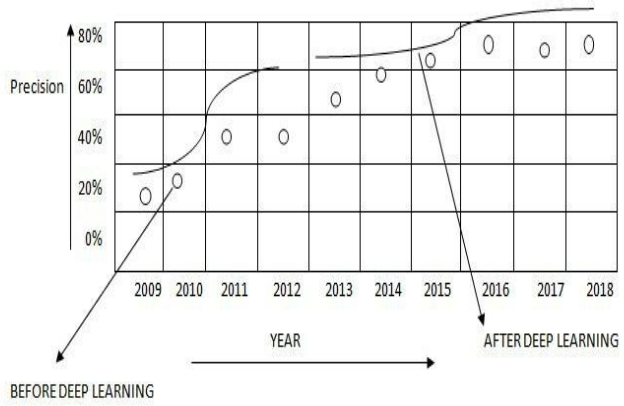


Fig.2.The image shows the comparison between mean average precision (mAP) with increasing years

D. Image labeling

Labeling data in medical imaging helps in classifying and identifying pathologies by grouping and tagging them together [18]. This data could further be used for building intelligent algorithm of ML that could reduce the time and effort of doctors in labelling of data [19]. Robust logic regression algorithm could be used for the labeling purpose.

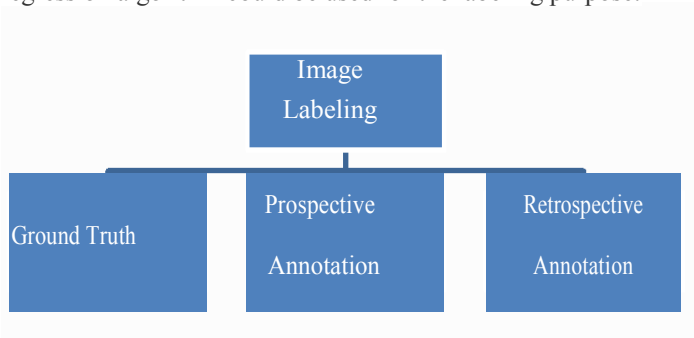


Fig.3. Image labeling and its sub-parts.

III. MULTIPLE APPLICATIONS

A. Tumor detection

With the property of high speed data analysis, machine learning is used to analyze brain tumorsdepending upon the cell type and its aggressiveness and malignancy.Also image segmentation such as watershed and threshold segmentation are also used to detect tumors[20].

B. Diabetic Retinopathy

Diabetic Retinopathy (DR) is an ailment where the poorly controlled sugar level damages the blood vessels at the back of retina. IDx-DR is a technology that uses artificial intelligence (AI) to diagnose diabetic retinopathy, providing screening decision [21]. DR could also be detected by deep neural network technology which vitalizes the human brain. Intelligent algorithms on deep learning could also be used for detection and treatment of DR.

C. Cancer

C.1 Supervised learning algorithms

It is used with the aim to find beingness or malignantness in the diagnosis of cancers such as breast cancer. Methods based on deep learning and machine learning are applied in huge data[20] sets such as genomic data, transcriptase data and various other morphologic data type for better diagnosis and treatment.

C.2 Neuroimaging

It portrays the structure of human brain precisely. Various technologies such as computed axial tomography, positron emission tomography, magnetic resonance imaging, and functional magnetic resonance Imaging help in identifying the biological traits of a disease at its initial phase. it also aim is to connect various regions of the brain and cure enfeebling neurological disorders

C.3 Osteoarthritis

The extremity of Knee Osteoarthritis, a degenerative knee disease, can be moderated from radiography based on deep convolution neural network and deep learning based cartilage lesion detection system using the process of image segmentation and image detection[16]. The AI based methods can screen the disease at an early stage and can bridge the gap between imaging and surgery.

C.4 Cardiovascular Disease

Cardiovascular disease is a condition that involves blocked up blood vessels leading to heart attack, chest angina and stroke[18]. Techniques based on machine learning can be used for the prediction of cardiovascular risks. Intelligent algorithms such as naive base, support vector machine and decision trees with the proper understanding of each problem can improve the accuracy of cardiovascular prediction rate.

IV. ADVANTAGES AND CHALLANGES

The advantages of artificial intelligence in medical imaging technology as:

Radiology- AI in radiology allows moving up the value chain and improving both efficiency and quality. Complex task such as image segmentation could be done easily and efficiently. AI technology can act as a key to the future of database enabling workflow, auto detection of normal and abnormal database.

MRI (medical resource imaging)-Combination of AI in MRI machines produces highly accurate results. It helps the medical practitioners to get adequate training on mixed findings. AI driven intelligent algorithms helps in prognosis in and diagnosis of early stage AD.
Deep learning that is considered to be a refined version of AI teaches computer to recognize image and form subtle distinction between them.

Ultrasound- Machine learning algorithms and deep learning techniques in ultrasound imaging guide the sonographers during the obstetric scans. They also provide information about the specific body part, i.e., helps in anatomy awareness. These real time aids help the users in communicating that which organ is being scanned and guiding them on the anatomical features relevant to the scan.

Computed Tomography- The cutting edge of deep learning is applied in the field of computed tomography (CT) to emerge a new technology Modularized Neural Networks. These modularized neural networks reduce the noise during image reconstruction in such a way that radiologist can actively involve in the optimization of the image reconstruction and increase the quality of image.

V. SUBSEQUENT YEARS OF EXISTING RESEARCH WORK

The subsequent years of research work held in the field of medical imaging. This development has been summarized in form of a survey, indicating number of research work done over the last 7 years in the field of medical image with deep learning. The methods surveyed in this graph are deep iterative registration, supervised transformation estimation, unsupervised transformation estimation [1,5]. The fig.3 shows that the number of papers on deep learning based on medical image registration that has suddenly shown a hike after 2016 and before 2016 the papers were based on medical imaging analysis.

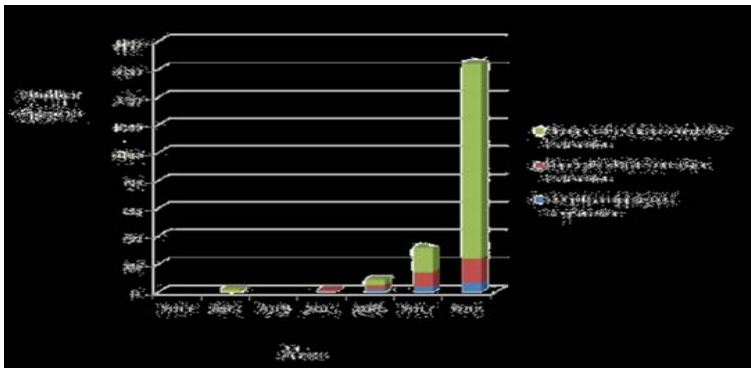


Fig.4. Deep learning based image registration research work

Data Availability	Lack of Data Sets	Text & Image	Minimizing Inheriting Biasness
Image de-identification	Lack of tools for image de-identification	Concrete automatic de-identification	Human review needed for human de-identification
Advance clinical images	More involvement of neural network is needed	Human inspection for quality check of data	Few sources of training data available
Patient meditated data sharing	No standards of data sharing	Educate patients about data sharing	Veracity and data quality issues

Table.2. Recent challenges faced in the field of medical imaging [2, 8, 10, 20, 21]

VI. DISCUSSION AND RECOMMENDATIONS

The development of AI in the field of medical image analysis is very important with respect to disease identification and diagnosis. The knowledge from basic research and clinical studies are implemented for addressing the need of healthcare. Foundational research leads to new methods which enhance the image data and data science that leads to the successful analysis of AI applications in medical imaging.

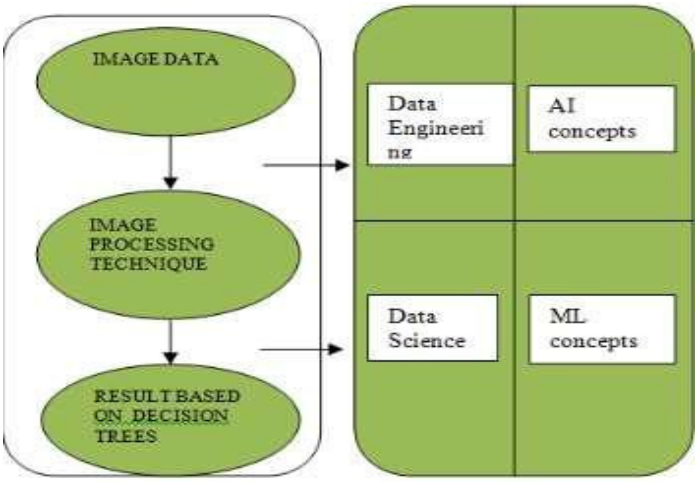


Fig.5. Transformation of technology in the field of medical imaging

VII. CONCLUSION

We have to accept the fact that in the coming years Artificial intelligence (AI) will be poised to move beyond the proof-of-concept stage and impact many facets of clinical practice. It is not surprising to see a flurry of AI activity in the health care sector whose success has already been demonstrated at a diverse range. We have seen the multidisciplinary approach of AI over medical imaging and its usefulness in the medical industry. The advancement in various processes such as image segmentation, detection etc., based on different technologies of AI, machine learning, deep learning ensure that the field's pace of evolution will continue to hasten. Deep learning technologies can potentially improve the consistency and accuracy of various underdeveloped health care system. Based on our research work, it is clear that AI will become an increasingly important part of clinical studies and will carry with it the accompanying benefits to both patients and physicians.

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