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AI REVOLUTIONIZING HEALTH CARE: A DESCRIPTIVE REVIEW

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ABSTRACT

The extraordinary human like intelligence acquired by machines has paved a wave of revolution in technologically advanced healthcare field. Recently, machine learning has become popular and a keen interest in the field of early diagnosis, treatment, imaging of several disease in a cost-effective manner. Medical experts are now easily detecting the future condition of any prevalent disease by using previous/past data. Investigation advantage-based computer-aided diagnostics have shown good sensitivity, accuracy and specificity for the detection of minor radiographic abnormalities, with the potential to improve public health. This article gives a broad description about application of artificial intelligence in medical field. Data collection, magnetic imaging and mining algorithm covers 60% of this article. Deep learning includes Recurrent Neural network (RNN), Auto-encoder, Support vector machine (SVM), Deep Belief Network (DBN) and AUROC curve. As the previous treatments were boisterous like EEG and others hence, the detection itself become a challenging task. Only through Artificial intelligence we came to a conclusive diagnosis of diseases with high accuracy other than clinical, Artificial intelligence work great in field of drug design, sports and improving patient assistance. The improvement in disease prediction and treatment has benefited a lot of individuals and increase the mortality rate. AI has improved the work efficiency of industries such as aviation, telecommunication, gaming and IT which reduces the manual work load of humans and save money and time. It leads to more effective use of resources in other work which provide higher earning and profits. It has facilitated the innovation in varied sectors that includes automobile industry (self-driving cars), farming (automatic soil nutrients detection and spraying of weedicide), and handling of hazardous substances.

Keywords: Machine learning, Artificial intelligence, Artificial Neural Network, Convolutional Neural Network, Magnetic Resonance Imaging, Computed Tomography.

1. INTRODUCTION

Artificial Intelligence (AI) is the broadest term applied to any technique that enables computers to mimic human intelligence by using logics. Nowadays, the entire world is towards the digitalization and for that purpose the AI, Machine learning and Deep learning concepts play an important role. AI has become an important area of almost all the fields whether it is for business, medicines, education, marketing, economics, science, finance etc. The two important factors where AI become the necessity in research (i) to give the well understanding to the new entrants about the AI (ii) the upsurge of interest in AI that has prompted an increased interest and huge investments in AI facilities [1]. There are diverse applications of AI like application of AI in general, on Robots, in planning and scheduling, in manufacturing field, in maintenance, in environmental pollution.

As a human it is important for every individual to know what exactly the Artificial Intelligence and Machine learning, means it is important to define the terms like artificial intelligence and machine learning. Machine learning (ML) is defined as the subset of AI which has the ability to learn and takes the data to get the best output. It's the field of study of algorithms [2]. Mainly there are three types of ML exists; Supervised ML, Unsupervised ML and Reinforcement ML. In Supervised learning, algorithms are applied on labelled training data which define the variables they want for the algorithm (input and output) to assess for correlations. In Unsupervised learning, the algorithms are trained on the unlabelled

data. The Reinforcement learning teaches the machine to complete a multi-step process which followed the defined rules. In this, an algorithm is programmed for completing the task also giving the positive as well as negative cues [3]. The one of the advantages of machine leaning is that it can understand the customer deeply as it collects the data of the customer and then correlates over time. Along with the advantage the disadvantage of ML is also there as it is not cost effective because as we discussed above the ML needs Data Scientists, who command high salaries. Secondly, the software is also expensive. Numerous machine learning applications have been made possible by breakthroughs in Deep Learning. Several contests in pattern recognition and machine learning have also won by Deep Learning [4]. Mainly the purpose for image diagnosis is to identify the abnormalities. In the healthcare industry, the applications of deep learning provide numerous solutions to the problems from personalized treatment to disease diagnostics. Deep Learning is a technique to perform machine learning inspired by our brains own network of neurons. Neural network grasp array of number that can be pixels, word, audio waveform and then run a series of functions on that array [5]. Studies in this area attempts to make better representations and create models to learn these representations from large-scale unlabelled data. The algorithms of deep learning are contrasted by oversimplified learning algorithms [6]. The major challenge while using neural networks has been identifying how to set all the massive arrays to values that will do a good job transforming the input signals into output predictions [7]. One of the models which is most widely used in deep learning is CNN *i.e.*, Convolutional Neural Network. This can be applied in many types of research fields such as image & video recognition, natural language processing [8]. CNN was first introduced and advocated for the HD image analysis by a postdoctoral computer science researcher, Yann Lecun [9]. He developed a multi-layer artificial neural network called LeNet-5 which could classify handwritten digits. Recently, the CNN has been successfully implemented in the medical area to assist disease diagnosis and inputs are properly normalized by the pixel's values on the image [10]. Researchers like Andre Esteva performed the CNN to identify skin cancer by clinical image and its yield accuracy on diagnosis & treatment suggestion is over 90%. This definitely indicates the superior performance of CNN [11]. There has been noteworthy development for AI in other areas too. In future we don't imagine the progress of world due to only artificial intelligence & innovative machines. We highlight specific AI techniques of interest and their applications in different fields and how that application will improve trial performances [12].

2. REVOLUTION OF AI IN MEDICAL FIELD

2.1. Cardiology

2.1.1. Arrhythmia

Arrhythmia, an irregular heartbeat, is analyzed clinically mainly by electrocardiogram (a low cost, simple) technique. The major drawback of ECG is collection of huge amounts of data which is reviewed by human operators/technicians. Several methods have been suggested for complete automatic detection of arrhythmia but this requires in depth domain knowledge [13]. Previously value of data & events (P wave, QRS complex, T wave, Events of S phase) including classifiers are plotted for detection. High instability in wave characteristics between patients as well as excessive sound make it complicated for automatic detection. In recent advancement of deep learning by using AI technique, precision & accuracy of data become more accurate [13]. Now, characteristics extraction and event determination are being done by Deep learning. In comparison to previous detection technique, in deep learning, data inserted (raw processing) into machine which consists of several layers followed by extraction and classification with high accuracy. Planning of deep learning include Convolutional neural networks (CNNs), Recurrent Neural network (RNN), Auto -encoder and Deep Belief Network (DBN). These all are the machine learning tools (CNN & RNN supervised & Auto-encoder & DBN unsupervised tools) which are being used for high precision of data [14].

2.1.2. Heart Attack

Heart disease is one of the most prevalent diseases in today's time [15]. So, it is now a prime demand in the medical field to get it checked and diagnose as early as possible, so that it can be treated on time as well as alleviate the death rate [16]. Mining data algorithm is now an important application where doctor use patient's data for discovery and to know more about it [15]. Today, by using techniques like artificial intelligence for diagnosis of cardiovascular diseases made it possible to design medical assistance system. Cardiovascular diseases are considered the world's most deadly disease mainly "coronary artery disease" which kills more than 25% of the population without any previous sign [17]. So far, amount and location of narrowing artery have been

detected by using angiography having high price with major severe side effects [18]. Data mining diagnosis (low price) is now used in the field of detection of any of the cardiovascular diseases [16]. Coronary atherosclerotic plaques identification can be done more precisely than clinicians by using deep learning in upcoming future. In comparison to clinical experts, AI tools present more accuracy in image recognition and its interpretation [18]. The table given below depicts the comparison between previously used algorithm and today's used data mining method.

Author/year	Algorithm used	Data mining method	Application
Mahmoudi/2013	CART Neural Network	Clustering based Perceptron neural networks	CAD (heart attacks)
Chaurasia et al. 2014	Bagging Naïve Bayer's J45DT	Used three clustering algorithms	Identification of heart related disease

2.1.3. Stroke

In the domain of stroke, AI provide aid in recognition and treatment by examining medical imaging data, leading to preliminary identification and diagnosis, outcome estimation and prognosis, assessment, assistance with therapy and rehabilitation. Machine learning is used for the purpose of automatic differentiation of medical imaging of stroke lesions and precise differentiation of the hematoma volume of cerebral haemorrhage on CT scans. Identification of cerebral haemorrhage, mass effect, hydrocephalus and other features in CT was done through AI algorithm. The automatic detection and quantification of cerebrospinal fluid in orderly CT examinations of patients with stroke, was used through ML-based algorithm predicting the development of cerebral edema.

Earlier it was difficult for physicians to diagnose the disease and take desired action at earlier stage. But with the help of artificial neural network the medical data of patients were analysed thoroughly so that the cerebral ischemia could be differentiated from other disease similar to stroke. AI is used to analyse the infract size of stroke patients. Recently few years back, US FDA approved the AI software to predict the stroke in patients by analysing CT images. When any blood vessel found to be blocked, a text message is sent to the neurologist. It directly notifies the neurologist priorly in case of suspected vascular occlusion and thus reducing the brain tissue damage. The enormous amount of MRI and structural images are used as input data for ML system to detect change in normal human physiology as a result of effects after stroke [19].

2.2. Neurology

2.2.1. Alzheimer

It is considered as a major challenge for healthcare in twenty first century. Globally it is believed that AD is the 6th leading cause of death in US. Dementia affects mainly old age people which results into AD. In past years, calculation was done by using error method where gap between the neural network output and the expected network output by using random weight values until the gap is no longer updated or till the value (differential) becomes zero. This method requires huge amount of computation time. To nullify this problem, some activated function adds into previous ones to alleviate the time and for more accuracy. For instance: To get faster and more frequent update SGD (stochastic Gradient Decent) is used. One more decent method named Adaptive Moment Estimation (Adam) is being used. Other techniques involve SVM, AR mining and Ensemble method [20].

Differentiation between AD and healthy individual is somewhat a major challenge for healthcare sector. For this purpose, there are various techniques which can be used for better results like: MRI, PET, CSF etc. and their combination data will give 10-time cross validation. It is proved that this multimodal approach achieves consistent improvement and is more robust over those using individual modality, for any number of brain regions selected [21].

2.2.2. Parkinson

Parkinson's disease (PD), a degenerative disorder of the central nervous system, is the second most common neurodegenerative disease. The number of people suffering from PD has increased rapidly worldwide, especially in developing countries in Asia. PD is characterized by tremors, rigidity, slowed movement, motor symptom asymmetry and impaired posture. Research has shown phonation and speech disorders are also common among PD patients [22]. Many other researchers conducted studies on the use of Hindawi Computational and Mathematical Methods in Medicine,

inspired by the findings of Little et al. Machine learning approaches to diagnose PD patients on the same dataset 2 Computational and Mathematical Methods in Medicine (hereafter Oxford dataset) [22]. Das compared the classification scores for PD diagnosis between artificial neural network (ANN), Neural, Regression and Decision Trees in his paper. Te ANN classifier yielded the best results of 92.9%. AStrom et al. created a parallel feed-forward neural network system that improved PD classification by 8.4 percent. To classify PD patients, Ozcif et al. introduced rotation forest ensemble classifiers with feature selection using the correlation method; the proposed model had the highest classification accuracy of 87.13 percent. Spadoto et al. used a combination of evolutionary-based techniques and the Optimum-Path Forest (OPF) classifier to detect PD with a maximum classification accuracy of 84.01% [23].

2.2.3. Epilepsy

It is a group of neurodegenerative disorder in which distortion of nerve cells occurs which results into seizures. It may occur in any age group of people. 'Epileptogenesis' is defined as a gradual development of normal brain cell develops seizures. Due to these changes, hyper-synchronous firing of neurons occurs [24]. It is also considered as most prevalent disease after stroke, Alzheimer's diseases and migraine. Initially EEG (Electroencephalography) method was employed to determine the brain activity during any ES attack. Through this method, predication and medication is done in earlier phase. EEG measures the electrical activity of brain which is then used for diagnosis of particular type of brain disorder. Manual collection of EEG data requires more time and there will be more chance of mistake during collection [25]. For instance, great deviation in pattern of seizures was seen with different individual. For early detection of seizure, there is requirement of automatic detection method which carry multiple EEG channels. By using Machine learning kharbouch *et al* found out a real-time seizures detection system on intracranial electrodes. Using Spectral energy (<37 Hz) of intracranial IEEgshoeb *et al* operate onset of seizure by training support vector machine (SVM, non-linear & linear) to check whether the patient has seizure activity or non-seizure activity [26]. For automatic seizure detection, Jeswal et al proposed two effective approaches for EEG feature extraction involving sub-part based PCA, incorporated with SVM. Hssain found out that SVM, KNN showedhighest accuracy as compare to other ML method (SVM, K-NEAREST neighbour classification, decision tree) for detection of seizures [24]. Other applications of AI is in detection of schizophrenia prion disease, motor neurone diseases, Huntington's diseases [26].

2.3. Oncology

2.3.1. Prostate Cancer

The recent application of deep learning in prostate cancer achieved promising results. Multiparameter magnetic resonance imaging (mpMRI) are used for the detection in the pattern of soft tissue, it also gives the information regarding anatomy, characteristics and function of tissue. mpMRI detects 'clinically significant' disease- Gleason pattern of 4 or above (gleason score ≥7) and/or a tumour volume> $0.5cm^3$.

In recent years, there is a growth in the volume of mpMRI test as it has the ability to allow the targeted biopsy sampling. In 2015, the second version of the Prostate Imaging Reporting & Data System (PI-RADS) was published [27] which aims to increase the consistency of the communication and interpretation of mpMRI findings. Early, the models of AI have been developed as CADe and CADx system for prostate tumour detection localization and for characterization. Along with PI-RADS, accurate CAD system interrater reliability and improves the accuracy of mpMRI reading and interpretation in diagnosis. Together CADx & CADe system use anatomic, intensity, texture, boldness and pharmacokinetic feature. Some investigators use intensity features including T2-weighted MRI, the apparent diffusion coefficient, high b-values, diffusion-weighted MRI, and T2 estimation by proton density mapping. Earlier, the CNNs have also been used and come under the highlight for prostate cancer diagnosis and detection in research whereas to classify the MRI findings with an auto windowing prevailed over high dynamic range of MR images and while others use different combination of mpMRI by assemble each model as a 2D & 3D [27].

2.3.2. Blood Cancer

For the cell count and leukocytes analysis, the haematology analysers are used. Nowadays, in many haematology analysers there is integrated reticulocyte count analysis with complete blood count analysis which provide the absolute count of the reticulocytes also the reticulocytes % in addition, it also provides reticulocyte haemoglobin content (CHr), microcytic anaemia factor, % hypochromic cell, immature reticulate fraction etc. Earlier the analysers which are used, provide white cell analysis also Lymph Index, also lymph index (Beckman

Coulter-LH series analysers) and Cell Population Data (CPD), Large unstained cell population (Advia Systems), Granularity Index (System XE Series) and hemiparasites which can be used in the malignant haematological conditions and in the benign tumour screening [28]. During the white cell analysis CPD is generated by using the VCS technology for each white cell subtype. This technology acquire data from more than 800 WBCs in a few seconds, the data which is obtained from the VCS technology is the similar reflection of cell morphology. From last few years, the VCS parameters formed through CPD data. For the differentiation and malaria/dengue infection screening, the CPD data is useful [29]. We'll discuss in each major leukaemia type also (CML, AML, CLL and ALL) by applying ML techniques on microscopic and flow cytometric diagnosis. In acute lymphoid leukaemia (ALL) diagnosis total 13 studies investigated the role of ML in which one study based on flow cytometric diagnosis remaining twelve on microscopic diagnosis. Most common methodology was the Pattern recognition based for example fuzzy c-mean and k-mean anther was threshold-based methodologies for example watershed. There were only 01 study which used deformable models (snakes) as a segmentation methodology [30]. From the past few years, there is rapid increase in the use of unsupervised algorithm and it holds opportunities for pathological diagnosis. Support Vector Machine (SVM) is the machine in most of the studies [31] which used more than one algorithm and its accuracy range from 74% to 99.5%. And in the detection of ALL, Bigorra et al [31] reported 74% accuracy by using SVM algorithm. For the evaluation in ML and AI the AUC (Area under curve) most widely used method. To differentiate between AML and ALL only Reta et al reported AUC of SVM algorithm [31].

2.3.3. Cervical Cancer

The mostly used imaging modality in cervical cancer is the Magnetic resonance imaging (MRI) as it is a preoperative method which is used to assess the status of LN in cervical cancer. The outcomes were studied Earlier, The LNM status with pathologic characteristics diagnosed by Lymphadenectomy. First, the DL model that is the MRI to diagnose LNM was used then the hybrid model comes under this *i.e.,* MRI reported LN (MRI-LN). The second primary outcome which was studied is DFS (Disease Free Survival). We assessed the prognostic ability of the hybrid model with regard to DFS by the Kaplan-Meier Method [32]. To diagnose the LNM Preoperatively in the patients which have cervical cancer, the end-to-end deep learning model was developed. The comparison of DL model with MRI sequences that are contrast enhanced T1 weighted imaging (CETWI), Axial, T2 weighted imaging (T2W2) and axial diffusion imaging (DW1) has been done. Also, the intratumoral and peritumoral regions have also explored. If we compare all the DL models, the CETW1 tumour + peritumoral model accomplished great results with best performance. The information in CETW1 is more as compared to T2W1 & DW1 [32].

Earlier, there was also a Visual inspection (VIA) application for the screening test of the cervix when more advance methods were not feasible. The VIA application is the simple as well as cost friendly. So, it was frequently in use however, by the VIA one cannot distinguish the pre-cancers from common minor abnormalities. So now DL based method called faster region-based Convolutional neural network (faster R-CNN) is used [33]. The method of algorithm was applied to the images of cervical taken during epidemiologic study. On the other hand, the algorithm of "automated visual evaluation" applied to archive those cervical images which are digitized. Other screening test, the Guanacaste cohort achieved the outstanding sensitivity for the CIN2+ detection when the age which is at highest risk of Pre-cancer [34]. Cystology method is also used like conventional pap smears, a prototype liquid-based method and first-generation automated approach. The conventional Pap smears is the method which is performed in Costa Rica. HPV testing is per-formed by MYO9MY11 consensus primer PCR but for the colposcopy referral the HPv testing is not used [35].

2.3.4. Gastric Cancer

The early gastric cancer (EGC) was detected through White light imaging earlier used in esophagogastroduodenoscopy but it was critical to detect small lesions. To improve the diagnosis further, the ME-NBI (Magnifying endoscopy with Narrow Band Imaging) image enhanced endoscopy was developed to detect small lesions. Recently, the CAD (Computer Aided Diagnosis) was integrated with ME-NBI for the recognition of EGC (early Gastric Cancer) using AI. It improved the imaging technique and detection of EGC at earlier stage. To analyze the imaging data captured using the water immersion technique with maximal magnification, AI-assisted convolutional neural network (CNN)-CAD systems were used. It has lower false negative detection rate and lower level of variation in the imaging data. AI-assisted CNN-CAD system (ResNet50)

was feeded up with dataset of 5574 ME-NBI images which includes 3797 EGCs, 1777 non-cancerous mucosa and lesions. A distinct test dataset of 2300 ME-NBI images (1430 EGCs, 870 non-cancerous mucosa and lesions) was assessed for evaluating the diagnostic accuracy using the AI-assisted CNN-CAD system [36].

2.3.5. Lung Cancer

Earlier the National Lung Screening Trial (NLST) has proved that screening with low dose CT (LDCT) has reduced 20% mortality and lead to detection of cancer at early stage and increase the survival chances. Medical imaging & AI helps in cancer classification and characterization for treatment selection and monitoring treatment response. AI aid in identifying the biomarkers that decrease the false-positive images results and precisely separates the benign and cancerous nodules.

To identify the lung adenocarcinomas the CANARY tool (Computer Aided Nodule Assessment and Risk Yield) was used as it facilitates the semantic based risk classification. In prognosis of various cancers such as lung cancer quantification of radiographic characteristic of various tumor phenotype can be done automatically with AI. A portion of tumor is subjected in bio marker testing rather than in AI that provide phenotype of complete tumor in 3 D dimension. The development of AI in oncology was based on the quantitative imaging endpoints in RECIST criteria (Response Evaluation Criteria in Solid Tumor). Earlier, to forecast response of target therapy, biopsy was performed to evaluate the status of mutation, but now, AI predictive model are used which are non-invasive and identify imaging phenotypes linked with mutational status. The mutational status of all the tumors can be characterized non-invasively and repeatedly, instead of biopsy which lack prediction of intratumoral heterogeneity. The intra observer variability linked with visual assessment of human experts are refrained with AI ability to recognize complex pattern within tumor images [37].

2.3.6. Breast Cancer

The statistical rise of mammographic screening has led revitalization in breast cancer treatment with advance-ment and integration of AI in imaging techniques has improved areas such as risk assessment, detection, diagnosis, prognosis, and response to therapy. The novel deep learning methods and predefined algorithms has automated CADe used for the detection of breast lesions on 3D ultrasound, breast MRI, breast tomo-synthesis. The detection of micro calcifications in digitized mammograms are done through CNNs. The breast density and parenchymal characterization are evaluated using deep learning methods, an illustration of that includes difference between women at normal risk of breast cancer and those at high risk based on their BRCA1/BRCA2 status evaluated using transfer learning technique. The automatic characterization of tumour is performed through AI method for CADx that involves differentiating malignant and benign breast lesions. Applications of AI in breast imaging include evaluation of molecular subtypes, prognosis, and therapeutic response by yielding predictive image-based phenotypes of breast cancer for precision medicine [38].

2.4. Nephrology

Kidney diseases include acute kidney injury and chronic kidney injury is predicted as a major health issue which results into high death rate. Patients with kidney disease have a high heterogeneity in disease manifestation, progression, and treatment response. With the help of AI, accurate precision of kidney disease can be done. A model (machine learning aided risk prognosis) named IgAN is grown by Chetan *et al.* in the field of nephrology. In contrast to previous predictions made with IgAN, which used standard modelling with a limited number of predefined variables, Chetan et al [39] discovered that machine learning can produce accurate results with large amounts of data. They studied on 36 patients where extreme Gradient boosting (XGBoost) is used for regular data collection without any pre determination of features. With the help of previous data this method (XGBoost) generates a series of illustration tree-based data. This tool has great advantage in case of any missing variables. For easy understanding in clinical practice Chetan *et al* finally demonstrated a validated simplified score card. They also modified it into online calculator with the help of this, pre-5-year prediction can be done with the classification like he/she is under high risk or low-risk category. Nephrologist can easily identify patient having high risk factor which can be improve by monitoring for the treatment of Anaemia in haemodialysis patient Barbieri *et al* begin a decision support system named ACM (anaemia Control Model) [39].

2.5. Clinical Trial Design

Clinical trial is the most delicate phase that decides whether the drug is safe or not before it reaches to the market. The statistics of drug approval in different phases of clinical trial is very less as the one third of compound

from Phase II moves to Phase III and one third of Phase III compound further reaches for final approval. Phase III trial cost almost 60% of clinical trial cost.

The factors leading to failure of clinical trials are patient cohort selection and recruiting mechanism. To solve all these problems machine learning (ML) and deep learning (DL) were introduced that examine large datasets of text, speech or images in automated way for detecting the meaningful patterns. For understanding and co-relating the content in written or spoken form natural language processing (NLP) is used. The large and varied datasets collected from different sources such as electronic health record (EHRs), medical literature and trial database are examined for automated patient monitoring system during clinical trial and development of better patient-trial co-relation for recruitment in clinical trials yielding more effective and efficient end results. The surface biomarkers that lead to easy identification and characterization of patient subpopulations are performed using sophisticated analytical techniques that combines womic data with electronic medical record (EMR), among different locations, owners and formats such as written paper to digital medical imagery [40]. For improving patient cohort selection AI models and methods are used out of which some are recognized by Food and Drug administration (FDA) that includes: (i) Prognostic enrichment (ii) predictive enrichment (iii) reduction of population heterogeneity. The automatic identification of possible matches between specific patients and trials of relevance are much effective and efficient through the use of AI & ML techniques such as NLP & OCR that deeply examine the publicly available web content such as social media, digital trial databases and trial announcements [41].

2.6. Drug Design

Drug design basically is a drug target identification, target validation, lead optimization and preclinical candidate identification. The computer assisted drug design is used to examine the molecular characteristic, discover the lead molecules and reduce the rejection rate of preclinical candidate compounds.

AI is used to discover new drugs by applying algorithms that analyze and learn the pharmaceutical related big data. Deep learning (DL) is applied in this field due to its generalization and feature extraction capability that reduces the chance of error and aid in providing satisfactory results. The final structure of protein is predicted by the feature extraction capability of DL which aid in learning the relationship between the sequence and the structure. PPI (Protein-protein interaction) interface is predicted through DL methods to find the most appropriate sequence feature. It consists of druggable hotspot sites that comprise of vast amount of binding energy [42]. If the structure of two interactive proteins is available, protein-protein docking methods such as ZDOCK & SymmDock can be used to predict the PPI interface. The first docking tool made was iFitDock used to predict the druggable hotspots in PPI interfaces. Variation in the drug-disease interaction led the use of network analysis to predict the interaction of these elements, there was a need of integrated multiple networks for this process, DTINet was established which integrate the information of multiple networks through network diffusion algorithm and dimensionality reduction approaches [43]. The new molecular libraries are screened through ML process techniques such as DNN and gradient boosting trees. ML is used in active scoring for the effective assessment of binding affinities of drug like molecule towards a target of interest. CNN has been introduced in the area of image processing to extract the features from protein-ligand interaction image to forecast protein-ligand affinity. The use of autoencoders to form the novel molecules is the important application of generation model with DL. CNN-ANN (Convolutional neural network-Artificial neural network) model is applied to detect the solubility of drug molecule through molecular graph [44].

2.7. Dentistry

AI in dentistry reduces the procedure time, cost and errors. It is used for effective diagnosis of orofacial pain, analysis of facial growth in orthodontia and radiographic interpretations. It helps in effective dental implant/ surgeries and fixed denture prosthetics. It helps in measuring the pain in teeth and provides effective medication. AI is used to detect the hidden cavity of teeth and aid in effective implementation of braces to straighten patient's teeth. The storage and monitoring of patient records along with diagnosis and therapy details could be done easily. The coordination in appointments of patients and dentist along with dental alert checkup before causing any dental disease or other type of allergies are the major highlights of the effective use of technology (AI) in this field. AI helps in deciding the desired dose to the patients and aid in evaluation of clinics and radical change for the best service of the patient. Smart tooth brush integrated with AI is used to capture the images of teeth and assess the defect in the teeth. It improves the communication between patient

and the dentist and decreases the risk of complicated cases [45].

2.8. Mental Health

AI is used to forecast, detect and treat the mental health care problems through integration with digital media and smart phones. The ML is used to forecast the mental health condition and psychological/ psychometric results by utilizing the sensor and usage data from digital devices which give contextual and behavioral information of an individual. The mental health conditions such as depression and anxiety are measured through PHQ-9 scale.

Natural language processing (NLP) is a part of AI system, used to characterize voice/language of an individual to predict the mental health, to evaluate the characteristic feature of language disturbances such as semantic incoherence, reduce synaptic complexity and poor vocabulary to determine severe mental illness such as schizophrenia/psychosis. ML methods are used to analyze the social media content precisely, to predict the signs of mental health issues and also for audio analysis of specific paralinguistic/acoustic feature that provide information of individual mental health. AI acts as virtual agents in chatbots to mimic the conversation with user either in text/voice format. The first established chatbot was ELIZA that was programmed to act like a Rogerian psychotherapist. Chatbots are the easiest way of communication for those who feel discomfort seeing a therapist and having limited access to traditional mental health services. The therapeutic health chatbots that are prevalent in the market are Woebot, Wysa and Tess [46].

2.9. Orthopedics

AI ameliorate the evaluation and decision capabilities of system in conditions such as treatment in Orthopaedics surgery like arthroplasty, measurement of bone dimensions, detection of bone marrow-related diseases, and traumatic fractures. The data of radiographic techniques such as MRI and CT are analyzed by AI. It is used for diagnosis and management of traumatic injuries and orthopaedic diseases. It is used to perform surgery accurately with minimum error leading improved surgical outcome that are reproducible. AI is used for surgical training of medical students on the basis of data obtained from different cases and aid in robot assisted orthopaedic surgery. It is used for improvised treatment of patients by developing the digital information system comprise of treatment, planning, imaging and diagnosis of orthopaedic diseases [47].

2.10. Nuclear Medicine

AI is used in nuclear medicine imaging of benign diseases that automatically facilitate image classification and clinical decision making. It used for reducing the attenuation in the PET images. It is used to define the specific anatomical section and put a specific label on that part of body which contains tumour so, that there could be easy determination of histological classification of PET data. Nuclear medicine imaging is used to examine therapy response, characterize lesions with unclear morphological findings and evaluate whole body tumour volume with help of AI that automatize the delineation of all metastases in whole body examination. It plays important role in diagnosing malignant lesions precisely and aid in PET imaging for detection of micro-metastases. ML & DL are applied in myocardial perfusion scintigraphy which utilizes nuclear medicine imaging technique to investigate blood supply to heart giving qualitative outcome. AI has made development in area of diagnosis of coronary artery disease (CAD), forecasting major adverse cardiac events (MACE) and myocardial perfusion imaging data. It includes vast amount of variable that humans are not able to see. MRI is the imaging technique that is generally used for glioma. Voxel-based analysis of dynamic FET PET is used to detect aggressive sub volumes in gliomas. CNN is applied for the segmentation of PET positive tumour volume. PET data are noisy, when low tracer activity applied which can be improved through image denoising by AI technique. This process is performed by post-processing of low dose reconstructed PET image utilizing denoising convolutional network. It reduces the exposure time of radiation and improves the overall image quality [48].

2.11. Dermatology

The rapid growth of telehealth, informatics and digitalization has increased the demand for screening of skin diseases through the continuous advanced machines for precise and accurate diagnosis and treatment of skin diseases.

The imaging technique integrated with AI is used for differentiating benign nevi Vs melanoma. The main working of the application is based on break down of dermatoscopic or non-dermatoscopic lesions images into individual pixels for analysis. Another AI model has been developed that distinguish actinic keratosis and normal skin with specificity of 89.8% and a sensitivity of 91.7% [49]. Presently, AI system use numerical values in various patterns and extract trends for imaging process and diagnosis of disease. It is used to precisely measure

wound area and distinguish different type of tissues involved. They are used to distinguish slough, necrotic and granulation tissues. AI is implemented for the psoriasis detection and classification through image recognition technique. They are used for determining psoriasis patient's response to biological therapy. It is used to distinguish lichen planus, pityriasis lichenoides, dermatomyositis and acne.

ML and statistical learning are implemented to detect new loci and determine the tendency of cutaneous psoriasis patients to develop psoriatic arthritis symptoms. For the identification of melanoma in clinical photographs with manual grading of same images is achieved by training CNN through dermoscopy images [50].

2.12. Hepatology and Gastrointestinal Bleeding

Liver fibrosis is mainly caused due to chronic liver disease. It is further developed into mild fibrosis to cirrhosis. Liver fibrosis is considered as a major hazard for Hepatocellular carcinoma Development (HCC) as well as hepatic decompensation. It is said that, without correct treatment, it may lead to worse. AI (DL method) utilizes in recognize high risk patients. (1) Many scientists have revealed that AI used in detection of small bowel bleeding which is based on endoscopy (wireless collection of images) [51]. Patient having acute upper or lower gastrointestinal bleeding leads to haemorrhage which is being detected by endoscopy techniques. Machine learning tool help for those having several repeated events of bleeding which require repeated analysis through endoscopy. This method is also used to estimate the mortality by using biological data with 90% accuracy [52]. With employment of US image Hassan *et al* [51] used the stacked sparse auto-encoder system to detect liver cyst, hemangioma and HCC. They alleviate buzz while allow the processing images firstly. Secondly, by using the level set method and fuzzy c-means clustering algorithm liver segmentation were directed. Consequently, stacked sparsed encoder was used to identify inactive attributes from pseudonymous input data in an individually fashion [51]. Evolved ML model for the prognosis of severity in patients having acute pancreatitis which were based on level of c-reactive protein and admission value of APACHE II score. Their model depicted 0.82%, 87% susceptibility and 71% accuracy with AUROC curve [52]. With AUROC curve of 0.08, Jovaanoic et al discovered ANN model for identification of cholendocholithiasis patient which require therapeutic endoscopic retrograde cholangiopancreatography based on clinical laboratory, and transcutaneous ultrasound finding [2]. By using an Inception-ResNet-v2 CNN pertained on Image Net for NAFLD Byra et al utilize 55 obese patients (come for bariatric surgery) In US where they took a wedge biopsy liver sample as a standard reference and found out that the AUROC was 0.9777, where conventional method having 0.9590 curve [53].

2.13. Surgeries

The usage of intelligent robots for surgery was started in 1980s. Intelligent robots were re-programmable AI algorithms used for mechanical movement of robot system precisely and accurately during surgery. For example, PUMA 560 used in neurological biopsy and prostate surgery and ROBODOC used in hip replacement in orthopaedic surgery. FDA has approved three types of robotic surgical system such as ZUES. The intelligent robots used for orthopaedic surgery can be classified into 3 types such as traumatic orthopaedic, joint surgery, and spinal orthopaedic robots. During gynaecological surgery, earlier ovarian cancer intelligent robots were used for the removal of numerous lymph nodes and a low blood transfusion rate in the patients [54].

2.14. Proficient decision System

Earlier AI software wasused for making proficient system. The first proficient system was Dendral System. Later on, other systems were developed such as AAP Help for the diagnosis of acute abdomen, INTERNIST-I for the diagnosis of complex system in internal medicine & MYCIN for the diagnosis of infectious diseases.

This was further used to diagnose various types of headaches such as- tension headaches, migraine headaches, and drug dependent headaches. Development of CHAT system for helping doctor in identifying type of headache detected [55].

2.15. Sports

Professional sports are an industry where AI is utilized for maintenance of player's health so that the player performance and availability could be achieved. The ML algorithms were utilized for forecasting the next season injury with accuracy of 94.7% with help of data such as his different performance metrics.

The advanced CT and MRI integrated with AI is used for predicting the acute cartilage/ligamentous pathology. AI(ML) is used in femoro-acetabular impingement syndrome (FAIS) for arthroscopic correction through radiographic indices from CT scans of the hip, forecasting the variation in one year and two-year patient reported

outcome measures (PROMs). The ML models were used for forecasting the variation in PROMs after arthroscopic FAIS surgery. For selecting the desired feature LASSO (least absolute shrinkage and selection operator) model was developed. The artificial neural network is used to forecast the length of stay (LOS), discharge disposition, and inpatient charges for primary anatomic (aTSA), reverse (rTSA), and hemi-shoulder arthroplasty. The inpatient costs, discharge disposition and LOS are forecasted with accuracy by using this model [56].

2.16. Telehealth

Presently in the time of COVID-19 pandemic, there is a high-rise demand for remote patient monitoring (RPM) system and telemedicine. RPM system is used for virtually monitoring the patients with continuous data transfer generated at patient's side to doctors/surgeons for rigorous evaluation so that patient could be recovered. The system such as Focus Motion & Santa monica use AI for remotely monitoring the patients recovering from different type of surgeries. The AI based algorithm were used to relay data from Bluetooth enabled braces and mobile health. PROMs, opioid consumption, wound appearance and rehabilitation compliance are shared with patient and care team that lead more patient engagement to rehabilitate post-operative patients [57].

3. APPLICATIONS OF AI IN OTHER FIELDS

With rapid advancement of technology, AI has been used in wide variety of fields such as material design where machine learning (ML) has been implemented to automate material characterization processes and analyse the characterization dataset. It rapidly examines the material design space. They characterize the properties of complex material systems. It has been used to layout high dimensional synthesis recipes to material with specific features and extract out scientific principles involved from varied material system. AI is suitable for material design due to its capability of handling enormous amount of data and high dimensional analysis of the material [58].

The entire manufacturing industry is rapidly moving towards automation by utilizing the facility of automatic control and maintenance through computer system that are applied in machine tool production, computer chip production and almost every high-tech process. AI tool has been utilized in hazardous tasks such as handling of radioactive materials efficiently and reducing the chance of error. Robotic pilot has been utilized for handling out complex maneuvering techniques of unmanned spacecraft sent in space [59]. ANN were used to detect charges or claims outside of the norm. It assists in orderly arrangement of vast amount of financial data, assist decision makers under time constraints and suggest alternative in searching and evaluation of data [60]. AI is implemented in form of Robotic Process Automation (RPA) to perform repetitive tasks generally done by humans. Analytics and CRM (Customer relationship management) integrated with machine learning algorithms are used to serve customers effectively. Chabot's have been integrated with websites for real time response to the customer queries which provide an improved communication system and save a lot of time. For example: EVA (Electronic Virtual Assistant) system developed by HDFC bank [61]. AI is assisting farmers to use the resources effectively and produce a higher yield. Automated robotic systems are utilized to protect the crop from weeds. For example, See & Spray robot developed by Blue River Technology which use object detection tool to monitor & accurately spray weedicide on cotton plants. AI based application has been developed called Plantix that detect nutrients deficiencies and defects in soil through image recognition technology and further provide suggestions regarding soil restoration technique, tips and other possible solutions [62]. It plays a vital role in computer games by acting as non-playing character (NPC) and adding specific characteristic features to the game. AI contributes to computer gaming through simulated perception, situation analysis, spatial reasoning, group coordination, resource allocation, target location, unit movement and many more [60]. In self-driving cars highly, advanced tool is used to collect information from sensors that includes long range radar, cameras and LIDAR. Each of these tools collect different type of data which are processed by artificial intelligence (AI). For example: Waymo company has developed first AI- based public riding service that gather information from GPS, camera, radar and cloud service to produce controlled signal that operate vehicle [61]. AI is used in social media for face identification and deep learning is utilized for tagging friends and detect facial features. Machine learning is implemented to design feed based on individual interest [62]. For example: Muse Net that composes classical music is a deep neural network generating 4-minute musical composition with 10 different instruments and can combine different type of styles of different countries. Further, the AI is used in aviation, weather forecasting, transportation, public security, speech recognition and telecommunication industries to enhance the prior systems and provide accurate and efficient services to the consumers [63].

4. CHALLENGES & FUTURE SCOPE

Many challenges are being faced during implementation of AI in healthcare and medical field. The privacy and confidentiality of vast amount of data received from hospitals led AI to face difficulties in gaining access to those resources. Less availability and credibility of clinically confirmed diagnosis reduce the chance of accurate diagnosis. Increased work load due to export of imaging data and medical record data. The clinical decision capability of AI is restricted to solve one problem at a time while patients under life threatening situations may have combination of complicated problems that needs a comprehensive consideration from multiple perspectives. Hospitals have to work parallel with software companies to develop powerful AI platform based on diagnosis and treatment data that is a long and a cumbersome process that require high precision. The imaging (CT/MRI) data require proper labelling, annotations, segmentation and quality assurance that need highly trained professionals to do that work which increases the overall cost and time. Imaging data is insufficient for proper development of AI system to diagnose disease. These all the above circumstances are barriers/hindrance for implementing AI into healthcare and medical field.

The later enhancement in AI and the software can be used for analysis of imaging data led to predict the diseases such as cancer with high accuracy and precision. A wide range research and analysis of imaging data will facilitate work guidelines for future clinical practices. Rehabilitation exercises could be improved after integrating with AI to achieve personalized assessment and rehabilitation training that enhances desired neurological function with regard to varied neurological dysfunction. Strong learning ability & generalization capacity of the new technologies are expected to achieve human like intelligence in future that will improve diagnostic approach and decision-making system for availability of better quality and affordable medical services. AI will improve medical services of primary hospitals and develop a black box model predictor to solve black box problem & develop 5G technology. The 5G network having high speed transmission will enhance real time remote technical guidelines for safe, reliable and stable remote collaborative surgeries reducing the risks of surgery.

5. CONCLUSION

AI has drastically enhanced the healthcare sector with improvement in diagnosis and prediction of diseases. Several imaging techniques like CT/MRI are integrated with AI for facilitating high quality images for effective treatment of disease. It has been used for classifying and analysing the imaging data precisely. Machine learning and deep learning has revolutionized the entire medical filed in terms of differentiating varied tissues structures, robotic surgeries, patient assistance and handling of hazardous substances. Due to the high technological advancement with AI in drug design has paved the way for accurate prediction of molecules/moieties that are highly effective at target site. It has enhanced the clinical trial process by facilitating easy and effective patient cohort selection and identification of lead compounds. Medical fields such as cardiology, neurology, hepatology, nephrology, oncology and various other has been integrated with AI for effective diagnosis of diseases. Further improvement in AI technology is essential for high-risk surgeries and effective continuous operational procedures. Collection & storage of vast amount of data in cloud and analysing that large data in real time require major developmental improvements in AI technology. We conclude that further research and development in AI technology will entirely change the human living and working. It will facilitate in more innovative developments that will benefit human race and create sustainable environment utilizing resources more efficiently.

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Conflict of interest

None

7. REFERENCES

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