ARTIFICIAL INTELLIGENCE- ITS DIAGNOSTIC FUTURE TOWARDS NEUROLOGICAL DISORDERS & DISEASES

Monisha S

M.Tech Biotechnology

Karunya institute of technology and sciences
Coimbatore, India

moniselvaraj06@gmail.com

ABSTRACT

Neurological diseases are frequently diagnosed around the world. About 1 in 6 people are affected by neurological diseases, or disorders. These diseases are not easy to diagnose. One of the common diagnosis methods are imaging systems. Diagnosis by images lacks accuracy in finding tumor spots, biomarkers, prognosis, and personalized treatment. Artificial intelligence with machine learning, and deep learning helps to assist physicians in diagnosis, and treatment. Neuro oncology, Parkinson's diseases, and autism spectrum disorder are common diseases found in humans. Random forest, Support vehicle machine, convolutional neural network, artificial neural network is some of the common algorithms that are used in detection of neural diseases. Machine learning, and deep learning algorithms helps to predict the forthcoming symptoms in healthy patients. The algorithms are mostly combined with scanning systems, and through image analysis they can detect the treatment, identify specific biomarkers, and increase the healing of patients. Data from machine learning, and neural networking from deep learning plays a key role in healthcare. iPhone, apple watches, and other wearable devices contain artificial intelligence that can detect epilepsy, cardiac arrest, and stroke ahead of an accident. Some of these devices also help doctors, and medic to understand the history of the patients. Artificial intelligence is indeed the future that can improve medicinal fields.

Keywords: Support Vehicle Machine, Parkinson's disease, Brain tumor, Deep Learning, Machine Learning.

I. INTRODUCTION

Human brain is one of the complex organs in the body. It contains a network of overlapped strongly bound strings called neurons. These neurons form a strong connection with one another sending signals. These signals are responsible for making decisions, critical thinking, language, creativity, and movement. The brain is the crown of the body. Small changes in these neural networks cause problems in the overall function of the body. Neural disorders, and diseases are becoming common health concerns. About 1 billion people are affected by neurological problems, while seven million die every year around the globe. Neurological disorders include headaches, stroke, epilepsy, cerebral aneurysm, Alzheimer's disease, Parkinson's diseases, and cancer. The common diagnostic method to identify brain diseases is imaging systems. Imaging systems include Computerized tomography (CT scan), Magnetic Resonance Imaging (MRI), Positron Emission Tomography (PET scan), and Electroencephalogram (EEG). The major setbacks of image analysis are the identification of biomarkers, exact area of the diseases, not being able to process treatment approaches ahead, and lack of data for prognosis.

Artificial intelligence (AI) was found by Alan Turing in the year 1950. Artificial intelligence is the use of computers to perform tasks using human intelligence. Artificial intelligence can perform simple tasks such as critical thinking, and problem solving. Machine learning (ML), and deep learning (DL) are part of artificial intelligence. Machine learning (ML) uses algorithms, and software's to collect data. These data give important information, definitions, and number of times a problem has appeared. Machine learning uses language, visual, and hearing features to predict the cause. Deep learning (DL) is equipped with neural networks. Deep learning is much advanced, and can automatically store, transfer, think, and practice data. Deep learning is the technology that is behind most of the automated machines, self-driving cars, and healthcare. Artificial intelligence is one of the widely used fields in all sectors. Google assistant, Siri, and Alexa are some of the common artificial intelligence used in many households. The use of artificial intelligence (AI) has grown its roots into medical, and health care. Machine learning can help in diagnosis based on generalized, and specific data. Deep learning helps in identification of specific areas of infection, and in better diagnosis. The algorithms of machine learning, and deep learning in healthcare helps in better detection, diagnosis, treatment, drug designing, precision medicine, and prognosis.

In most cases artificial intelligence works along with imaging features. Machine learning (ML), and deep learning (DL) have contributed to a large scale in neurological disorders. The paper focuses on three neurological diseases such as Parkinson's disease, Autism spectrum disorder (ASD), and neuro oncology. Diagnosis of these diseases using artificial intelligences along with imaging systems were discussed in detail.

II. ARTIFICIAL INTELLIGENCE

Artificial intelligence (AI) is a broad term for the small acronym it has. Artificial intelligence operates by imitating human behavior, and other cognitive functions of the brain. Artificial intelligence uses computers to perform human tasks. Most of the tasks performed by AI includes learning, and problem solving. Machine learning is a part of AI. Machine learning uses complex algorithms, and data to perform tasks. Machine learning makes its own predictions to differentiate, and understand the future progress based on data. Machine learning mostly uses big data, and improvises its ability to solve critical problems. ML can use visual perception, speech recognition, and decision making to solve problems based on the present data, and alters them over time. Deep learning is a part of artificial neural networks (ANN). Deep learning uses huge datasets, and has higher performance. They are able to perform individually. As machine learning is considered data needed to be fed manually. In deep

learning the data are automatically taken in and perform tasks as a human brain. They are convenient, and overcome most of the drawbacks in the field of medicine [1].

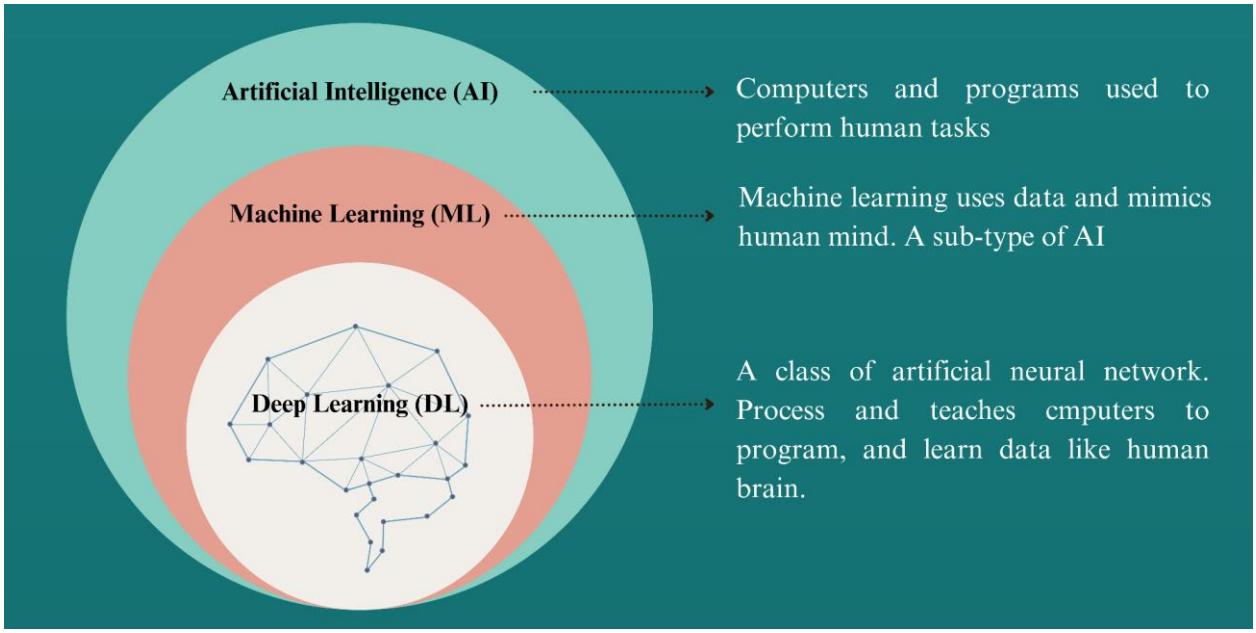

Figure 1: Artificial intelligence, and its types in neural diseases

III. ARTIFICIAL INTELLIGENCE IN NEURAL DISEASES

The brain is the most complex organ of the body. Its possibilities are limitless. Brain controls the overall activity of the body including thinking, cognitive behavior, and movements. The brain is affected by internal, and external factors. The World Health Organization reported that about 1 million people are affected each year due to neurological disorders. The numbers include from headache, stroke to complex health conditions such as epilepsy, Alzheimer's, head injuries, infection, multiple sclerosis, and Parkinson's. About 6.8 million people die each year due to any of these problems worldwide. The critical point for any kind of brain related problems is diagnosis. Diagnosis varies for different persons, the biological markers differ, and most time no symptoms appear in the area of injury. Diagnosis, treatment, prognosis, and rehabilitation differs for individuals. AI plays an important role in understanding the human brain. Machine learning, and deep learning helps to identify the problem faster aiding early detection, improvised prognosis, enhanced imaging, and prevents future critical conditions. AI in smart watches, tablets, and other forms of devices helps to identify sleeping patterns, arrhythmia, and moving complications in a detailed manner. Different sets of features in iPad, identify stroke, dementia, and early epilepsy in patients. This helps in early detection, and treatment. Deep learning helps neuroscientists to identify how neural communication is signaled throughout the body. This helps in identifying movement related disorders such as paralysis, Parkinson's, which helps to start early treatment delaying the conditions, and improving the prognosis [2].

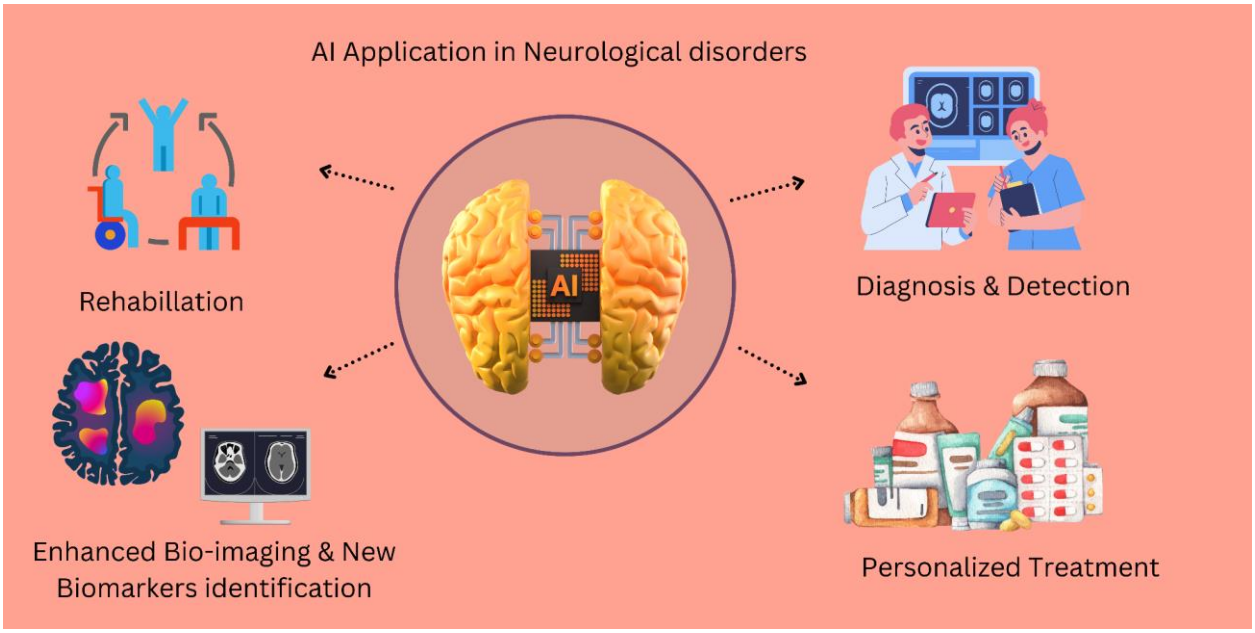

Figure 2: Application of AI in neurological diseases

IV. AI IN PARKINSON'S DISEASES:

Parkinson's is one of the widely seen disorders that primarily affects elderly people. It causes movement illness impacting the whole body. There are various diagnostic symptoms for Parkinson's disease. The common diagnosis includes motor defect (bradykinesia-slow movements, akinesia- lack of action), gait, posture, tremor, Dyskinesia, Speech monitoring, Handwriting analysis, and Brain imaging. The diagnosis of Parkinson's is not simple, as the symptoms vary for individuals. The datasets play an important role in detection of Parkinson's disease. PaHaW dataset, HandPD, and NewHandPD are the three different Parkinson's diseases databases on handwriting. Parkinson's disease is diagnosed by analyzing the hand writing, and spiral sketch along with the thirteen experiments in each dataset. Apart from these MRI, and ECG are taken as private datasets. Each dataset in Parkinson's diseases displays specific details such as biomarker, genetic information, psychiatric evaluation, and cognitive assessments. Machine learning uses new and old data at the same time in the same model to generate accurate diagnosis. Convolutional Neural Network (CNN) helps in diagnostic classification, and is popular among scientists. Artificial Neural Network (ANN) containing backpropagation filters has successfully diagnosed Parkinson's disease in 75.4% out of 195 samples who are declared healthy. Multiple Layer Perceptron ANN uses biomarkers from datasets for diagnosis. Applying Convolutional Neural Network (CNN) to speech classification datasets has increased the diagnosis accuracy to 77%. A study conducted by Bourouhou et al. [112] with 20 Parkinson's patients and 20 normal people with the naive Bayes resulted in 65% of detection accuracy, 68% of sensitivity rate, and 66% of specificity rate. Signal processing technique of naive Bayes algorithm displayed 69.24% in detection accuracy, and a precision rate of 92% for 22 voice characteristics. SysFor, ForestPA, and random forest classifiers are used as Parkinson's detectors. Incremental tree in random forest classifier shows highest accuracy of 93.58% compared to other two. Support Vector Machine (SVM), Artificial Neural Network (ANN), naive Bayes, gradient-boosted trees, and ensemble- based methods are widely used in detection of Parkinson's. With artificial neural networks in combination these methods have a high accuracy rate of about 94.93%**.** 97.23% accuracy in detection of PD using handwriting analysis is from convolutional neural network (CNN), Support Vector Machine (SVM), And random forest. 100% of Parkinson's diagnosis for gait parameters was achieved using Support Vector Machine (SVM). AI helps in assisting physicians in early diagnosis, detection, treatment, prognosis in a personalized way. AI helps neuroscientists to understand the working of neurons, and helps to read the pathways better [3].

Imaging of Parkinson's or any other detection uses radioactive material for diagnosis. The tracer or the radioactive element is injected. Once the material reaches the bloodstream they emit fluorescence due to the emission of positron from the body. The generated 3D images display the distribution of tracers in specific areas. Most of the markers used in imaging targets dopaminergic neurons. Dopaminergic neurons release dopamine's as neurotransmitters, and drugs that can increase these are used in Parkinson's treatment. Machine learning and other statistical data are used in imaging for quantitative analysis and to distinguish the results. Predictive models obtained from hand-made features that are common in machine learning algorithms. Machine Learning (ML) with algorithms namely K-nearest neighbors (KNN), Artificial neural network (ANN), Random forest (RF), Support vector machine (SVM), and other prominent algorithms were used in imaging irrespective of site or organs. The

current interest, and models in machine learning are utilized to investigate, and identify neurodegenerative diseases such as Alzheimer's, Parkinson's, and dementia. Positron emission tomography (PET), single photon emission computed tomography (SPECT), Magnetic resonance imaging (MRI) are common imaging methods used for detection of Parkinson's disease (PD). A study conducted by on 27 normal patients, and 19 early Parkinson's patients demonstrated an accuracy of 86.96% using a support vector machine (SVM). To get features of sMRI, an advanced support vector machine made a novel scale invariant feature transform (SIFT) algorithm to identify, and get data of brain images. This classifier was able to detect Parkinson's disease in 9 patients with an accuracy of 80%. Support vector machine (SVM) for network feature, and Random forests (RF) were integrated to identify, and understand the prodromal phase of Parkinson's disease. The combined network feature (NF), and clinical feature (CF) achieved 93% sensitivity, 93% accuracy, and 92% specificity. They were able to classify, and distinguish the diagnosis of 374 PD, and 169 NC subjects from Parkinson's Progression Markers Initiative (PPMI) database. 97.84% of accuracy was achieved using the cortex reference VOI with affine geometric transformation. Over the past decades Positron emission tomography (PET), single photon emission computed tomography (SPECT), Magnetic resonance imaging (MRI) keep increasing. Machine learning along with these tools are used to quantify from different datasets. As far as Positron emission tomography (PET), single photon emission computed tomography (SPECT) are considered the image detection, along with the tracer were still in research. Magnetic resonance imaging (MRI) with machines, and deep learning faces certain drawbacks. The data comes primarily from Parkinson's Progression Markers Initiative (PPMI) database, and in most cases, accuracy is below 80%. Further research of AI in Parkinson's will improve treatment methods, and helps in identifying the specific point of problem in the brain [4].

V. AI IN NEURO ONCOLOGY

Neuro oncology involves tumors in the central nervous system, and brain. The tumor can be both primary, and metastatic. There are different types of tumors related to the brain of which meningioma is a common primary tumor, and glioma is a common metastatic tumor. Identifying biomarkers helps in further treatment, as the areas are more complicated, and some are invisible. Hence, artificial intelligence along with imaging systems were used for identification of specific biomarkers. Artificial intelligence plays a key role in neuro oncology. Machine learning, and deep learning helps to identify molecular markers, enhanced imaging, risk response, and personalized treatment methods. One of the widely used applications of artificial intelligence is imaging. Convolutional neural networks in deep learning helps to identify, and analyze data in pixel levels. Identification of biomarkers using non-invasive techniques for diagnosis has made possible with deep learning. Identification of biomarkers such as isocitrate dehydrogenase, O-6-methylguanine-DNA methyltransferase (MGMT) methylation, and 1p/19 codeletion were identified with 100% accuracy. Support vector machines, a part of machine learning, were able to distinguish EGFRvIII markers in glioblastoma. Random forest classifies central nervous system lymphoma versus atypical glioblastoma. LASSO regression, and K-mean clustering plays an important role in risk assessment. Changes in DNA methylation, and epigenetic modifications of brain metastasis were diagnosed by Random forest. Artificial intelligence can predict the results of histological variations, and genomic changes by analyzing pathology in specimens of brain tumors. Artificial intelligence has outperformed the recent golden score of Response Assessment in Neuro-Oncology (RANO) for assessing tumor responses [5]. Machine learning has laid an important part in employing radiomic-based techniques that have shown specific identification, and employment of precision treatments. Deep learning uses artificial neural networks. This helps in more defined imaging, and biomarker discovery. Radiomics Signature for Precision Diagnostics (ReSPOND) was developed currently to overcome the drawbacks of heterogeneity in imaging protocols, data lack in new patients across hospitals, and to fill training setbacks. ReSPOND uses specific data of individuals, and generalizes it later detecting potent makers that are validated. Machine learning is able to detect tumors past the visible areas like peritumoral edematous tissues. Machine learning has successfully discovered between pseudo prognosis, and real prognosis in neuro oncology. XGBoost helps to identify fibrosis on neck muscles with the help of MRI data of nasopharyngeal carcinoma from patients. Fully Convolutional Neural Network (FCN) helps in identifying prostate cancer in patients using 3D dose distribution of Stereotactic Body Radiation Therapy (SBRT) with the help of MRI data on nasopharyngeal carcinoma. Generative Adversarial Networks (GAN) is a neural network that uses generators, and differentiators. It helps in generating Computed Tomography Scan images from MRI datasets. These images help in perfect calculation of radiation dose for patients suffering from prostate cancer, rectal cancer, and cervical cancer. Reinforcement learning (RL) with deep Q networks helps to make automated adaptation protocols for radiation for patients suffering from non-small cell lung cancer (NSCLC). Artificial intelligence in neuro oncology to improvise image analysis, that can lead to specific biomarker discovery, targeting personalized drugs, dosage, and prognosis analysis in patients. They were also used in other types of cancer, and are accurate [6].

VI. AI IN AUTISM SPECTRUM DISORDER

Millions of tangled neurons work at synchronization to control, motor, and perform a specific task in the human body. A small defect in these neurons leads to neurological disorders such as autism spectrum (ASD), schizophrenia, Parkinson's disease, and bipolar disorder. Autism spectrum disorder is a neurological disorder that starts from childhood that affects verbal, and nonverbal forms of communication. Autism starts as early as in embryo development. Neuroimaging techniques is one way of diagnosing autism. Functional Magnetic Resonance Imaging (fMRI) is one of the commonly used imaging methods to record data non-invasive. Machine learning (ML) combines both structural, and functional data from magnetic resonance imaging (MRI). This data helps to detect autism spectrum in younger ages with accuracy. Deep learning is preferred when compared to machine learning. Deep learning algorithms work on neural networks eliminating longer steps for extraction, and classification. Support vector machine (SVM), k-nearest neighbor (KNN), random forest (RF), and linear discriminant analysis (LDA) are the widely used CADS tools used for diagnosis of autism spectrum disorder. Support vector machine (SVM) is one of the oldest classifications, and reads the hyperplane between two separate datasets. Random forest trains individual trees with a fraction of data so that all the features are available on all the trees. Facial expression is one of the important features to diagnose autism. Mobile software's, or wrist watches that are powered by artificial intelligence, helps to monitor different feelings. Multi-axis inertial measurement units (IMUs) is a new application of deep learning. It helps to identify and facilitate stereotypical motor movements (SMM) automatically [7].

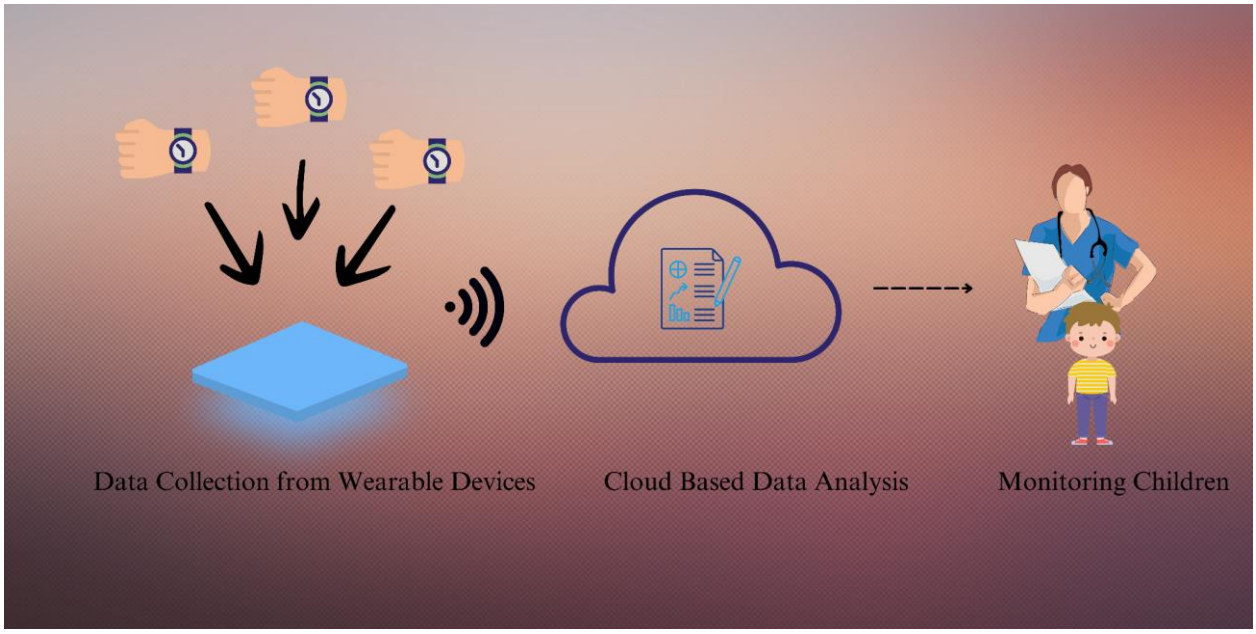

Figure 3: Working and application of wearable devices in Autism Spectrum Disorder (ASB)

In diagnosis of Autism spectrum disorder wearable devices that are embedded with sensors play an important role. The sensors use convolutional neural networks to measure the brainwaves, and send regular updates to the caregivers. This helps in collection of data, and predict the disorder accurately. Deep learning helps to identify emotional, and visual indicators with accuracy. Deep learning has shown specific, and accurate monitoring of emotions of autistic children. Machine learning based autism detection has less accuracy compared to deep learning. Genetic algorithms use robots to train, and take care of autistic children. Genetic algorithms also help children to improve their talent. Autism spectrum disorder primarily focuses on emotions, hence monitoring, and collection of data plays an important role. Artificial intelligence in autistic disorders has been studied for a long time, and still needs improvements in the case of imaging. Magnetic resonance imaging is primarily used in image analysis for autism diagnosis [8].

VII. AI APPLICATION IN MEDICINE

Table 1: Application of AI in Medicine

Neurological Disease & Disorders	AI Used	Application in Diagnosis	References
Parkinson's Disease	Auto Associative Neural Network	Classification of healthy control, Parkinson's disease, and essential tremor.	[2] [3]
Parkinson's Disease	Support Vehicle Machine (SVM)	A semi quantitative analysis was performed to classify the difference between Parkinson's, and non-Parkinson's patients respective to age.	[4]
Lung Carcinoma	Variational Auto-encoders (VAE)	Prediction of radiation with patients suffering from pneumonitis in non-small-cell-lung cancer.	[6]
Brain Metastasis	Convolutional Neural Network (CNN)	Segmentation, and automatic detection of tumors.	[5]
Glioblastoma	LASSO Regression	Risk stratification	[5]
Brain Tumors	Random Forest	Classification based on DNA methylation	[5]
Autism Spectrum Disorder (ASD)	Virtual Reality	The situation of the autism children are assisted with virtual reality	[8]
Breast Cancer	Artificial Neural Network (ANN)	Identification of breast cancer using surface images from mammography indicating the accuracy of tumor at the site.	[1]
Congenital Cataract Diseases	Convolutional Neural Network (CNN)	90% accuracy in identification, and treatment suggestions by learning from ocular images.	[1]
Skin Cancer	Convolutional Neural Network (CNN)	Clinical images used for identification of skin cancer.	[1]
Diabetic Retinopathy	Convolutional Neural Network (CNN)	Retinal fundus photography is used for identification of referable diabetic retinopathy.	[1]
Cerebral Aneurysm Diseases	Natural Language Processing (NLP)	On the basis of clinical remarks identified 14 cerebral aneurysm diseases.	[1]
Cerebrospinal Fluid (CSF)	Random Forest	Examination of changes in cerebrospinal fluid by Computerized tomographic images.	[1]

VIII. CONCLUSION

Artificial Intelligence plays a key role in our day to day life. Without being aware we use them on a daily basis. The field of artificial intelligence has skyrocketed in recent centuries. Artificial intelligence in healthcare has benefits over traditional methods. Artificial intelligence can detect the symptoms in patients even before encountering a particular disease. They also help in discovery of neural biomarkers, and precision treatment methods. Artificial intelligence such as machine learning, and deep learning was able to classify pseudo parkinsonism from Parkinson's patients. Healthy people who are prone to Parkinson's in the future were also identified. In brain tumors molecular markers play an important role. Many tumors in the brain don't show any signs, and some tumors are formed in the layers that cannot be detected. The use of artificial intelligence along with magnetic resonance imaging has aided in detection of these areas, and in discovery of new biomarkers. Autism spectrum disorder in children uses virtual reality, and wearable gadgets powered by AI that helps in monitoring the patients. In Spite of these differences artificial intelligence does have certain drawbacks. The data driven are mostly generalized, and not specific. There are no standardized regulations that ensure the safety of AI usage. Artificial intelligence uses historical data for prediction. Data exchange plays a crucial role in clinical

studies. Hence, they need to be trained further to utilize the data to a maximum extent. Once these shortcomings are met, artificial intelligence may be the best assistance for physicians.

IX. REFERENCE

1. Park, Ji Eun. "Artificial Intelligence in Neuro-Oncologic Imaging: A Brief Review for Clinical Use Cases and Future Perspectives." *Brain Tumor Research and Treatment* 10, no. 2 (2022): 69. https://doi.org/10.14791/btrt.2021.0031.
2. Raghavendra, U., U. Rajendra Acharya, and Hojjat Adeli. "Artificial Intelligence Techniques for Automated Diagnosis of Neurological Disorders." *European Neurology* 82, no. 1–3 (2019): 41–64. https://doi.org/10.1159/000504292.
3. Dixit, Shriniket, Khitij Bohre, Yashbir Singh, Yassine Himeur, Wathiq Mansoor, Shadi Atalla, and Kathiravan Srinivasan. "A Comprehensive Review on AI-Enabled Models for Parkinson's Disease Diagnosis." *Electronics* 12, no. 4 (2023): 783. https://doi.org/10.3390/electronics12040783.
4. Xu, Jingjing, and Minming Zhang. "Use of Magnetic Resonance Imaging and Artificial Intelligence in Studies of Diagnosis of Parkinson's Disease." *ACS Chemical Neuroscience* 10, no. 6 (2019): 2658–67. https://doi.org/10.1021/acschemneuro.9b00207.
5. Huynh, Elizabeth, Ahmed Hosny, Christian Guthier, Danielle S. Bitterman, Steven F. Petit, Daphne A. Haas-Kogan, Benjamin Kann, Hugo J. Aerts, and Raymond H. Mak. "Artificial Intelligence in Radiation Oncology." *Nature Reviews Clinical Oncology* 17, no. 12 (2020): 771–81. https://doi.org/10.1038/s41571-020-0417-8.
6. Aneja, Sanjay, Enoch Chang, and Antonio Omuro. "Applications of Artificial Intelligence in Neuro-Oncology." *Current Opinion in Neurology* 32, no. 6 (2019): 850–56. https://doi.org/10.1097/wco.0000000000000761.
7. Sundas, Amit, Sumit Badotra, Shalli Rani, and Raymond Gyaang. "Evaluation of Autism Spectrum Disorder Based on the Healthcare by Using Artificial Intelligence Strategies." *Journal of Sensors* 2023 (2023): 1–12. https://doi.org/10.1155/2023/5382375.
8. Al Banna, Md. Hasan, Tapotosh Ghosh, Kazi Abu Taher, M. Shamim Kaiser, and Mufti Mahmud. "A Monitoring System for Patients of Autism Spectrum Disorder Using Artificial Intelligence." *Brain Informatics*, 2020, 251–62. https://doi.org/10.1007/978-3-030-59277-6_23.