Literature Survey on Brain tumor and Alzheimer detection in MRI's

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ABSTRACT – The modern world consists of an impending issue of brain tumors and development of Alzheimer's. According to a report issued in 2020 by ASCO.NET, more than 308,102 people were diagnosed with brain tumors and another report from the National library of medicine states that in the U.S.A. alone, more than 6.5 million individuals live with Alzheimer's dementia. A huge amount of civilians in the world also consist of undetected tumors and the onset of Alzheimer's in their brain. An efficient method to detect tumors and the onset of Alzheimer's is of the essence in order to help people to address such issues and help in early diagnosis of tumors and Alzheimers.

Hence we are developing an ML and DL based Image Processing system which would help detect the development of Alzheimer's and use classification methods to help with early detection of tumors and onset of Alzheimer's in the MRIs.

Keywords: Brain tumor, CNN, Alzheimer's, tumors, Machine Learning, Deep Learning, MRI's, Algorithms, Dataset

I. INTRODUCTION

Brain Tumors are one of the leading causes of brain related deaths in the world and Alzheimer's is one of the worst disorders affecting the proper functioning of the brain. According to some recent statistics from a medical journal, there exists a 1 in 200 chances of an individual to develop some type of brain tumor whereas an estimated 10-15% of people suffering from Mild Cognitive Impairment (MCI) suffer from Progressive Alzheimer's development.

A Brain Tumor is one of the most devastating and most dangerous places for a tumor to develop as it is very risky to operate and remove a brain tumor due to the structure and delicate nature of the human brain. Hence it is of paramount importance to detect the tumors as early as possible. An early detection as well as the exact classification of the tumor increases the survival chances of the affected.

Alzheimer's on the other hand is one of the most devastating situations to deal with for anyone in the world, especially the elderly. Alzheimer's causes basic memory loss to extreme

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memory loss, to a point where a person might even forget who he is or who he used to live with. It does not only affect the person, but also affects the people around him emotionally and causes a very grim state for all who have to deal with people suffering from Alzheimer's. Early detection of Alzheimer's can help bring lifestyle changes and good dietary plans to slow the process in order to give a happy and better quality life for the affected.
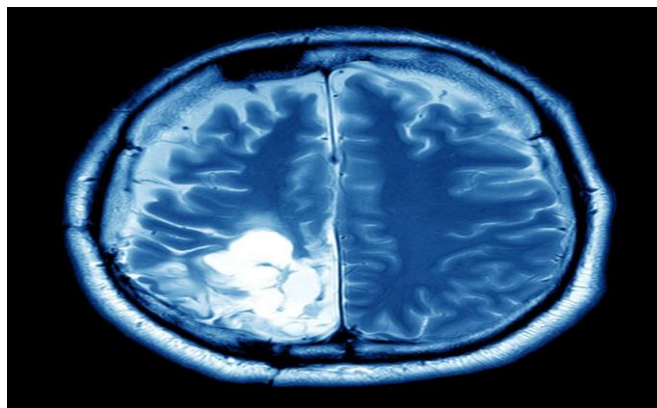

Fig 1: A Typical Brain Tumor MRI Scan

The various ML and DL approaches taken in order to classify and detect brain tumor consists of ML
Algorithms like FCM(Fuzzy C-Means), SVM(Support Vector Machine), KNN(K- Nearest Neighbours) algorithms along with DL models like CNN and other types of neural networks are used whereas in Alzheimer's similar approaches are used to classify and detect the onset of Alzheimer's. Keeping the conventional methods in mind, we are focussing on developing a two way detection system for Brain tumors and Alzheimer's and help in the early detection of both brain tumors as well as the onset of Alzheimer's.
Our main aim is to provide a platform for people where people can upload their MRI's in various file formats(PDFs, JPGs Etc.) and help them analyze and detect whether they have any type of development of tumors or Alzheimer's in them. Furthermore our model aims to classify the various stages of Alzheimer's or the type of tumors in order to provide a detailed analysis to the image that was uploaded by the user.
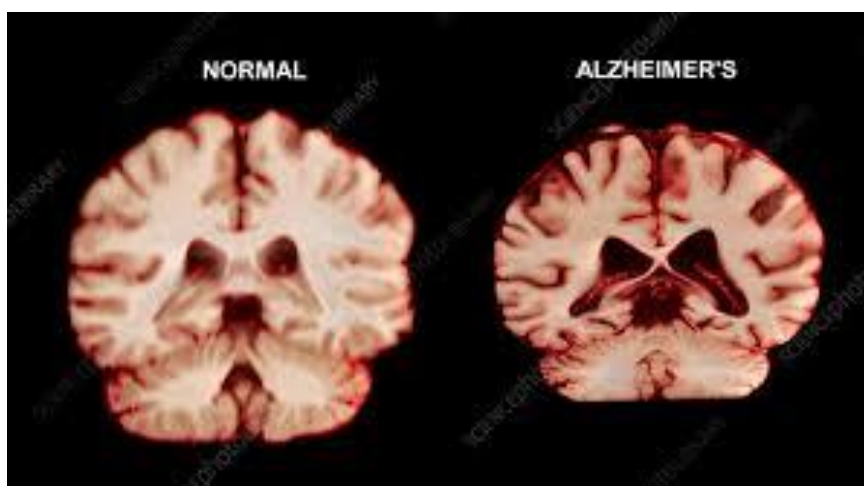

Fig 2: Normal vs Alzheimer's Brain MRI

II. LITERATURE REVIEW

In order to understand the process and the working of an ML and DL based classification of MRI's and detection of Brain Tumors and Alzheimer's, we had to review the process and procedure followed by other groups with similar problem statements. In this Section, we shall go through the various research papers and literature we went through in order to make our very own approach to the problem statement.

The process of understanding their approach and their methodology has helped us in achieving the information and mindset required in creating our very own solution for our problem statement.

Some of the various approaches we have studied for getting our own approach towards the problem statement are given below:

1. A Researcher named Dan Pan and his group of researchers from China used an approach of combining the conventional Convolutional Neural Networks with Ensemble learning methods to help in early detection of Alzheimer's in the MRI's(Magnetic Resonance Imaging) of the ADNI dataset consisting of 787 MRI's and used Ensemble method of stratified Bagging in order to detect and predict new MRI data[1].

2. A paper published by Janani Venugopalan and team of researchers focussed on using a multimodal deep learning model for the early stage detection of Alzheimer's. They used DL to analyze the images, the genetics and the clinical test data for classification of patients into AD, MCI and controls. Their multimodal approach has been tested to be better than the shallow SVM, decision trees, random forests and k nearest neighbors models in working with ADNI dataset[2].

3. A research paper by Roobaea Alroobaea and the group worked on the early detection of Alzheimer's using Machine Learning Techniques. Their approach to solving the problem consisted of deploying the ADNI and Open Access Series of Imaging Studies(OASIS) dataset through common supervised Machine Learning Techniques like logistic regression, support vector machine, random forest, linear discriminant analysis and more for automatic Alzheimer's detection. The best accuracy values that was achieved by them was with logistic regression and support vector machines on the ADNI dataset (99.43 and 99.1%) and with logistic regression and random forest for OASIS dataset (84.33 and 83.92%)[3].

4. A research paper by Maha Gharaibeh and team developed a novel approach to neuroimaging and deep learning for Alzheimer's , they used a cerebral catheter Angiogram Imaging method dataset acquired from a Saudi Hospital (K.A.U.H). They then preprocessed the dataset and used methods to remove noise from the data. After which they extracted the features using various pretrained models such as InceptionV3 and DenseNet201 and then the PCA with highest variance ratio was applied to the Machine Learning classifiers. The approach taken by them was on par with many state of the art approaches of the same problem set and achieved an accuracy level of 99.14% with their method[4].
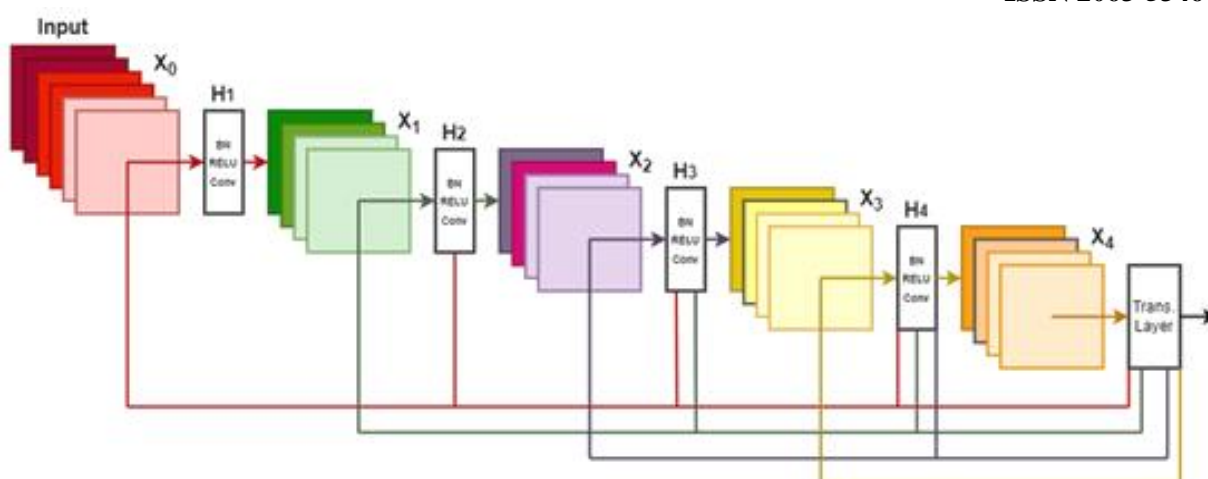
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Fig 3: Densenet Structure used for Alzheimer's

5. A research paper by Muskan Kapoor and team focussed on the early detection of Alzheimer's and classification of the 5 stages of Alzheimer's from the ADNI Longitudinal data in order to understand the development of Alzheimer's. While Random Forest and ANN (Artificial Neural Networks) were implemented by them, they focussed majorly on TADPOLE (The Alzheimer's Disease Prediction Of Longitudinal Evolution) approach on the ADNI dataset in order to explore the method and get more refined classification standards for Alzheimer's[5].

6. A research paper published by Ji Hwan Park and team has focussed on prediction of Alzheimer's in patients using Machine Learning models and Large Scale administrative health data. They obtained the data of people above the age of 65 and then trained and validated random forest, support vector machines and Logistic Regression to predict the incidence of Alzheimer's in 1,2,3,4 subsequent years. The model was able to accurately predict Alzheimer's with accuracy of 0.775 and 0.759 for probable and definitive for the first year, 0.730 and 0.693 for 2nd year, 0.677 and 0.644 for 3rd and 0.725 and 0.683 for 4th year. The scores were similar for balanced as well as unbalanced data for the dataset. The paper focussed on prediction of Alzheimer's rather than classification which can be used for helping in the early diagnosis of Alzheimer's and help to deal with it more effectively[6].
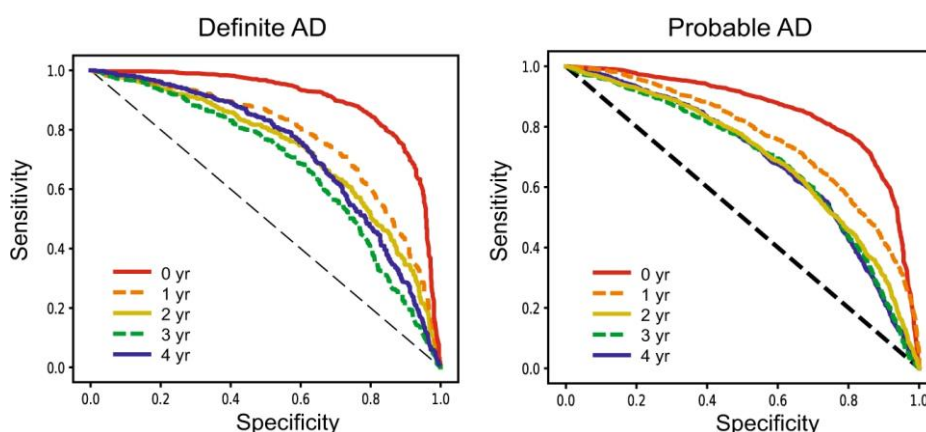

Fig 4: Regression Graphs for the Models

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7. A Research paper published by Fatma M. Refaat focuses on using generic Machine Learning Algorithms to detect and classify Brain tumors. The paper focuses on three types of brain tumors: Meningioma, Glioma and pituitary tumor. The suggested methods used are KNN(K Nearest Neighbours) , Support vector machines and GRNN (Generalised Regression Neural Networks). The accuracy gained by the algorithms were 97%, 96.24% and 94.7% for KNN, SVM and GRNN algorithms. The main goal of the paper was to establish an auto differentiator for the types of tumors and help doctors in pre-surgery decisions. The features are extracted with Gray Level Co Occurrence Matrix in the methodology[7].

8. A research paper published by Masoumeh Siar and group focussed on using a convolutional neural network (CNN) to detect brain tumors in MRI's. The accuracy of the fully connected layer was found to be 98.67%, the accuracy through radial basis function was established as 97.34% and with decision tree specifiers it was obtained as 94.24%. They used the benchmark specifications of sensitivity, specificity and precision in order to evaluate the network performance. The test provided an accuracy of 99.12% on test data and helps in the diagnosis of brain tumors in MRI's for doctors to help them treat their patients early[8].
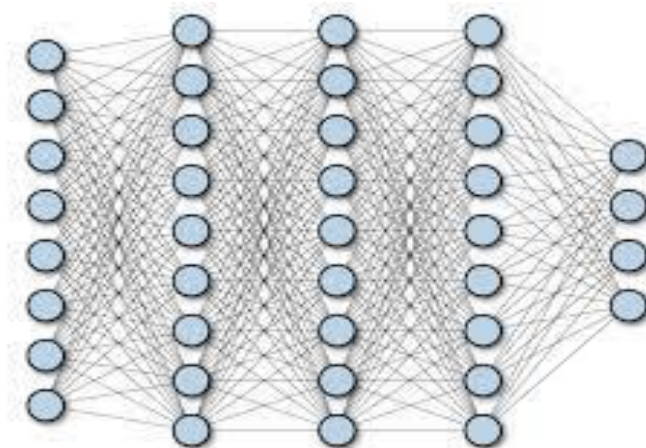

Fig 5: CNN Layers for Fully connecting Layers

9. A research performed by Peiyi Gao and a team of doctors from China developed a deep learning model to help in diagnosis and classification of brain tumors in MRI. The study has proven that a deep learning model system used by neuroradiologists has helped in better accuracy in the diagnosis and Classification of Brain tumors in MRI compared to no deep learning system. The MRI data was used from 37000 patients between the years 2000-2019 and a deep learning model was created for the classification and detection of 18 intracranial tumors. The study generated an accuracy of 75.5% with the aid of the system in comparison to 63.5% accuracy without the DL system[9].

10. An early diagnosis system created by Ebrahim Mohammed Senan and team focuses on using hybrid techniques between deep learning and machine learning techniques. In the study AlexNet and ResNet-18 are used with Support Vector Machines Algorithms for Tumor classification and diagnosis. The MRI's are enhanced using classic filtering techniques.Then the features are extracted using AlexNet and ResNet-18 and the features are classified using

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SoftMax and SVM. AlexNet along with SVM provided the best results with 95.1% accuracy, 95.25% sensitivity and 98.5% specificity on the test data[10].
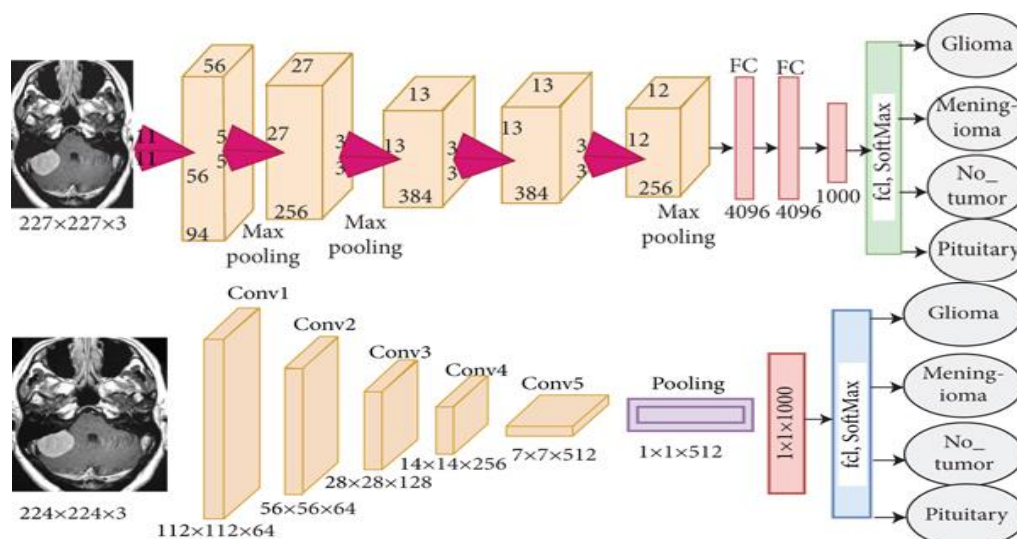

Fig 6: AlexNet and ResNet Architectures

11. A research paper by P Gokila Brindha and team was devised to use ANN (Artificial Neural Networks) to classify and detect brain tumors. The paper uses a self defined ANN and CNN networks and uses them to classify and detect brain tumors and then their performance is compared on using the MRI dataset. The paper concludes on the idea that CNN is efficient enough for image processing and identifying and analyzing brain tumors in the MRI dataset and that ANN can also perform well on the usage of more image data[11].

III. PROPOSED APPROACH ON THE PROBLEM STATEMENT

Our Project focuses on two basic principles to deal with Alzheimer's and tumors, Detection and Classification. We will begin with developing a DL model, which will be chosen after rigorous trial and error method, in order to find the perfect model to classify and detect tumors, the same method will be applicable for Alzheimer detection and classification as well.

Once the suitable models have been established, we begin training the models, testing the models and validation of the models. After achieving a certain testing score, which would preferably be above 95%, we will finally integrate the model to our custom front-end where it will be used to analyse the images provided by the user.

This is a generic approach that is being proposed by us, however the final product may vary based on the incremental changes during the project development.

IV. FUTURE SCOPE/ FUTURE WORK

Our Project consists of tumor and Alzheimer's detection as well as classification, which would become an essential method to analyse tumors and Alzheimer's in the future as ML and DL would replace a lot of conventional methods.

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Our Project scope is largely going to be in the medical field, where in future the model can be advanced further such that it can also detect tumors and Alzheimer's based on certain biological markers, which would also eliminate the use of MRI's as well.

IV. CONCLUSION

In this paper, we have established the problem statement in front of us and provided an insight on the research that was undertaken in order to find our very own solution to the problem statement. We have also proposed our very own way to help in the further research into the problem statement and increase the effectiveness of Detection and Classification of tumors and Alzheimer's.

It is important to fight with such adverse and debilitating diseases as they cause disruption in the normal function of human society. With the help of this research and our project, we would like to contribute to the betterment of mankind and create a happy and peaceful place for all in the world.

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REFERENCES

[1] Pan D, Zeng A, Jia L, Huang Y, Frizzell T and Song X (2020) Early Detection of Alzheimer's Disease Using Magnetic Resonance Imaging: A Novel Approach Combining Convolutional Neural Networks and Ensemble Learning. Front. Neurosci. 14:259. doi: 10.3389/fnins.2020.00259

[2] Venugopalan, J., Tong, L. Hassanzadeh, H.R. et al. "Multimodal deep learning models for early detection of Alzheimer's disease stage". Sci Rep 11,3254(2021).

[3] Roobaea Alroobaea, Seifeddine Mechti, Mariem Haoues, Saeed Rubaiee, Anas Ahmed, Murad Andejany, "Azheimer's disease early detection using Machine Learning Techniques.", June 2021, License: CC BY 4.0

[4] Gharaibeh, Maha, Mothanna Almahmoud, Mostafa Z. Ali, Amer Al-Badarneh, Mwaffaq El-Heis, Laith Abualigah, Maryam Altalhi, Ahmad Alaiad, and Amir H. Gandomi. 2022. "Early Diagnosis of Alzheimer's Disease Using Cerebral Catheter Angiogram Neuroimaging: A Novel Model Based on Deep Learning Approaches" Big Data and Cognitive Computing 6, no. 1: 2.

3878

Eur. Chem. Bull. 2023, 12 (Si6), 3872 – 3881

[5] Muskan Kapoor, Mehak Kapoor, Rohit Shukla, Tiratha Raj Singh, "Early Diagnosis of Alzheimer's Disease using Machine Learning Methods." IC3 '21, August 2021, Pages 70-76, Published: 4 Nov 2021.

[6] Park, J.H., Cho, H.E., Kim, J.H. et al. Machine learning prediction of incidence of Alzheimer's disease using large-scale administrative health data. npj Digit. Med. 3, 46 (2020).

[7] Refaat F. M, Gouda M. M, Omar M. Detection and Classification of Brain Tumor Using Machine Learning Algorithms. Biomed Pharmacol J 2022;15(4).

[8] M. Siar and M. Teshnehlab, "Brain Tumor Detection Using Deep Neural Network and Machine Learning Algorithm," 2019 9th International Conference on Computer and Knowledge Engineering (ICCKE), Mashhad, Iran, 2019, pp. 363-368, doi: 10.1109/ICCKE48569.2019.8964846.

[9] Peiyi Gao, Wei Shan, Yue Guo, YinYan Wang, "Development and Validation of a Deep Learning Model for Brain Tumor Diagnosis and Classification Using Magnetic Resonance Imaging", 2022 Aug; 5(8): e2225608, published: 8 Aug 2022

[10] Ebrahim Mohammed Senan, Mukti E. Jadhav, Taha H. Rassem, Abdulaziz Salamah Aljaloud, Badiea Abdulkarem Mohammed, Zeyad Ghaleb Al-Mekhlafi, "Early Diagnosis of Brain Tumor MRI Images Using Hybrid Techniques between Deep and Machine Learning", Computational and Mathematical Methods in Medicine, vol. 2022, Article ID 8330833, 17 pages, 2022. https://doi.org/10.1155/2022/8330833

[11] P Gokila Brindha et al 2021 IOP Conf. Ser.: Mater. Sci. Eng. 1055 012115

[12] A. C. Jinisha and T. S. S. Rani, "Brain tumor classification using SVM and bag of visual word classifier," in Proceedings of the 2019 International Conference on Recent Advances in Energy-efficient Computing and Communication (ICRAECC), pp. 1–6, IEEE, Nagercoil, India, March 2019.

[13] Abd El Kader I, Xu G, Shuai Z, Saminu S, Javaid I, Ahmad IS, Kamhi S. Brain Tumor Detection and Classification on MR Images by a Deep Wavelet Auto-Encoder Model. Diagnostics (Basel). 2021 Aug 31;11(9):1589. doi: 10.3390/diagnostics11091589. PMID: 34573931; PMCID: PMC8471235.

[14] Saeedi, S., Rezayi, S., Keshavarz, H. et al. MRI-based brain tumor detection using convolutional deep learning methods and chosen machine learning techniques. BMC Med Inform Decis Mak 23, 16 (2023). https://doi.org/10.1186/s12911-023-02114-6

[15] Kavitha C, Mani V, Srividhya SR, Khalaf OI, Tavera Romero CA. Early-Stage Alzheimer's Disease Prediction Using Machine Learning Models. Front Public Health. 2022 Mar 3;10:853294. doi: 10.3389/fpubh.2022.853294. PMID: 35309200; PMCID: PMC8927715.

3879

Eur. Chem. Bull. 2023, 12 (Si6), 3872 – 3881

[16] S. Al-Shoukry, T. H. Rassem and N. M. Makbol, "Alzheimer's Diseases Detection by Using Deep Learning Algorithms: A Mini-Review," in IEEE Access, vol. 8, pp. 77131-77141, 2020, doi: 10.1109/ACCESS.2020.2989396.

[17] Patil, V., Madgi, M. & Kiran, A. Early prediction of Alzheimer's disease using convolutional neural network: a review. Egypt J Neurol Psychiatry Neurosurg 58, 130 (2022). https://doi.org/10.1186/s41983-022-00571-w

[18] Diogo, V.S., Ferreira, H.A., Prata, D. et al. Early diagnosis of Alzheimer's disease using machine learning: a multi-diagnostic, generalizable approach. Alz Res Therapy 14, 107 (2022). https://doi.org/10.1186/s13195-022-01047-y

[19] Amin J, Anjum MA, Sharif M, Jabeen S, Kadry S, Moreno Ger P. A New Model for Brain Tumor Detection Using Ensemble Transfer Learning and Quantum Variational Classifier. Comput Intell Neurosci. 2022 Apr 14;2022:3236305. doi: 10.1155/2022/3236305. PMID: 35463245; PMCID: PMC9023211.

[20] Irmak, E. Multi-Classification of Brain Tumor MRI Images Using Deep Convolutional Neural Network with Fully Optimized Framework. Iran J Sci Technol Trans Electr Eng 45, 1015–1036 (2021). https://doi.org/10.1007/s40998-021-00426-9

[21] Khan MSI, Rahman A, Debnath T, Karim MR, Nasir MK, Band SS, Mosavi A, Dehzangi I. Accurate brain tumor detection using deep convolutional neural network. Comput Struct Biotechnol J. 2022 Aug 27;20:4733-4745. doi: 10.1016/j.csbj.2022.08.039. PMID: 36147663; PMCID: PMC9468505.

[22] Das, Sunanda & Aranya, O. & Labiba, Nishat. (2019). Brain Tumor Classification Using Convolutional Neural Network. 1-5. 10.1109/ICASERT.2019.8934603.

[23] Ebrahimi A, Luo S; Alzheimer's Disease Neuroimaging Initiative. Convolutional neural networks for Alzheimer's disease detection on MRI images. J Med Imaging (Bellingham). 2021 Mar;8(2):024503. doi: 10.1117/1.JMI.8.2.024503. Epub 2021 Apr 29. PMID: 33937437; PMCID: PMC8083897.

[24] Alzubaidi, L., Zhang, J., Humaidi, A.J. et al. Review of deep learning: concepts, CNN architectures, challenges, applications, future directions. J Big Data 8, 53 (2021). https://doi.org/10.1186/s40537-021-00444-8

[25] Jun Deng et al 2020 J. Phys.: Conf. Ser. 1684 012028

[26] Wei Li et al 2021 J. Phys.: Conf. Ser. 1757 012003

[27] Akritidis, Leonidas & Bozanis, Panayiotis. (2013). A supervised machine learning classification algorithm for research articles. Proceedings of the ACM Symposium on Applied Computing. 115-120. 10.1145/2480362.2480388.

[28] Kundaram, S. S. and Pathak, K. C. (2021). Deep learning-based Alzheimer disease detection. InSpringer Science and Business Media LLC, pages 587–597. Springer.

3880

Eur. Chem. Bull. 2023, 12 (Si6), 3872 – 3881

[29] Barik, S., Mohanty, S., Rout, D., Mohanty, S., Patra, A. K., and Mishra, A. K. (2020). Heart disease prediction using machine learning techniques. In Advances in Electrical Control and Signal Systems,pages 879–888. Springer.

[30] Naik B, Mehta A, Shah M. Denouements of machine learning and multimodal diagnostic classification of Alzheimer's disease. Vis Comput Ind Biomed Art. 2020. https://doi.org/10.1186/s42492-020-00062-w.

3881

Eur. Chem. Bull. 2023, 12 (Si6), 3872 – 3881