



IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 Issue: II Month of publication: February 2023 DOI: https://doi.org/10.22214/ijraset.2023.48955

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Detection of Dementia Disease using Machine Learning Techniques: A Survey

Payal Sharma¹, Deepika Bansal²

^{1, 2}Department of Information Technology, Maharaja Agrasen Institute of Technology, Rohini, Delhi-86

Abstract: Dementia is a cognitive and neurological disease that affects millions of numbers of people whole around the world. In this paper, different machine-learning algorithms are discussed to analyse dementia disease. The main objective of this paper is to study dementia using various machine learning algorithms to inspect their causes and how to decrease the high-risk group of people. A structured literature review has been presented which includes 15 research papers that take a view of different techniques implementing machine learning used for dementia.

Keywords: Dementia, Alzheimer's Disease, Machine Learning, Convolution Neural Network, K-Nearest Neighbor.

I. INTRODUCTION

Dementia is a neuropsychological condition brought on by brain disease or damage that impairs one's capacity for rational thought, memory, and normal behaviour. According to the report of 2022, there are almost 55 million people who are elder persons (aged 60 and above) who have dementia and this number is on an increasing scale which is a very serious and important topic for the whole nation. So, with a changing environment and in a world of new technologies, we can solve our problems on our own. We can also see the types of dementia like Alzheimer's Disease, Frontotemporal Dementia, and Dementia with Vascular and Lewy's Bodies. And out of all their variations, Alzheimer's Disease accounts for between 75% and 80% of all cases. Dementia can cause a variety of symptoms, such as cognitive problems like memory loss, trouble speaking and finding the right words, confusion, and disorientation. The second one is psychological changes like depression, anxiety, agitation, hallucinations, etc. Dementia is caused by the loss or damage of brain connections and nerve cells. Depending on whatever area of the brain is affected, dementia can have a variety of impacts on different people and cause specific symptoms. Other disorders linked to dementia is Parkinson's Disease, Huntington's Disease, Traumatic Brain Injury, Cruetzfeldt-Jakob Disease.

II. LITERATURE SURVEY

A thorough literature review of machine learning methods for dementia detection is presented in this section. Author Mathotaarachchi classifies the dementia category of AD using the technique of RUSRF for MRI image modularity with 84% accuracy, sensitivity of 70.8%, and 86.5% specificity in 2017.[1]. In the second paper Hazarika, R.A. Kandar dementia category of AD which uses the technique of DNN, DenseNet and uses MRI as an image modularity with an accuracy of 90.22% in 2021. [2].

S. AlzVNet uses MRI as an image modularity with a dementia category of AD which uses the technique of CNN and an accuracy of 98.3%, sensitivity of 97% in 2022.[3]. In the fourth paper Dolezel, D uses the technique of ResNet-50, GBM and uses MRI as an image modularity with an accuracy of 99% in 2019 [4]. Kang, M.J. Kim, S.Y. uses a dementia category of MCI, Dementia which uses the technique of ANN and uses NPT data as an image modularity with an accuracy of 96.66%, sensitivity of 96.8%, specificity of 96.6% in 2019.[5]. In the sixth paper authors uses the dementia category of AD which uses the technique of CNN and uses MRI as an image modularity with an accuracy of 97%, sensitivity of 95% in 2021. [6].

Pan, D. Zeng, A. Jia uses the technique of CNN and has a dementia category of AD, using MRI as an image modularity with an accuracy of 84% in 2020. Authors Herzog, N.J.; Magoulas use MRI as an image modularity which uses the technique of SVM and KNN and with an accuracy of 77%, sensitivity of 72.5%, specificity of 67% in 2021.[7]. E.E. Steketee, R.M.E. Houston uses the technique of Linear SVM and uses MRI, PET as an image modularity with an accuracy of 89%, sensitivity of 83%, specificity of 79% [8]. In 2017, J. Mattila, J. Soininen uses the technique of SVM and uses MRI/CT as an image modularity with an accuracy of 95%, sensitivity of 93%, specificity of 99% [9]. N. Amenta have successfully achieved the accuracy of 90.1%, sensitivity of 68.4% and has a dementia category of PD which uses the technique of SVM, KNN, LDA, LR and uses Clinical data as image modularity with an accuracy of 90.1%, sensitivity of 68.4% in 2022.[10]. In 2021, authors use a dementia category of AD and Frontotemporal Dementia which uses the technique of DT, RF, ANN, SVM, Naïve Bayes, and KNN and uses EEG as an image modularity with an accuracy of 80%, sensitivity of 94%, specificity of 58%. [11].



International Journal for Research in Applied Science & Engineering Technology (IJRASET) ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538

Volume 11 Issue II Feb 2023- Available at www.ijraset.com

With an accuracy of 77% and a sensitivity of 72.5 in 2021, Herzog, N.J. Magoulas, G.D. utilises a dementia category of AD that employs the method of Linear SVM and uses MRI as an image modularity. [12]. An accuracy of 74.1%, sensitivity of 70.6%, and specificity of 79.2% in 2020, authors utilise a dementia category of PD that employs the techniques Classification tree, Gaussian Kernel, LDA, Ensemble, KNN, Naive Bayes, SVM, RF, and uses Clinical data as a picture modularity. [13]. Using the techniques of gradient boosting, SVM, LR, RF, and using MRI as an image modularity with 2020, Battineni, Chintalapudi, and Amenta were able to reach an accuracy of 95.96% and a sensitivity of 95%. [14]

Ref	Year	Dementia	Validation	Technique	Image	Accur	Specifi	Sensiti
		Category	Methods		Modality	-ac y	-city	-vity
[1]	2014	AD	Cross-	Linear	MRI,	89%	79%	83%
			validation	SVM	PET			
[2]	2017	AD	Independe	RUSRF	PET,	84%	86.50%	70.86%
			nt test set		MRI			
[3]	2017	Dementia	5-fold	SVM	MRI/CT,	95%	99%	93%
			cross-		clinical			
			validation		data			
[4]	2019	AD	10-fold	ResNet-	MRI	N/A	N/A	99%
			cross-	50, GBM				
			validation					
[5]	2019	MCI,	10-fold	ANN	NPT data	96%	96.8%	96.66%
		Dementia	cross-					
			validation					
[6]	2020	AD	5-fold	CNN	MRI	84%	N/A	N/A
			cross-					
			validation					
[7]	2020	PD	Leave-	Classificati	Clinical	74.1	79.2%	70.6%
			one-	on tree,	data	%	(SVM)	(SVM)
			subjectout	Naïve		(SVM	-84.6%	-88.5%
			cross-	Bayes,)—	(LR)	(KNN)
			validation	SVM, RF,		84.5		
				Gaussian		%		
				Kernel,		(KNN		
				LDA,)		
				Ensemble,				
				KNN				
[8]	2020	AD	Cross-	Gradient	MRI	95.96	N/A	95%-
			validation	Boosting		%		96%
						(NB)		
[9]	2021	AD	Independ-	Residual	MRI	90.22%	N/A	N/A
			ent test set	Networks,				

Table 1 Summary of dataset of previous research papers



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				DNN,							
				Inception-							
				V1, V2, V3,							
				And							
				DenseNet							
[10	2021	AD	10-fold	CNN		MRI		97%	N/A	95%	
]			cross-								
			validation								
[11] 20	21 Dementia	10-fold cross- validation	NB, LD, SVM, and KNN	М	1RI 7 (1 9 S)- (C- 1)	67% (KNN) -95% (SVM)	72.5% (CNN) -99% (KNN)	
[12] 20	21 AD and Frontotem poral Dementia	10-fold cross- validati on with one patient left out.	DT, RF, ANN, SVM, Naïve Bayes, and KNN	EI	EG	94% (NB) 98.6 (RF))— %	58% (NB)– 99% (RF)	80% (DT)– 99.1% (RF)	
[13] 20	21 Dementia	10-fold cross- validation	Linear SVM	М	RI	72.5% (CNN)– 99% (KNN)		67% (KNN) -95% (SVM)	77% (NB)– 93% (C- SVM)	
[14] 20	22 AD	Independ- ent test set	CNN	М	RI	98.3	0%	N/A	97%	
[15] 20	22 PD	10-fold cross- validation	SVM, KNN, LDA, LR	Cl da	linical Ita	68.4 (SVI	% M)	N/A	95.96% (NB)– 97.58% (GB)	

III. PROPOSED METHODOLOGY

The dataset for the proposed investigation was obtained from OASIS-Brains.org [16]. The age range of the 150 individuals in this longitudinal cohort is 60 to 96. Each patient underwent a total of 373 imaging sessions, with at least two visits spaced by at least a year. For each patient, three or four different T1-weighted MRI images from one scan session are displayed. All individuals, including both sexes, are right-handed. 72 of the patients were categorised as non-demented throughout the whole research. Among the 64 patients, 51 had mild to severe Alzheimer's disease at the time of the first diagnosis and remained demented throughout the course of the scans.

The steps involved in the suggested work are as follows:

A. Data Collection

The dataset is collected from the oasis-brains[16].org including 150 subjects in cross-sectional data aged from 60 to 96. All throughout the study, 72 of the participants were classified as nondemented. 51 people with mild to moderate Alzheimer's disease were among the 64 subjects who were initially diagnosed as demented and remained so throughout the course of the scans. At the time of their second visit, 14 additional subjects who had previously been classified as nondemented were found to be suffering from dementia.



B. Data Pre-processing

Because real-world data is inconsistent and incomplete, data pre-processing is becoming an increasingly crucial issue for data mining. The column mean and median values are used to fill in the gaps left by the missing entries.

C. Classification

Specifically, the four classifiers are used namely, Random Forest, Decision Tree, Voting Classifier, SVM.

- 1) Random Forest Classifier: On various samples, the Random Forest classifier constructs decision trees and uses their majority vote for classification and average for regression[17].
- 2) *Decision Tree Classifier*: Decision Tree Classifier develop a model that forecasts the value of a target variable by learning straightforward decision rules derived from the attributes of the data[18].
- *3) Voting Classifier*: Voting classifiers learn from a variety of models and predict an output (a class) based on how likely it is that the result will fall into the category that was selected during training. It simply takes the results of each classifier that is given into the voting classifier and arithmetically averages them to anticipate the output class based on the vote with the largest majority [19].
- 4) *SVM:* For both classification and regression, the Support Vector Machine (SVM), a method of supervised machine learning, is used. The best fit is classification, even if we additionally take into account regression problems. Finding a hyperplane in an N-dimensional space that categorizes the data points unambiguously is the objective of the SVM method [20].

D. Performance Evaluation

Finally, the classification accuracy is determined and examined. The percentage of successfully categorized samples over all samples obtained is known as the classification accuracy.

IV. EXPERIMENTAL ANALYSIS

As shown in Table 1 we can conclude that Random Forest Classifier is showing the best classification accuracy of 83.9% which is the highest amongst all. And the lowest accuracy percentage is given by SVM classifier which is 77%.

V. CONCLUSION

As of now after studying all the previous research papers, it will conclude that dementia is a major health problem, and we must focus on risk reduction instead of its cure. According to the literature review, a lot of effort has been made to use different machinelearning algorithms for diagnosing dementia in subjects early. Determining the crucial traits that might spot dementia at a very early stage is still necessary, though. Future research's primary objective will be to identify unique features that are more sensitive for the early diagnosis of dementia. Eliminating pointless and superfluous characteristics from the feature sets currently in use is crucial for enhancing the efficacy of dementia diagnosis algorithms.

The extraction of novel traits that are more sensitive for the early identification of dementia is a task for the future. In order to improve the effectiveness of dementia detection algorithms, it is also important to remove unnecessary and redundant features from existing feature sets.

Table 1: Classification accuracy for Oasis Data					
Classifier	Classification Accuracy				
Random Forest	83.92%				
Decision Tree	79.62%				
Voting Classifier	83.03%				
SVM	77.43%				

REFERENCES

- [1] Bron, E.E.; Steketee, R.M.E.; Houston, G.C.; Oliver, R.A.; Achterberg, H.C.; Loog, M.; Van Swieten, J.C.; Hammers, A.; Niessen, W.J.; Smits, M.; et al. Diagnostic classification of arterial spin labeling and structural MRI in presenile early stage dementia. Hum. Brain Mapp., 2014.
- [2] Mathotaarachchi, S.; Pascoal, T.A.; Shin, M.; Benedet, A.L.; Kang, M.S.; Beaudry, T.; Fonov, V.S.; Gauthier, S.; Rosa-Neto, P. Identifying incipient dementia individuals using machine learning and amyloid imaging. Neurobiol. Aging, 2017.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)



ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538

Volume 11 Issue II Feb 2023- Available at www.ijraset.com

- [3] Pekkala, T.; Hall, A.; Lötjönen, J.; Mattila, J.; Soininen, H.; Ngandu, T.; Laatikainen, T.; Kivipelto, M.; Solomon, A. Development of a late-life dementia prediction index with supervised machine learning in the population-based CAIDE study. J. Alzheimer's Dis., 2017.
- [4] Fulton, L.V.; Dolezel, D.; Harrop, J.; Yan, Y.; Fulton, C.P. Classification of alzheimer's disease with and without imagery using gradient boosted machines and resnet-50. Brain Sci., 2019.
- [5] Kang, M.J.; Kim, S.Y.; Na, D.L.; Kim, B.C.; Yang, D.W.; Kim, E.J.; Na, H.R.; Han, H.J.; Lee, J.H.; Kim, J.H.; et al. Prediction of cognitive impairment via deep learning trained with multi-center neuropsychological test data. BMC Med. Inform. Decis. Mak,. 2019.
- [6] Pan, D.; Zeng, A.; Jia, L.; Huang, Y.; Frizzell, T.; Song, X. Early Detection of Alzheimer's Disease Using Magnetic Resonance Imaging: A Novel Approach Combining Convolutional Neural Networks and Ensemble Learning. Front. Neurosci., 2020.
- [7] Juutinen, M.; Wang, C.; Zhu, J.; Haladjian, J.; Ruokolainen, J.; Puustinen, J.; Vehkaoja, A. Parkinson's disease detection from 20-step walking tests using inertial sensors of a smartphone: Machine learning approach based on an observational case-control study, 2020.
- [8] Battineni, G.; Chintalapudi, N.; Amenta, F.; Traini, E. A Comprehensive Machine-Learning Model Applied to Magnetic Resonance Imaging (MRI) to Predict Alzheimer's Disease (AD) in Older Subjects. J. Clin. Med., 2020.
- [9] Hazarika, R.A.; Kandar, D.; Maji, A.K. An experimental analysis of different Deep Learning based Models for Alzheimer's Disease classification using Brain Magnetic Resonance Images. J. King Saud Univ.-Comput. Inf. Sci, 2021.
- [10] Helaly, H.A.; Badawy, M.; Haikal, A.Y. Deep Learning Approach for Early Detection of Alzheimer's Disease. Cognit. Comput., 2021.
- [11] Herzog, N.J.; Magoulas, G.D. Brain asymmetry detection and machine learning classification for diagnosis of early dementia. Sensors, 2021.
- [12] Miltiadous, A.; Tzimourta, K.D.; Giannakeas, N.; Tsipouras, M.G.; Afrantou, T.; Ioannidis, P.; Tzallas, A.T. Alzheimer's disease and frontotemporal dementia: A robust classification method of eeg signals and a comparison of validation methods. Diagnostics, 2021.
- [13] Herzog, N.J.; Magoulas, G.D. Brain asymmetry detection and machine learning classification for diagnosis of early dementia. Sensors, 2021.
- [14] Goenka, N.; Tiwari, S. AlzVNet: A volumetric convolutional neural network for multiclass classification of Alzheimer's disease through multiple neuroimaging computational approaches. Biomed. Signal Process. Control, 2022.
- [15] Sabry, F.; Eltaras, T.; Labda, W.; Alzoubi, K.; Malluhi, Q. Machine Learning for Healthcare Wearable Devices: The Big Picture. J. Healthc. Eng. 2022.
- [16] OASIS Dataset, www.oasis-brains.org.
- [17] Breiman, L. (2001) "Random forests", Machine learning, 45(1): pp. 5-32.
- [18] Quinlan JR. Induction of decision trees. Machine learning. 1986
- [19] Bernardo, J.M., & Smith, A.F. (1993). Bayesian theory. John Wiley & Sons.
- [20] Bansal, D., Khanna, K., Chhikara, R., Dua, R. K., & Malhotra, R. (2022). A superpixel powered autoencoder technique for detecting dementia. Expert Systems, 39(5), e12926.
- [21] Cortes C. and Vapnik V., "Support vector networks", Machine Learning, 20:1--25, 1995.
- [22] Bansal, D., Khanna, K., Chhikara, R., Dua, R. K., & Malini, R. (2021). Towards Detecting Dementia via Deep Learning. International Journal of Healthcare Information Systems and Informatics (IJHISI), 16(4), 1-17.











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