Automated Diagnosis of Alzheimer's Disease Using Convolutional Neural Networks and MRI Scans

Aishwarya Bharti, Prof. Pramod G. Patil, Divya Patil, Vaishnavi Shelke, Hemangi Akhade
Department of Computer Engineering
Sandip Institute of Technology and Research Centre (SITRC), Nashik, India

Abstract: *Alzheimer's disease is a progressive brain disorder that affects memory, thinking, and behavior. Early detection of Alzheimer's disease is crucial for timely intervention and effective treatment. This paper proposes a deep learning-based approach to detect Alzheimer's disease using magnetic resonance imaging (MRI) scans. Specifically, we train a convolutional neural network (CNN) on a large dataset of MRI scans to automatically identify patterns that distinguish between healthy controls and patients with Alzheimer's disease. We evaluate the performance of our approach on a separate test set and achieve promising results with an accuracy of 90%. Our approach has the potential to improve the accuracy and speed of Alzheimer's disease detection, enabling earlier intervention and better patient outcomes.*

Keywords*:* Alzheimer's disease, Convolutional Neural Network, Magnetic Resonance Imaging, Deep learning, Machine learning, Image processing

REFERENCES

[1]. Association Et Al., ―2017 Alzheimer's Disease Facts And Figures,‖ Alzheimer's Dementia, Vol. 13, No. 4, Pp. 325‑373, 2017.

[2]. S. Li, O. Okonkwo, M. Albert, And M.-C. Wang, ―Variation In Variables That Predict Progression From Mci To Ad Dementia Over Duration Of Follow-Up,‖ American Journal Of Alzheimer's Disease (Columbia, Mo.), Vol. 2, No. 1, Pp. 12‑28, 2013.

[3]. R. Roberts And D. S. Knopman, ―Classification And Epidemiology Of Mci,‖ Clinics In Geriatric Medicine, Vol. 29, No. 4, Pp. 753‑772, 2013.

[4]. N. Fox, R. Black, S. Gilman, M. Rossor, S. Griffith, L. Jenkins, M. Koller Et Al., ―Effects Of A Immunization (An1792) On Mri Measures Of Cerebral Volume In Alzheimer Disease,‖ Neurology, Vol. 64, No. 9, Pp. 1563‑1572, 2005.

[5]. G. B. Frisoni, N. C. Fox, C. R. Jack Jr, P. Scheltens, And P. M. Thompson, ―The Clinical Use Of Structural Mri In Alzheimer Disease,‖ Nature Reviews Neurology, Vol. 6, No. 2, Pp. 67‑77, 2010.

[6]. R. Jack, R. C. Petersen, Y. C. Xu, P. C. Obrien, G. E. Smith, R. J. Ivnik, B. F. Boeve, S. C. Waring, E. G. Tangalos, And E. Kokmen, ―Prediction Of Ad With Mri-Based Hippocampal Volume In Mild Cognitive Impairment,‖ Neurology, Vol. 52, No. 7, Pp. 1397‑1397, 1999.

[7]. R. Cuingnet, E. Gerardin, J. Tessieras, G. Auzias, S. Lehericy, M.-O. Habert, M. Chupin, H. Benali, O. Col-´ Liot, A. D. N. Initiative Et Al., ―Automatic Classification Of Patients With Alzheimer's Disease From Structural Mri: A Comparison Of Ten Methods Using The Adni Database,‖ Neuroimage, Vol. 56, No Pp. 766‑781, 2011.

[8]. F. Falahati, E. Westman, And A. Simmons, ―Multivariate Data Analysis And Machine Learning In Alzheimer's Disease With A Focus On Structural Magnetic Resonance Imaging,‖ Journal Of Alzheimer's Disease, Vol. 41, No. 3, Pp. 685‑708, 2014.

[9]. E. Moradi, A. Pepe, C. Gaser, H. Huttunen, J. Tohka, A. D. N. Initiative Et Al., ―Machine Learning Framework For Early Mri-Based Alzheimer's Conversion Prediction In Mci Subjects, ‖ Neuroimage, Vol. 104, Pp. 398‐412, 2015.

[10]. S. Liu, S. Liu, W. Cai, S. Pujol, R. Kikinis, And D. Feng, Early Diagnosis Of Alzheimer's Disease With Deep Learning, ‖ In Biomedical Imaging (Isbi), 2014 Ieee 11th International Symposium On. Ieee, 2014, Pp. 1015‐1018.

[11]. Ghafoorian M, Karssemeijer N, Heskes T, Et Al. Location Sensitive Deep Convolutional Neural Networks For Segmentation Of White Matter Hyperintensities. Sci Rep. 2017;7(1):5110. Doi:10.1038/S41598-017-05219-7

[12]. Li X, Qin T, Wang Z, Et Al. Detection Of Alzheimer's Disease From Magnetic Resonance Images Using A Convolutional Neural Network Architecture With A Two-Stage Classification Strategy. Front Neuroinform. 2018;12:62. Doi:10.3389/Fninf.2018.00062

[13]. Liu S, Liu S, Cai W, Et Al. Multimodal Neuroimaging Feature Learning For Multiclass Diagnosis Of Alzheimer's Disease. Ieee Trans Biomed Eng. 2018;65(12):2765-2777. Doi:10.1109/Tbme.2018.2838618

[14]. Hosseini-Asl E, Keyvanrad Ma, Mahmoudi M, Et Al. Alzheimer's Disease Diagnostics By A Deeply Supervised Adaptable 3d Convolutional Network. Front Biosci (Elite Ed). 2018;10:462-475.

[15]. Sarraf S, Tofighi G. Deepad: Alzheimer's Disease Classification Via Deep Convolutional Neural Networks Using Mri And Fmri. Biorxiv. 2016;092460. Doi:10.1101/092460

[16]. Liu M, Cheng D, Yan W, Et Al. A Deep Learning-Based Radiomics Model For Differentiating Benign And Malignant Renal Tumors. Cancer Imaging. 2019;19(1):58. Doi:10.1186/S40644-019-0251-X

[17]. Zhu X, Sobhani F, Xu C, Pan L, Ghasebeh Ma, Kamel Ir. Quan- Titative Volumetric Functional Mr Imaging: An Imaging Biomarker Of Early Treatment Response In Hypo-Vascular Liver Metastasis Patients After Yttrium-90 TransarterialRadioembolization. Abdominal Radiology. 2016 Aug 1;41(8):1495-504.

[18]. Kurth F, Gaser C, Luders E. A 12-Step User Guide ForAnalyzing Voxel-Wise Gray Matter Asymmetries In Statistical Parametric Mapping (Spm). Nature Protocols. 2015 Feb;10(2):293.

[19]. Zheng X, Shi J, Zhang Q, Ying S, Li Y. Improving Mri-Based Diagnosisof Alzheimer's Disease Via An Ensemble Privileged Information Learning Algorithm. In2017 Ieee 14th International Symposium On Biomedical Imaging (Isbi 2017) 2017 Apr 18 (Pp. 456-459). Ieee.

[20]. Vapnik V, Izmailov R. Learning Using Privileged Information: Similarity Control And Knowledge Transfer.Journal Of Machine Learning Research. 2015 Jan 1;16(2023-2049):2.

[21]. Lahmiri S, Boukadoum M. New Approach For Automatic Classification Of Alzheimer's Disease, Mild Cognitive Impairment And Healthy Brain Magnetic Resonance Images. Healthcare Technology Letters. 2014 Jan1;1(1):326.

[22]. Dubois B, Padovani A, Scheltens P, Rossi A, Dellagnello G. Timely Diagnosis For Alzheimer's Disease: A Literature Review On Benefits And Challenges. Journal Of Alzheimer's Disease. 2016 Jan 1;49(3):617-31.

[23]. World Health Organization. World Health Statistics 2010. World Health Organization,2010

[24]. Jin K, Simpkins Jw, Ji X, Leis M, Stambler I. The Critical Need To Promote Research Of Aging And Aging-Related Diseases To Improve Health And Longevity Of The Elderly Population. Aging And Disease. 2015 Feb;6(1):1.

[25]. Padilla P, Lpez M, GrrizJm, Ramirez J, Salas-Gonzalez D, Alvarez I. Nmf-Svm Based Cad Tool Applied To Functional Brain Images For The Diagnosis Of Alzheimer's Disease. Ieee Transactions On Medical Imaging. 2011 Sep 12;31(2):207-16.

[26]. Song S, Lu H, Pan Z. Automated Diagnosis Of Alzheimer's Disease Using Gaussian Mixture Model Based On Cortical Thickness. In2012 Ieee Fifth International Conference On Advanced Computational Intelligence (Icaci) 2012 Oct 18 (Pp. 880-883). Ieee.

[27]. Reynolds D. Gaussian Mixture Models. EncyclopediaOf Biometrics. 2015:827-32.

[28]. Srinivasan A, Battacharjee P, Prasad A, Sanyal G. Brain Mr Image Analysis Using Discrete Wavelet Transform With Fractal Feature Analysis. In2018 Second International Conference On Electronics, Communication And Aerospace Technology (Iceca) 2018 Mar 29 (Pp. 1660- 1664). Ieee.

[29]. Aruchamy S, Kumar Rk, Bhattacharjee P, Sanyal G. Automated Skull Stripping In Brain Mr Images. In2016 3rd International Conference On Computing For Sustainable Global Development (Indiacom) 2016 Mar 16 (Pp. 2043-2047). Ieee.

[30]. SirignanoJa. Deep Learning For Limit Order Books. Quantitative Finance.2019 Apr 3;19(4):549-70.

[31]. Wu Hm, TienYj, Ho Mr, Hwu Hg, Lin Wc, Tao Mh, Chen Ch. Covariate-Adjusted Heatmaps For Visualizing Biological Data Viacorrelation Decomposition. Bioinformatics. 2018 Apr 26;34(20):3529- 38.

[32]. Chatfield C. Introduction To Multivariate Analysis. Routledge; 2018 Feb 19.

[33]. Zhang Yd, Jiang Y, Zhu W, Lu S, Zhao G. Exploring A Smart Pathological Brain Detection Method On Pseudozernike Moment. Multimedia Tools And Applications. 2018 Sep 1;77(17):22589-604.

[34]. PramodGorakhPatil, PramodGorakhPatil, "A Recent Survey On Different Symmetric Key Based Cryptographic Algorithms", Ijcat, Issn : 2348 – 6090, Vol. 3, February 2016.

[35]. PramodGorakhPatil, Vijay Kumar Verma, "A Reliable Secret Key Algorithm For Encryption And Decryption Of Text Data", Ijrter, Issn:2455-1457, Vol. 2, February – 2016.

[36]. Pramod G Patil, Aditya Dixit, Aman Sharma, PrashantMahale, MayurJadhav, "Secure Data Deduplication System With Tag Consistency In Cloud Data Storage", Issn: 2320-2882, Vol. 6, February 2018.

[37]. P. G. Patil ,VishakhaKhalane , Payal Tank, "Wi-Fi Dustbin", Issn 2321-3469, Vol. 12, March 18.

[38]. PramodPatil, AmrutaBhange, ShwetaJagtap, RakshaliMarathe, SwikrutiChaudhary, "Melanoma Skin Cancer Detection Using Image Processing", Ijrar, E-Issn 2348-1269, Vol. 6, March 2019.

[39]. PhalguniNikam, Prof. PramodPatil, MeetaliPatidar, AishwaryaNanoskar, PranavParmar, Jayesh More, "Cheque Bounce Detection System Using Image Processing", Irjet, E-Issn: 2395-0056, Vol. 7, Jan 2020.

[40]. Prof. PramodPatil , AnkitaKashmire , PoojaKute, PradnyaRathor , AnamShaikh, "Tract Angle Using Machine Learning", Ijraset, Issn: 2321-9653, Vol. 8 , Jan 2020.

[41]. Prof. PramodPatil, Vaibhav Kale, Ganesh Kadam, ChetanUgale, MohitDeore, "Service Base Application", Irjet, E-Issn: 2395-0056, Vol. 7, Feb 2020.

[42]. Mr.PrathameshShrinivasSahasrabhojane , Prof. Pramod G. Patil , Mr.Pushkar Ashok Thakur, Mr.Hrithik Sanjay Sanghavi, "Augmented Reality Media (Ed.Ar)", Ijraset, Issn: 2321-9653, Vol. 9, Mar 2021.

[43]. SwagatAhire, Prof. PramodPatil ,TejasPatil , Satyam Chaudhar , DaminiPagar, "Result Analysis: Remotely Accessible Security System Using Iot", Ijraset, Issn: 2321-9653, Vol. 9, Mar 2021.

[44]. Gaurav Kumar D. K. Singh, Prof. PramodPatil, PoojaMahendraSali, RameshwariDevidas More, MayuriRajuPawar, "Face Mask Detection With Alert System Using Artificial Intelligence Implementation Of A Pre-Trained Model In Detection Of Masks", Ijraset, Issn: 2321-9653, Vol. 9, Mar 2021.

[45]. Gaurav Kumar D. K. Singh , Prof. PramodPatil, PoojaMahendraSali, RameshwariDevidas More, MayuriRajuPawar, "A Result Analysis Of Mask Detection Based Notification System", Ijraset, Issn: 2321- 9653, Vol. 9, Jun 2021.

[46]. ParasPatil, Prof. PramodPatil, SwapnilPatil, Nikhil Shinde, PurabKharchane, "Affinity Finder For Matrimonial Site Using Ai", Ijcrt, Issn: 2320-2882, Vol. 9, December 2021.

[47]. AbhishekSasale, Prof.PramodPatil, AbhishekRathi , Vinit Salve, SanketGite, "An Intelligent Secure Question Paper Generation System", Ijcrt, Issn: 2320-2882, Vol. 9, December 2021

[48]. AniketFulzele, Prof.PramodPatil, AbhishekThakre, AmeyaMahale, ShubhamShelke, "A Mobile Application For Early Diagnosis Of Pneumonia", Ijcrt, Issn: 2320-2882, Vol. 10, January 2022.

[49]. Chetana Mali, Prof. PramodPatil, SanketMahajan, PranavPardeshi, "Restaurant Menu Card By Using Augmented Reality", Ijres, Issn : 2320-9364, Vol. 9, Dec 2021.

[50]. HemangiAkhade , Prof. Pramod G Patil , AishwaryaBharti , VaishnaviShelke , DivyaPatil, "Alzheimer's Disease Detection Using Machine Learning Techniques In 3d Mr Images", Ijaresm, Issn: 2455-6211 Vol. 10, November-2022