Research Methodology Assignment- 1
Analysis of a Research Paper:

Chosen Research Paper:

Deep Learning Applications in MRI-Based Detection of the Hippocampal Region for Alzheimer's Diagnosis.

This research paper was published in the IEEE Journal (date of publication: 29th July 2024)

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Analysis:

The problem identified by the researchers is the application of deep learning to detect Alzheimer's Disease using the MRI images of the Hippocampal Region. The hypothesis of the researchers is that by using the deep learning models to automatically detect Alzheimer's disease will present a potent methodology for analysing alterations in the hippocampal region. This will in turn save the neurologists and medical expert's time. All the authors have declared that there are no conflicts of interest regarding the publication of the article.

The solution proposed is to use YOLO models to detect Alzheimer's disease using three views of the MRI images of the hippocampal region. They have chosen YOLOv3, YOLOv4 and YOLOv5 as other studies have used these models to detect brain tumours. They have mentioned that while other YOLO models like YOLOv6, YOLOv7 and YOLOv8 offer advanced object detection, they are typically under-utilized in medical imaging. The dataset used by the team was obtained from the publicly available Alzheimer's Disease Neuroimaging Initiative (ADNI) database. They selected images of three views – axial, coronal and sagittal from three categories - Alzheimer's disease (AD), Mild Cognitive Impairment (MCI) and Normal Control (NC). This data was collected and contributed by the ADNI investigators but they did not influence the analysis.

The researchers compared the performance of the three YOLO models, and identified YOLOv5 has the highest accuracy for detecting Alzheimer's disease compared to YOLOv3 and YOLOv4. Another advantage of the YOLOv5 model is that it is usable on noisy, blurry and foggy

images as well. Hippocampal volume is the biomarker they selected as it is established that it is the best imaging biomarker for AD diagnosis. They have used mean Average Precision(mAP) which is the metric used by the computer vision research community for calculating accuracy. They also found the accuracy is the highest on using the sagittal view of the MRI for AD detection and the coronal view has the least accuracy. The accuracy for detecting MCI was the lowest on using the coronal view of the MRI images, thus establishing the hippocampal region in the coronal view is unreliable for observing brain regions affecting AD.

The researchers have mentioned that as they have limited their study to detect only the landmarks in MRI images and did not apply the multiple class classification. Another limitation they have mentioned is using Mask R-CNN saves time but reduces reproducibility and accuracy may be increased by using other data augmentation methods.

The researchers have referred and cited 60 published research papers. Some of the research papers which they have referred are given below

[1] A. Gustavsson, N. Norton, T. Fast, L. Frölich, J. Georges, D. Holzapfel, T. Kirabali, P. Krolak-Salmon, P. M. Rossini, M. T. Ferretti, L. Lanman, A. S. Chadha, and W. M. van der Flier, ''Global estimates on the number of persons across the Alzheimer's disease continuum,'' Alzheimer's Demen□tia, vol. 19, no. 2, pp. 658–670, Feb. 2023.

[2] K. Clifford, M. Moreno, and C. M. Kloske, ''Navigating late-stage dementia: A perspective from the Alzheimer's association,'' Alzheimer's Dementia, Diagnosis, Assessment Disease Monit., vol. 16, no. 1, Jan. 2024, Art. no. e12530.

[3] G. B. Frisoni, N. C. Fox, C. R. Jack, P. Scheltens, and P. M. Thompson, ''The clinical use of structural MRI in Alzheimer disease,'' Nature Rev. Neurol., vol. 6, no. 2, pp. 67–77, Feb. 2010.

[4] M. Rahimi, M. Mostafavi, and A. Arabameri, ''Automatic detection of brain tumor on MRI images using a YOLO-based algorithm,'' in Proc. 13th Iranian/3rd Int. Mach. Vis. Image Process. Conf. (MVIP), Mar. 2024, pp. 1–5.

[5] W. Kang, L. Lin, B. Zhang, X. Shen, and S. Wu, ''Multi-model and multi-slice ensemble learning architecture based on 2D convolutional neural networks for Alzheimer's disease diagnosis,'' Comput. Biol. Med., vol. 136, Sep. 2021, Art. no. 104678.

[6] R. Craig-Schapiro, A. M. Fagan, and D. M. Holtzman, ''Biomarkers of Alzheimer's disease,'' Neurobiol. Disease, vol. 35, no. 2, pp. 128–140, 2009.

[7] H. A. Pahlavani, ''Exercise therapy to prevent and treat Alzheimer's disease,'' Frontiers Aging Neurosci., vol. 15, Aug. 2023, Art. no. 1243869