

Advanced Image Processing Techniques for Medical Diagnostics in Brain Stroke Prediction

Bhavya.B ¹, Nagaraja S R ², Eranti Sai Kishan ³, Eranti Sai Dinesh⁴, Lakki Reddi Varshitha⁵,
Meghana GS ⁶

¹ Assistant Professor, Presidency University, Bangalore

² Associate Professor, Presidency University, Bangalore

^{3,4,5,6} Department of CSE, Presidency University, Bangalore

Abstract— Stroke is the main cause of disability and death worldwide. There is a significant need for the development of early and accurate mechanisms for stroke prediction. The following project is a new innovative approach to the brain stroke prediction and classification process based on advanced deep learning models, such as 2D-CNN, VGG Model. These models have been optimized for the purposes of the precise segmentation of medical images such as CT and MRI scans.

The proposed system would integrate a user-friendly web interface that allows for the easy input of CSV data or medical images, followed by automated processing using state-of-the-art AI models. By combining traditional machine learning methods with cutting-edge deep learning techniques, the solution would enhance predictive accuracy, automate segmentation, and reduce diagnostic time.

This is an interdisciplinary framework that seeks to provide an efficient, scalable, and robust tool for the early detection of stroke. This work is integrated into clinical workflows and seeks to help healthcare professionals improve patient outcomes through timely intervention.

Keywords: cerebrovascular accident (CVA), convolutional neural network(CNN), Brain stroke prediction, deep learning, image segmentation, medical imaging, AI in healthcare, 2D-CNN models.

I. INTRODUCTION

A brain stroke, often referred to as a cerebrovascular accident (CVA), is a severe medical condition caused by the interruption of blood flow to the brain, leading to very severe consequences such as neurological damage, disability, or death. Strokes are broadly classified into ischemic strokes, caused by blocked arteries, and hemorrhagic strokes, resulting from ruptured blood vessels. The importance of early and accurate detection lies in the fact that the earlier the intervention, the better the chances of minimizing long-term complications.

A typical traditional approach depends heavily on various medical imaging modalities including computed tomography and magnetic resonance imaging. Manual examination of these images, though time-consuming and error-prone, often depends directly upon the radiologist's knowledge. This deficiency has opened up a growing demand for completely automated AI-driven solutions supporting the identification and diagnosis of stroke conditions.

Recent breakthroughs in deep learning have shown an exceptional potential in medical image analysis. Models such as 2D convolutional neural networks (2D-CNNs) have proven very effective in tasks such as image segmentation, feature extraction, and classification. This methodology opens up the possibility of designing systems that can identify stroke-related early indicators with high accuracy and help clinicians make decisions.

This paper will discuss the development of an AI-driven framework that utilizes state-of-the-art deep learning architectures for automated brain stroke detection. The system, in this case, aims to improve diagnostic accuracy, reduce analysis time, and thus improve patient care in stroke management.

II. BRAIN STROKE PREDICATION SYSTEM

A.Process

The process of machine learning and deep learning in detecting a brain stroke involves processing medical imaging data, such as MRI or CT scans. First, the data preparation process is done, which involves cleaning, normalization, and resizing images for analysis. Deep learning models, such as VGG16 and 2D-CNN are used for feature extraction and to identify critical patterns, such as ischemia or hemorrhage. These models are trained on labeled datasets to learn the differences between stroke and non-stroke cases, ensuring high accuracy.

Finally, the trained model is tested and deployed to classify new scans, providing predictions on stroke presence, type, and severity for timely medical intervention.

ARCHITECTURE DIAGRAM

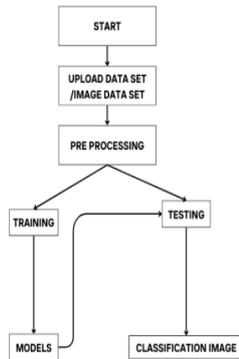


Fig 1. Architecture diagram

Start:

This is the initiation of the workflow or process. This is when all parts are ready to begin the task.

Upload Data Set/Image Data Set:

At this step, the user uploads a dataset which comprises raw data or image data. For instance, for you, this would include MRI/CT scan images or any other type of medical imaging data.

This step loads all of the data that will feed the model into the system for further processing.

Preprocessing:

This involves cleansing and preparing the raw data, or images, in getting ready for model training and testing. It involves three main steps:

Data cleaning: removal of missing values, outliers, or generally irrelevant data.

Data augmentation: enhancing image data with possibly transformation like rotation, flip, or scaling.

Image resizing: standardizing image dimensions according to the model's requirement.

Normalization: Scaling pixel values to a specific range, for instance, 0 to 1.

Splitting the data: Divide the dataset into training, testing, and validation sets.

Training:

In this stage, the preprocessed data are used to train machine learning or deep learning models.

Models like 2D-CNN, VGG16 were fitted on the training dataset to learn patterns and features.

Hyperparameters such as learning rate, batch size were optimized to enhance the performance of the model.

Models:

This step outputs the trained models. These models are saved and can be used for inference or further testing at a later time.

Metrics such as accuracy, precision, recall, and F1-score can also be used to evaluate the models during this step.

Testing:

The trained models are tested on a separate dataset (testing set) to evaluate their performance on unseen data.

This step helps in assessing the generalization capability of the model.

Classification Image:

After testing, the final output involves classification of input images into appropriate categories or labels (like detecting stroke and no stroke).

The outcome is then displayed or saved. From these, insights will be made for further consideration.

III. RELATED WORK

Deep learning has revolutionized medical imaging in the last few years, and it has made tremendous strides in the detection and diagnosis of brain stroke. The use of CNNs and transfer learning with pre-trained models such as VGG16 has been highly effective in automating and improving the accuracy of stroke prediction systems.

Application of CNNs in Stroke Detection

Many researches have discussed the adoption of custom 2D CNN architectures in stroke prediction. For instance, one research proposed lightweight CNNs for medical image analysis by using convolutional and pooling layers for feature extraction and classification of stroke patterns.

These models are resource-efficient and adaptable, and thus suitable for resource-limited environments. However, they often do not provide adequate performance when applied to complicated medical datasets and, hence, require more advanced architectures to be used.

Transfer Learning with VGG16

Transfer learning has revolutionized medical imaging, especially with pre-trained models such as VGG16. This model was originally developed for large-scale image classification tasks but has shown impressive performance in medical applications because it can extract deep and complex features. Researchers have fine-tuned VGG16 on stroke-specific datasets, achieving high accuracy and reliability in detecting ischemic and hemorrhagic strokes. The use of pre-trained weights reduces the requirement for extensive labeled data, which is one of the common limitations in medical datasets.

Comparative Studies

Comparative studies of the custom 2D CNNs and VGG16 model revealed that although CNNs are pretty effective for baseline performance, the latter is always better and VGG16 is due to the deeper architecture and good feature extraction capabilities. There are also hybrid approaches that blend custom CNNs with pre-trained models for a balance between computation and predictive accuracy.

Challenge and Limitations

Despite these advances, there are still several challenges. The availability of labeled medical datasets is limited, and the quality of images varies, while artifacts in CT/MRI scans may also impact the performance of models. To overcome these challenges, researchers have used data augmentation, domain adaptation, and ensemble learning techniques.

Future Directions

Building on the success of the CNNs and VGG16, recent studies propose integrating transformer-based models or attention mechanisms to enhance the accuracy of stroke-prediction systems. As a multimodal approach can integrate imaging data with clinically and demographically related details to provide a holistic health view of the patient's health, such approaches also are being investigated.

This body of work highlights the potential that may be found by merging traditional CNN architectures with the latest pre-trained models such as VGG16 for brain stroke prediction

IV. CONCLUSION

In conclusion, brain stroke prediction using VGG16 and 2D-CNN models provides an efficient approach for analyzing medical imaging data, such as MRI or CT scans. By leveraging the feature extraction capabilities of these deep learning architectures, the models can accurately classify images to determine the presence or absence of a stroke. The performance is evaluated based on metrics like accuracy, ensuring reliability and effectiveness. This method aids in early detection and diagnosis, supporting timely medical intervention and improved patient outcomes. Over all we got 96% accuracy.

REFERENCES

- [1] 2020, date of publication June 25, 2020, date of current version July 7, 2020. Digital Object Identifier 10.1109/ACCESS.2020.3004977 Automated Ischemic Stroke Subtyping Based on Machine Learning Approach GANG FANG1,3, PENG XU 1,2, AND WENBIN LIU 1, (Member, IEEE)
- [2] Neuroimaging and deep learning for brain stroke detection - A review of recent advancements and future prospects Author links open overlay panel Dec 2020 R. Karthik a, R. Menaka a Annie Johnson b, Sundar Anand b
- [3] Dis Model Mech. 2021 Dec 7;14(12):dmm048785. doi: 10.1242/dmm.048785 Current approaches and advances in the imaging of stroke Pragati Kakkar 1, Tarun Kakkar 1, Tufail Patankar 2, Sikha Saha 1,*
- [4] Sensors (Basel). 2021 Dec 20;21(24):8507. doi: 10.3390/s21248507. A Review on Computer Aided Diagnosis of Acute Brain Stroke Mahesh Anil Inamdar 1, Udupi Raghavendra 2, Anjan Gudigar 2, Yashas Chakole 2, Ajay Hegde 3, Girish R Menon 3, Prabal Barua 4 5 6, Elizabeth Emma Palmer 7, Kang Hao Cheong 8, Wai Yee Chan 9, Edward J Ciaccio 10, U Rajendra Acharya 11 12 13 14
- [5] Automatic brain ischemic stroke segmentation with deep learning: A review Author links open overlay panel Hossein Abbasi a, Maysam Orouskhani b, Samaneh Asgari c, Sara Shomal

Zadeh d Received 3 June 2023, Revised 2 September 2023, Accepted 18 September 2023, Available online 22 September 2023, Version of Record 27 September 2023.

- [6] Automated Stroke Prediction Using Machine Learning: An Explainable and Exploratory Study With a Web Application for Early Intervention January 2023 Authors: Krishna Mridha Case - Western Reserve University School of Medicine, Sandesh Ghimire - Jungpil Shin University of Aizu, Anmol Aran
- [7] Stroke Prediction Using Deep Learning and Transfer Learning Approaches January 2024 Authors: Dong-Her Shih - National Yunlin University of Science and Technology, Yi-Huei Wu, Wu Tin-Wei - National Yunlin University of Science and Technology, Huei-Ying Chu
- [8] An Improved Concatenation of Deep Learning Models for Predicting and Interpreting Ischemic Stroke January 2024 Authors: Sapia Sakri, Shakila Basheer, Zuhaira Muhammad Zain, Nurul Halimatul Asmak Ismail, Dua Nassar, Ghadah Aldehim, Mais Ayman Alharaki