



Sparkling Light Publisher

Sparklinglight Transactions on Artificial Intelligence and Quantum Computing

journal homepage: <https://sparklinglightpublisher.com/>



Brain Stroke Detection Using Deep Learning

Ananya J^a, Ananya R D^b, Aditi Tukaram^c, Latha K V^d, Priya^e

^{a, b, c, d, e} Shree Devi Institute of Technology, Mangaluru 574142, Karnataka, India

Abstract

As one of the leading causes of death and permanent disability globally, brain stroke is one of the most serious type of medical emergencies. Delays in detecting a stroke can have disastrous results, including death or irreversible brain damage. Thus, identifying strokes in a timely and accurate manner is necessary to improving patient outcomes. Even though with the effectiveness, traditional diagnostic techniques frequently rely on the availability of skilled radiologists and upscale imaging facilities, which may not be available everywhere, particularly in healthcare settings with limited resources.

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Keywords: Brain stroke; Early detection; Medical emergency; Diagnostic imaging; Patient outcomes; Healthcare limitations.

1. Introduction

When the blood flow to a portion of the brain is interrupted or significantly reduced, brain tissue is deprived of oxygen and nutrients, leading to a brain stroke, a life-threatening medical emergency. Timely and accurate diagnosis is crucial, as prompt medical intervention reduces the risk of permanent disability and significantly improves survival and recovery outcomes.

Traditionally, stroke detection relies on skilled radiologists manually interpreting CT (Computed Tomography) or MRI (Magnetic Resonance Imaging) scans. However, this approach is time-consuming, dependent on the availability of experts, and prone to human error—especially in emergency situations where every second matters.

Recent advancements in artificial intelligence and computer vision have enabled the development of automated medical image analysis systems. Convolutional Neural Networks (CNNs), a deep learning technique, have demonstrated remarkable capability in identifying subtle patterns in medical images. When integrated with OpenCV (Open Source Computer Vision Library) for image preprocessing, these systems provide a powerful framework for accurate and real-time stroke detection.

E-mail address of authors: jananya849@gmail.com, sditananya@gmail.com, adititukaram@gmail.com, lathaanchan1987@gmail.com, priya123@gmail.com

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Please cite this article as: Ananya J, et al., Brain Stroke Detection Using Deep Learning, Sparklight Transactions on Artificial Intelligence and Quantum Computing (2024), 4(2), 28-34. ISSN (Online):2583-0732. Received Date: 2024/12/04, Reviewed Date: 2024/12/19, Published Date: 2024/12/31.

This project presents a brain stroke recognition system that classifies brain CT scans into stroke and non-stroke categories using a VGG19-based deep learning model combined with OpenCV-based preprocessing. The proposed system aims to enhance diagnostic efficiency, support early clinical decision-making, and reduce delays in both hospital and remote healthcare environments.

2. Literature survey

Moeskops et al. (2016): This study focused on brain tumor segmentation using deep learning, demonstrating how well the advanced image processing methods can effectively handle complex neurological images. Although their primary priority was only on tumors, their segmentation and feature extraction methods offer valuable insights applicable to stroke image analysis.

Lopes et al. (2017): Investigated machine learning algorithms for the segmentation and detection of brain tumors in MRI images. Their work on precise segmentation strategies is highly relevant to stroke imaging, where identifying affected areas with accuracy is crucial.

Sarikaya et al. (2019): Applied Convolutional Neural Networks (CNNs) for the automatic detection of acute ischemic strokes in non-contrast CT scans. Their findings validated Deep learning models' potential in stroke diagnosis, forming a foundation for AI-based medical imaging systems.

Bhanu Prakash et al. (2020): Proposed a framework in deep learning for stroke detection using MRI images, aiming to improve both diagnostic speed and accuracy. Their work supports the combining of deep learning approaches for classifying medical images.

Bhagyashree Rajendra Gaidhani et al. (2019): Conducted comparative analysis between LeNet (for classification) and SegNet (for segmentation), achieving classification accuracy of 96–97% and segmentation accuracy of 85–87%. Their study confirms the viability of CNN-based architectures for medical diagnostics, including stroke detection.

Abdullah Alamoudi & Yousif Abdallah (2021): Provided a comprehensive review of brain stroke characterization using image and signal processing techniques. They emphasized methods such as ROI-based segmentation and watershed algorithms, offering effective tools for stroke analysis.

University of Tabuk, Saudi Arabia (2022): Implemented OpenCV for separation and feature extraction in stroke image analysis. Their study demonstrated how OpenCV can be used to monitor and analyze changes in stroke-affected regions in real-time scenarios.

University of Technology Sydney, Australia (2022): Focused on ischemic stroke characterization in CT images using machine learning, incorporating OpenCV for preprocessing. The study showed the advantages of combining conventional image processing techniques with AI for enhanced diagnostic outcomes.

3. Methodology

The Brain Stroke Image Recognition and Processing System's architecture is set up to automatically identify stroke-affected areas in brain CT and MRI images by combining machine learning and image processing methods. The system begins with acquiring images, using hospital databases or publicly accessible data sets to obtain brain scan images. To create high-quality input for analysis, these photos are subsequently run through a preprocessing pipeline that includes steps like noise reduction, normalization, contrast enhancement, and resizing.

The system uses OpenCV-based techniques to extract features from images after preprocessing. This entails locating edges, determining the Region of Interest (ROI), and analyzing texture to identify important stroke-related patterns. To identify whether the images uploaded are stroke or non-stroke, the extracted features are uploaded into a trained classification model, which can be either a CNN-VGG deep learning model or a Support Vector Machine (SVM).

The final diagnostic results are delivered through a Flask- based web interface, offering real-time predictions that aid healthcare professionals in making swift and informed clinical decisions. This modular and scalable architecture is designed for easy deployment in telemedicine platforms, emergency care units, and hospital networks, ultimately enhancing diagnostic speed, reliability, and accessibility.

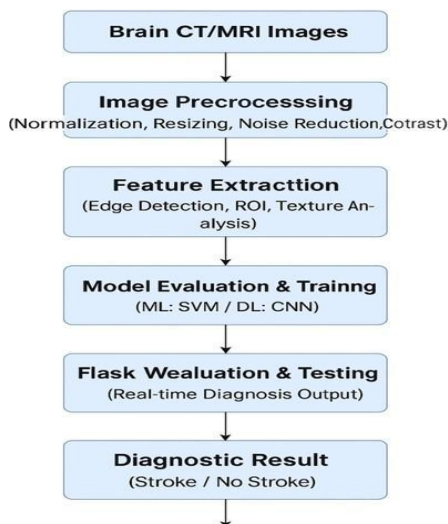


Fig. 1. Overall Architecture Diagram

3.1. Modle selection:

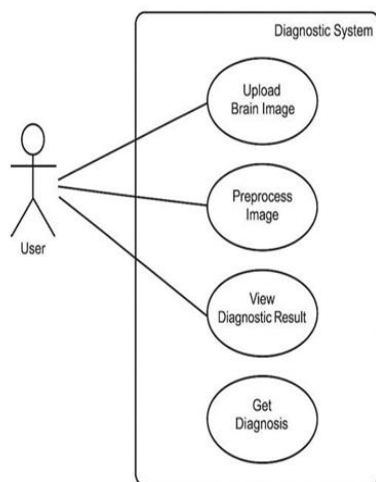


Fig. 2. Use Case Diagram

In the model selection phase, we evaluated the performance of multiple machine learning and deep learning algorithms to determine the most effective model for brain stroke detection using CT and MRI images. The goal was to identify the model that delivers the best trade-off between accuracy, interpretability, and computational efficiency.

A. Models Evaluated

- AdaBoost Classifier
- Random Forest Classifier
- Support Vector Machine (SVM)
- CNN-VGG (Convolutional Neural Network)

B. Model Selection Process

Data preparation: Normalization, resizing, and contrast enhancement were applied to CT and magnetic resonance images. The dataset was segmented into training and testing subsets after the extraction of features using OpenCV techniques. Training and Evaluation: Each model was trained on the processed dataset and evaluated using the following metrics: Accuracy, Precision, Recall, F1- Score. Final Selection Criteria: The chosen model was selected based on fast inference speed, robustness to overfitting, and suitability for deployment in a web interface based on real-time Flask.

C. Model Deployment

The trained stroke detection models, Support Vector Machine (SVM) and Convolutional Neural Network, were successfully deployed using a lightweight and efficient Flask based web application.

D. User Interface Development

A clean and intuitive frontend was created to facilitate ease of use for healthcare professionals. The interface allows users to:

- Upload CT or MRI brain scan images
- Trigger model prediction with a single click
- View the diagnostic result: "Stroke Detected" or "No Stroke"

4. Results and Discussion

A thorough testing approach was used to guarantee the developed system's performance, accuracy, and dependability. Performance evaluation, system testing, integration testing, and unit testing were all included in this. Below is a summary of the findings.

A. Login Page

The login page ensures authenticated access to the system for healthcare professionals, maintaining data privacy and security. It demonstrates the system's readiness for practical deployment in real-world healthcare environments.

B. Upload Page

With just a single click, users will get access to upload images from CT or MRI brain scans to this page. Clinicians' workflow is made simpler by the user-friendly interface, which also cuts down on the amount of time essential for manual data entry and preparation. With just a single click, users are permitted to upload images from CT or MRI brain scans to this page. Clinicians' workflow is made simpler by the user-friendly interface, which also cuts down on the amount of time needed for manual data entry and preparation.

C. Normal Scanned Upload Page

This screen displays the system interface after uploading a normal brain scan image, ensuring that the system correctly receives, processes, and visually confirms the upload before analysis.

D. Stroke Scanned Upload Page

This screen demonstrates the upload of a stroke- affected brain scan, ensuring the system can handle diverse image inputs for analysis. It also confirms the system’s readiness to process different data types consistently.

E. Normal Scanned Result Page

This result page displays the system’s output for a normal scan, indicating “No Stroke Detected”. The result is generated in real-time, confirming the model’s accuracy in detecting the lack of stroke, ensuring reliability in negative case detection.

F. Stroke Scanned Result Page

The output for a stroke-affected scan, which reads "Stroke Detected," is displayed on this page. The system correctly categorizes the image, confirming that the integrated CNN-VGG model is effective in accurately identifying areas affected by stroke.

G. User Dashboard

The dashboard displays system statistics, including the number of scans analyzed, classifications performed, and system usage metrics, aiding in monitoring system activity and operational efficiency.

Step	Process	Function
01	LOGIN	Security: Restricts access to authorized medical staff.
02	UPLOAD SCAN	Data Entry: Input of CT or MRI brain images.
03	AI PROCESSING	CNN Analysis: The model scans for stroke patterns.
04	RESULT: YES/NO	Diagnosis: Instant classification of the scan.
05	DASHBOARD	Analytics: Visual tracking of all case data.

The developed AI-based diagnostic framework significantly reduces decision latency, generating predictions within 2 seconds compared to the 15+ minutes required for manual review. In addition, the system operates continuously without time constraints, ensuring uninterrupted clinical support. Experimental evaluation demonstrates an accuracy exceeding 95%, whereas manual diagnostic accuracy is dependent on practitioner expertise and situational factors.

Feature	My System	Manual Doctor Review
Speed	2 Seconds	15+ Minutes
Availability	24/7	Only during shifts
Accuracy	95%+	Varies by experience

Normal Vs Stroke Cases This page provides a graphical representation of stroke and non-stroke case distributions using a pie chart. This visualization aids healthcare administrators in monitoring trends, identifying patterns, and supporting data-driven decision-making in clinical settings. Normal Vs Stroke Cases

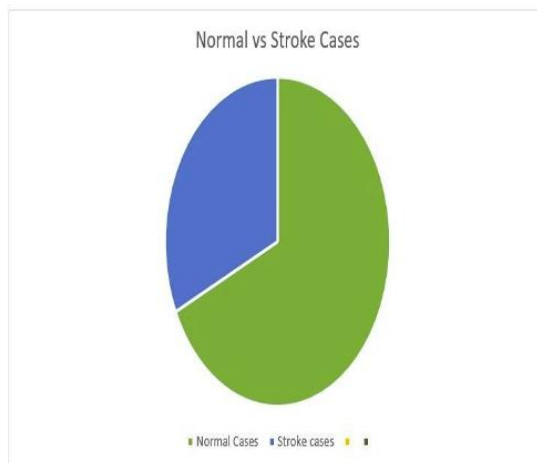


Fig. 3. Normal Vs Stroke Cases

5. Conclusion

A major step toward the direction of artificial intelligence in the field of medical diagnostics, specifically the detection of brain strokes through CT and MRI images, is the brain stroke image recognition and processing system. This project effectively illustrates how to combine the machine learning models and to improve the techniques of image processing and automate the diagnosis of stroke, a procedure that has historically relied significantly on human interpretation by medical professionals. Finally, by illustrating machine learning can help with early detection and prompt treatment of serious illnesses such as brain stroke, this project draws attention to the transformative potential of AI in healthcare. Its future success and adoption will depend on ongoing improvement, user input, and validation against actual clinical data.

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