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BRAIN STROKE PREDICTION FROM NEURO IMAGES USING DEEP LEARNING CLASSIFIER

Balaji A [1], Mohamed Javith M [2], Rajakumar V [3], Sibiraj V [4], Nijanthan N [5]

[1,2,3,4] B.E. Computer Science and Engineering, Department of Computer Science and Engineering, Pavai College of Technology, Paavai Institutions, Paavai Nagar, NH-44, Pachal - 637 018. Namakkal Dist., Tamil Nadu, India.

[5] Assistant Professor, M.Tech IT, Department of Computer Science and Engineering, Pavai College of Technology, Paavai Institutions, Paavai Nagar, NH-44, Pachal - 637 018. Namakkal Dist., Tamil Nadu, India.

A B S T R A C T :

Brain stroke, a leading cause of disability and mortality worldwide, necessitates early detection and intervention for improved patient outcomes. This study proposes a novel approach for predicting brain stroke using magnetic resonance imaging (MRI) scan images and deep learning algorithm. A dataset comprising MRI scan images of patients with and without strokes is collected and pre-processed to enhance image quality. Features are extracted from the images, capturing radiomic information indicative of stroke pathology and implement deep learning model including convolutional neural networks (CNN), are trained on the extracted features to classify MRI scan images into types of strokes (ischemic and hemorrhagic) and non-stroke categories. Model performance is evaluated using standard metrics, and validated models are integrated into clinical workflows for real-time stroke prediction. The proposed approach offers a promising avenue for early detection and intervention in brain stroke cases, potentially improving patient outcomes and reducing the burden of stroke-related disabilities. The utilization of MRI scan images provides a non-invasive and highly detailed imaging modality for assessing brain health and detecting stroke-related abnormalities. This includes extracting radiomic features from MRI images, which capture subtle variations in tissue characteristics associated with stroke pathology.

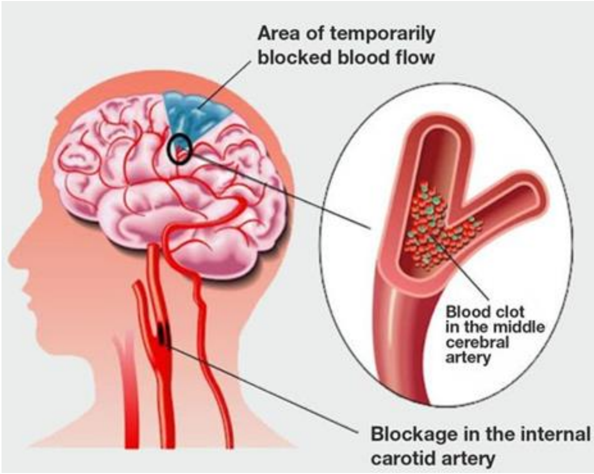
Keywords: Brain Stroke, Deep Learning, Convolutional Neural Networks (CNN), MRI Scan Images, Ischemic Stroke, Hemorrhagic Stroke, Radiomics, Medical Imaging, Stroke Prediction, Artificial Intelligence In Healthcare.

1. Introduction

Stroke, a devastating medical condition characterized by the sudden disruption of blood flow to the brain, poses a significant global health challenge. Stroke, often referred to as a brain stroke or cerebrovascular accident, is a critical medical emergency characterized by the sudden interruption of blood flow to the brain. This interruption can occur due to the blockage of a blood vessel (ischemic stroke) or the rupture of a blood vessel (hemorrhagic stroke), leading to damage to brain tissue and potentially life-threatening consequences. Stroke is a leading cause of disability and mortality worldwide, with profound implications for individuals, families, and healthcare systems.

With its potential to cause severe neurological impairment, disability, and even death, stroke stands as a leading cause of mortality and long-term disability worldwide, according to the World Health Organization (WHO). Despite advancements in medical science and healthcare, the incidence of stroke remains a pressing concern, highlighting the need for effective strategies for early detection, risk assessment, and intervention. Early identification of stroke warning signs and risk factors is paramount for mitigating its impact and improving patient outcomes. Timely intervention can not only reduce the severity of the condition but also minimize the risk of long-term disability and mortality.

Traditional methods of stroke risk assessment often rely on subjective interpretation of medical data and clinical evaluation, which may be limited in accuracy and efficiency. In recent years, the emergence of advanced computational techniques, particularly deep learning algorithms, has revolutionized various domains, including healthcare. Deep learning algorithms, characterized by their ability to automatically learn hierarchical representations from data, offer tremendous potential for enhancing the accuracy and efficiency of stroke prediction and risk assessment. In this diagram specifies the brain stroke information in figure 1



2. Objective

- **Develop a Statistical Prediction Model**
  Build a predictive model through standard statistical methods (e.g., logistic regression, Cox proportional hazards models) to predict a person's risk of suffering a stroke based on analyzed risk factors.

- **Validate Model Performance**
  Estimate the accuracy, sensitivity, specificity, and predictive value of the model with proper validation techniques like cross-validation or independent dataset testing to assess reliability and applicability.

- **Enable Early Identification and Prevention**
  Apply the model to detect high-risk populations early on, making it possible for timely clinical interventions and lifestyle adjustments to lower stroke incidence.

- **Improve Public Health Initiatives**
  Educate healthcare policies and prevention programs through the offering of evidence-based information regarding stroke risk factors and relative importance, in turn aiding more efficacious public health efforts.

3. Literature Review

Senjuti Rahman,et.al,…[1] analysed to forecast the possibility of a brain stroke occurring at an early stage using deep learning and machine learning techniques. To gauge the effectiveness of the algorithm, a reliable dataset for stroke prediction was taken from the Kaggle website. Several classification models, including Extreme Gradient Boosting (XGBoost), Ada Boost, Light Gradient Boosting Machine, Random Forest, Decision Tree, Logistic Regression, K Neighbors, SVM - Linear Kernel, Naive Bayes, and deep neural networks (3-layer and 4-layer ANN) were successfully used in this study for classification tasks. The Random Forest classifier has 99% classification accuracy, which was the highest (among the machine learning classifiers). The three layer deep neural network (4-Layer ANN) has produced a higher accuracy of 92.39% than the three-layer ANN method utilizing the selected features as input. The research's findings showed that machine learning techniques outperformed deep neural networks.

Susmita Chennareddy, et.al,…[2] explores the development, functionality, and effectiveness of portable stroke detection technologies used in prehospital environments. It examines various wearable sensors, AI-powered diagnostic tools, and non-invasive imaging techniques that assist emergency responders and healthcare professionals in detecting stroke symptoms outside hospital settings. The review highlights advancements in electro encephalography (EEG), near-infrared spectroscopy (NIRS), transcranial Doppler ultrasound (TCD), and machine learning-based assessment models. Additionally, challenges related to accuracy, portability, cost, regulatory approvals, and integration with emergency medical systems (EMS) are discussed. The findings suggest that while portable stroke detection devices hold great potential in improving stroke care, further research, clinical validation, and technological refinements are necessary to enhance their reliability and widespread adoption.

Smita Patil, et.al,…[3] explores current methods for AIS detection, including clinical assessments, neuroimaging techniques such as computed tomography (CT) and magnetic resonance imaging (MRI), and emerging biomarker-based diagnostics. The diagnosis of AIS relies heavily on advanced imaging modalities that differentiate between ischemic and hemorrhagic stroke, assess perfusion deficits, and guide therapeutic decisions. Treatment strategies for AIS primarily include intravenous thrombolysis (IVT) using recombinant tissue plasminogen activator (rtPA) and mechanical thrombectomy (MT) for large vessel occlusions. Recent advancements in endovascular therapy, neuroprotective agents, and personalized medicine have shown promise in expanding treatment options and improving patient recovery

Tomas Pokorny, et.al,…[4] presents an experimental validation of the Distorted Born Iterative Method (DBIM) combined with the Two-Step Iterative Shrinkage/Thresholding (TwIST) algorithm for accurate stroke identification and classification. A multi-layered anatomically complex head phantom, designed to simulate human brain tissues and cerebrovascular structures, is employed for validation. The proposed approach utilizes microwave imaging techniques to reconstruct stroke-affected regions and differentiate stroke types based on dielectric contrasts. Experimental results demonstrate that the DBIM-TwIST algorithm enhances imaging resolution, improves stroke localization, and achieves high accuracy in distinguishing between ischemic and hemorrhagic strokes. Comparative evaluations with conventional imaging methods, such as computed tomography (CT) and magnetic resonance imaging (MRI), reveal that microwave-based stroke detection offers a low-cost, non-ionizing alternative for real-time monitoring. Furthermore, the algorithm's iterative optimization approach refines image reconstruction, reducing artifacts and improving diagnostic precision.

Olympia karadima, et.al,…[5] presents an experimental validation of the Distorted Born Iterative Method (DBIM) combined with the Two-Step Iterative Shrinkage/Thresholding (TwIST) algorithm for stroke detection and differentiation. The proposed approach is evaluated using a multi-layered anatomically complex head phantom that mimics the human brain's structural and dielectric properties. The aim is to assess the feasibility of microwave imaging-based stroke detection and validate the effectiveness of DBIM-TwIST for accurate stroke classification. Stroke is a leading cause of disability and mortality worldwide, necessitating rapid and accurate diagnosis to improve patient outcomes. The ability to differentiate between ischemic and hemorrhagic strokes is critical, as treatment approaches vary significantly. Conventional imaging modalities such as Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) are widely used for stroke diagnosis but are often limited by high costs, ionizing radiation (in the case of CT), and limited portability. Microwave imaging, an emerging non-invasive technique, has shown promise in real-time stroke detection by exploiting the dielectric property differences between healthy and stroke-affected brain tissues.

4. Existing System

The most challenging and crucial task in image processing is picture segmentation. Segmentation is the process of breaking down an image into its individual objects or areas and grouping visual elements that have similar traits. A crucial step in digital image processing, segmentation has several uses, including compression, automatic text handwriting interpretation, remote sensing, arthritis diagnosis from joint images, and medical image processing. Any image may be divided into several groups using the clustering algorithms based on similarity criterion like colour or texture. The K-means clustering technique, which separates the picture into K groups depending on how similar the pixels in each cluster are, is implemented in the current system. Brain stroke segmentation involves applying a straightforward algorithm to identify the size and shape of a stroke in an MR picture of the brain. Typically, an MRI or CT scan may be used to diagnose a condition by displaying the structure of the brain. K-means is a frequently used clustering technique that divides the data into K different clusters. In this strategy, clusters are specified in advance, which heavily depends on the early discovery of items that accurately reflect the clusters. Additionally, a fuzzy C-means clustering approach was constructed. However, this algorithm cannot deal with the intricate topredict the brain strokes. architecture of brain tissues.

Fig 2 shows the existing methodology

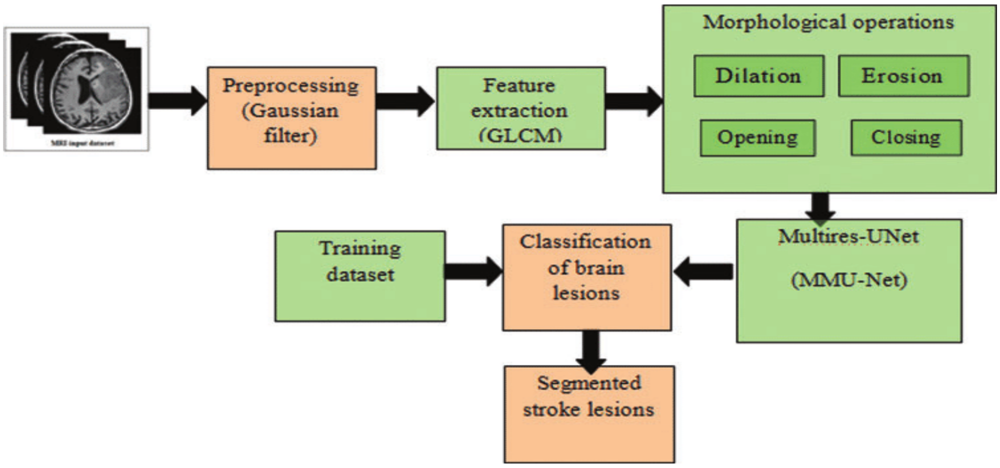


Fig 2 illustrates a process for segmenting brain stroke lesions from MRI images.

The process can be broken down into several key stages:

1. MRI Input Dataset: The process begins with an MRI image of the brain, which serves as the input data.

2. Preprocessing (Gaussian filter): A Gaussian filter is applied to the MRI image to reduce noise and smooth the image, enhancing the quality for subsequent analysis.

3. Feature extraction (GLCM): The Gray-Level Co-occurrence Matrix (GLCM) is used to extract textural features from the preprocessed image. These features provide information about the spatial relationships of pixel intensities, which can help distinguish different tissue types.

4. Morphological operations: Techniques like dilation, erosion, opening, and closing are applied to refine the image and remove imperfections.

Dilation: Expands the boundaries of bright regions, which can help fill small holes and connect nearby regions.

Erosion: Shrinks the boundaries of bright regions, which can remove small noise artifacts.

Opening: Typically involves erosion followed by dilation and can remove small objects and smooth contours.

Closing: Usually involves dilation followed by erosion and can fill small holes and connect nearby objects.

5. Multires-UNet (MMU-Net): A deep learning model, specifically a Multires-UNet architecture, is employed for segmentation. This network is trained to identify and delineate the stroke lesions.

6. Training dataset: A labeled dataset of MRI images with marked stroke lesions is used to train the MMU-Net model.

7. Classification of brain lesions: The trained MMU-Net classifies different regions in the MRI image, identifying those corresponding to stroke lesions.

8. Segmented stroke lesions: The final output is a segmented image where the stroke lesions are clearly delineated, providing a visual representation of the affected areas.

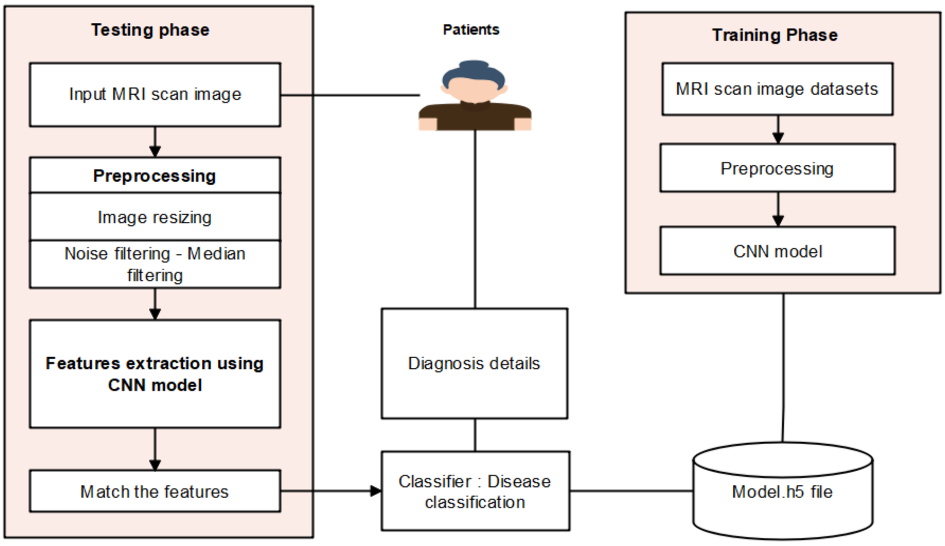
This process combines traditional image processing techniques with deep learning to accurately segment stroke lesions, which can aid in diagnosis, treatment planning, and monitoring of stroke patients.

5. Proposed System

The proposed brain stroke prediction system using MRI scan images employs Convolutional Neural Networks (CNNs) to enhance early stroke detection and improve clinical decision-making. The system follows a structured pipeline, beginning with data acquisition and preprocessing, where MRI scan images are collected from clinical or publicly available datasets. To ensure optimal image quality, preprocessing techniques such as noise reduction, contrast enhancement, and normalization are applied. Additionally, segmentation is performed to highlight the region of interest (ROI), enabling more precise stroke detection.

Following preprocessing, the system utilizes a deep CNN model to extract intricate radiomic features from MRI images, including variations in texture, intensity, and structural abnormalities indicative of stroke pathology. These features play a crucial role in stroke classification, where the model is trained to categorize MRI images into three groups: ischemic stroke (caused by blocked blood flow), hemorrhagic stroke (caused by brain bleeding), and non-stroke cases. The CNN model is trained using labeled datasets, ensuring its ability to accurately detect stroke patterns.

Once trained and validated using standard performance metrics, the stroke prediction system is integrated into clinical workflows, providing radiologists with an automated risk assessment and decision support tool. This AI-powered approach enhances the accuracy and efficiency of stroke diagnosis, facilitating timely medical intervention. Additionally, continuous updates and refinements to the model improve its adaptability and robustness, making it a valuable asset for stroke detection in real-world healthcare applications.



Training Phase:

- MRI scan image datasets: The process begins with a collection of MRI scan images.
- Preprocessing: These images undergo preprocessing, which may include resizing and noise filtering.
- CNN model: The preprocessed images are then used to train a CNN model.
- Model.h5 file: The trained model is saved as a Model.h5 file, which stores the learned parameters.

Testing Phase:

- Input MRI scan image: A new MRI scan image from a patient is input into the system.
- Preprocessing: Similar to the training phase, the input image is preprocessed, including resizing and noise filtering.
- Features extraction using CNN model: The preprocessed image is fed into the trained CNN model to extract relevant features.
- Match the features: The extracted features are compared against the features learned by the model.
- Classifier: Disease classification: Based on the feature matching, the system classifies the disease.
- Diagnosis details: The diagnosis details are then provided as the output.

The diagram shows the flow of data and processes involved in using a CNN model to classify diseases from MRI scans, separating the model training from the testing and diagnosis of new patient data.

6. Experimental Result

This system forecasts brain strokes using a deep learning algorithm on the front end (Python framework) and a back end (MYSQL). For this study, we can submit the image datasets from KAGGLE interface

TABLE 1 DATASETS DETAILS

DISEASE NAME	IMAGE COUNT
Haemorrhagic	186 files
Ischemic	30 files
Normal	399 files

A hemorrhagic stroke, also known as a brain hemorrhage, occurs when a blood vessel in the brain leaks or ruptures, causing bleeding in or around the brain, which can lead to severe neurological damage

An ischemic stroke, the most common type of stroke, occurs when a blood clot or plaque blocks a blood vessel in the brain, preventing blood flow and causing brain tissue damage.

The training accuracy of the brain stroke prediction system using MRI scan images depends on various factors, including dataset size, preprocessing techniques, CNN architecture, and hyperparameter tuning.

$$Training\ accuacy = \frac{Number\ of\ Correct\ predictions}{Total\ number\ of\ Training\ samples}\ X\ 100$$

Number of Correct Predictions: The count of samples that the model correctly classified during training.

Total Number of Training Samples: The total number of images or data points used in the training phase.

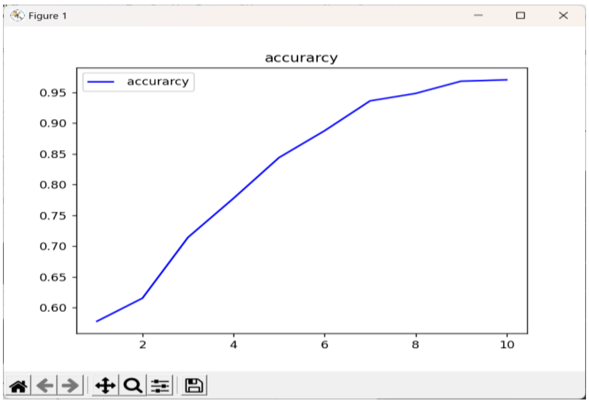


Fig 4: Training accuracy

From the figure, the proposed system achieved 95% accuracy in brain stroke prediction

7. Conclusion

Brain stroke prediction using Convolutional Neural Networks (CNNs) represents a cutting-edge application of artificial intelligence in healthcare, aimed at improving early detection and intervention for stroke patients. By leveraging the power of CNNs, which excel at extracting intricate features from complex visual data, this approach seeks to revolutionize stroke care by enabling automated analysis of MRI scan images for signs of stroke pathology. At its core, the CNN-based approach involves training deep learning models on large datasets of MRI images, annotated with stroke labels, to learn patterns and features indicative of stroke occurrence. These models are trained to classify input images into stroke types (ischemic, hemorrhagic) or non-stroke cases, with the ultimate goal of providing clinicians with early warnings and decision support tools for timely intervention.

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