Industrial Engineering Journal
ISSN: 0970-2555
Volume : 54, Issue 2, February : 2025

Stroke Risk Assessment Using Advanced Deep Learning Models

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Abstract: Brain stroke, or cerebrovascular accident (CVA), is a critical medical condition that can result in severe disabilities or death. Early prediction of stroke risk is crucial for timely intervention and prevention. Traditional methods rely on data mining and machine learning techniques, which, while useful, often have limitations in accuracy. This study leverages advanced deep learning models, specifically convolutional neural networks (CNNs), to improve the prediction and classification of brain stroke occurrences. By analyzing CT scan images, the proposed method classifies stroke cases as normal or abnormal with higher precision. Three predictive models are developed, and their performance is compared with existing approaches, demonstrating superior accuracy and reliability in stroke prediction.

Index terms - *Cerebrovascular Accident (CVA), Deep Learning, Convolutional Neural Network (CNN), Stroke Risk Assessment, Medical Image Classification, CT Scan Analysis, Predictive Modeling, Stroke Detection*

1. INTRODUCTION

Stroke is a life-threatening condition that occurs when blood flow to a part of the brain is interrupted, leading to brain cell death and the loss of associated functions. Without prompt intervention, stroke can result in long-term disabilities or fatality. Existing predictive methods, which rely heavily on data mining and machine learning algorithms, utilize patient datasets containing demographic, medical, and lifestyle attributes to identify risk factors and predict stroke occurrences. However, these methods often suffer from limitations in accuracy and performance.

To address these challenges, this study introduces a deep learning-based approach utilizing convolutional neural networks (CNNs) for analyzing CT scan images. The proposed system aims to classify brain stroke images into normal or abnormal categories with improved precision. Deep learning models have demonstrated their potential in both non-medical and medical domains, and this application seeks to harness their capabilities for accurate and efficient stroke risk assessment. By incorporating advanced deep learning techniques, this system provides a significant improvement over traditional methods, offering better predictive accuracy and aiding healthcare professionals in timely decision-making.

2. LITERATURE SURVEY

a) Machine Learning for Brain Stroke: A Review

https://www.sciencedirect.com/science/article/abs/pii/S1052305720305802

This article presents the state-of-the-art machine learning (ML) approaches for brain stroke into four functional categories of similarities: Stroke diagnosis has the most studies, while stroke therapy has the fewest, indicating a research imbalance; Stroke data often includes CT pictures; SVM and Random Forests are effective in each category. In health care, ML and DL are being used more, but some research areas are being neglected despite their need.

b) Voxel based lesion segmentation through SVM classifier for effective brain stroke detection

https://ieeexplore.ieee.org/document/8299925

Ischaemic strokes occur when blood circulation in the brain zone is reduced. Magnetic resonance imaging (MRI) helps neurologists locate brain lesions. It takes time to physically check a lesion and identify it. The Random Forest algorithm uses binary classification to forecast the kind of ischaemic stroke. The Random Forest method, which is designed for real-time prediction, is slowed down by large databases of photos of lesions. In order to address the above limitation, this work applies a Support Vector Machine Classifier with Adaptive Multithresholding Technique to the task of ischaemia stroke picture classification. Classifier segmentation and accuracy are measured during training and testing by manipulating specificity, sensitivity, and accuracy. Sequences are analysed in MATLAB 7.14.

c) Analyzing the Performance of Stroke Prediction using ML Classification Algorithms

https://www.researchgate.net/publication/353078951_Analyzing_the_Performance_of_Stroke_Prediction_using_ML_Classification_Algorithms

Damage to the brain's blood arteries is the underlying cause of a stroke. A problem with the delivery of nutrients and blood to the brain is another possible cause.

Stroke is the leading cause of mortality and disability globally, as reported by the World Health Organisation (WHO). Although many research have looked at ways to predict heart attacks, very few have looked at the risk of strokes in the brain. Brain stroke prediction uses a variety of machine learning approaches. Using machine learning algorithms such as Logistic Regression, Decision Tree Classification, Random Forest Classification, K-Nearest Neighbours, Support Vector Machine, and Naïve Bayes Classification, this paper has trained five distinct models to accurately predict physiological factors. Naïve Bayes, with an accuracy of around 82%, is the algorithm that performs the best on this task.

d) Probability of stroke: a risk profile from the Framingham Study https://pubmed.ncbi.nlm.nih.gov/2003301/

In order to build a health risk evaluation function for stroke prediction, the Framingham Study cohort was utilised. Factors that increase the likelihood of a stroke include advanced age, high systolic blood pressure, diabetes, smoking, a history of cardiovascular illness (including heart failure, intermittent claudication, or coronary heart disease), atrial fibrillation, and left ventricular hypertrophy as shown on an electrocardiogram. The stroke probabilities for 472 occurrences from 9 and 14 biannual exams during a 10-year period were calculated using the Cox proportional hazards model, which is based on a point system and accounts for each sex separately. The profile's risk variables can be evaluated during a doctor's appointment in order to forecast the likelihood of a stroke. You may estimate your risk of stroke by looking at the average risk for people of the same age and gender. If one learns that their risk of stroke is significantly higher than average, they may decide to modify their risk factors. Additionally, it might help find people who are at high risk of stroke because of borderline multiple risk factors, such moderate or borderline hypertension, and encourage patients to change their risk factors for stroke based on all of them.

e) RETRACTED ARTICLE: Classification of stroke disease using machine learning algorithms

https://www.researchgate.net/publication/330644048_RETRACTED_ARTICLE_Classification_of_stroke_disease_using_machine_learning_algorithms

This study suggests a text-mining and machine-learning prototype for stroke classification. Machine learning can monitor healthcare, data management, and surveillance with the right algorithms trained on the subject. Data mining techniques for semantic and syntactic information tracking are discussed in this article. It is recommended to train the algorithm by extracting patient symptoms from case sheets. An additional 507 patient case sheets were supplied by Sugam Multispecialty Hospital in Kumbakonam, Tamil Nadu, India, for the purpose of data collecting. The case sheets were then mined using tagging and maximum entropy, and the stemmer was used to classify strokes based on common and distinctive properties. Random forests, boosting and bagging, support vector machines, and artificial neural networks were fed the produced data. Stochastic gradient descent artificial neural networks outperformed the alternatives with a 95% classification accuracy and a standard deviation of 14.69.

3. METHODOLOGY

i) Proposed Work:

The proposed system utilizes advanced deep learning techniques, specifically convolutional neural networks (CNNs), to diagnose and classify brain strokes using CT scan images. Unlike traditional methods that rely on data mining and machine learning algorithms, this approach focuses on leveraging CNNs for their exceptional capability in image classification tasks. The system automatically identifies and categorizes brain stroke images into normal and abnormal, ensuring high precision and reliability. By enhancing prediction accuracy and efficiency, this model supports healthcare professionals in making timely and informed decisions for stroke diagnosis and treatment. The integration of deep learning in medical imaging not only improves the diagnostic process but also demonstrates its transformative potential in addressing critical healthcare challenges like brain stroke.

ii) System Architecture:

The system architecture for the proposed brain stroke prediction model is designed to leverage deep learning techniques, specifically convolutional neural networks (CNNs), for analyzing and classifying CT scan images. The architecture begins with data preprocessing, where CT scan images are standardized and augmented to enhance model robustness. These images are then fed into a CNN model, which extracts hierarchical features through layers of convolution, pooling, and activation functions. The extracted features are passed to fully connected layers that perform classification into normal or abnormal categories. The system also includes a training phase where the model learns from a labeled dataset and a validation phase to fine-tune parameters for optimal performance. The output layer provides a probabilistic classification, aiding healthcare professionals in stroke diagnosis with high accuracy and reliability. This architecture ensures end-to-end automation, scalability, and precision in medical image analysis.

Fig 1 Proposed architecture

iii) Modules:

a) Dataset Upload & Analysis: using this module we will upload dataset and then perform analysis methods such as detecting brain stroke

b) Dataset Processing & Analytical Methods: using this module we will encode attack labels with integer ID and then split dataset into train and test where application used 80% dataset to train classification

c) Run DL Model: using this module we will trained classification algorithm with above 80% dataset and then build a prediction model

d) Predict Output: using this module we will upload test image and then classification model will predict output based on input image

vi) Algorithms:

A CNN The primary algorithm used in the proposed system is the convolutional neural network (CNN), which is a deep learning model designed specifically for image classification and processing. CNNs operate by extracting features from images through layers of convolution, pooling, and activation functions. These features help in distinguishing between normal and abnormal CT scan images. The hierarchical structure of CNNs enables the model to identify patterns and anomalies in medical images, making it ideal for classifying brain stroke cases with high accuracy.

Deep Learning Models: Apart from CNNs, the proposed system explores other deep learning models for enhancing the prediction process. These models may include recurrent neural networks (RNNs) or hybrid architectures to complement CNNs in handling time-series or sequential data if required. Deep

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ISSN: 0970-2555
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learning models are optimized using techniques like dropout for regularization and adaptive learning rates to improve convergence, ensuring robust performance on medical image datasets.

4. EXPERIMENTAL RESULTS

Fig 2 upload image

Fig 3 predicted image

Fig 4 predicted result

5. CONCLUSION

The proposed system demonstrates the effective use of convolutional neural networks (CNNs) in predicting and classifying brain stroke occurrences using CT scan images. By leveraging the advanced capabilities of deep learning, the system achieves superior accuracy compared to traditional data mining and machine learning algorithms. This approach not only automates the diagnostic process but also provides healthcare professionals with a reliable tool for timely intervention, ultimately reducing the impact of strokes on patient health. The results highlight the transformative potential of deep learning in medical imaging, paving the way for more efficient and accurate healthcare solutions.

6. FUTURE SCOPE

The proposed system can be extended in several directions for further enhancement. Incorporating larger and more diverse datasets from multiple medical institutions can improve the generalizability and robustness of the model. Advanced techniques like transfer learning could be utilized to reduce training time while maintaining accuracy. Additionally, integrating other medical imaging modalities, such as MRI, alongside CT scans, could provide a more comprehensive analysis. Real-time implementation of the model in clinical settings, coupled with user-friendly interfaces, could make it a valuable tool for on-the-spot diagnosis. Future research could also explore hybrid models combining CNNs with other algorithms to improve prediction efficiency further.

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