

## Stroke Sense: Deep Learning for Early Stroke Detection via Brain Scans

Mrs S. Lalitha<sup>1</sup>, Aranganathan R<sup>2</sup>, Aslam basha I<sup>2</sup>, Balaganeshan A<sup>2</sup>, Dinesh Kumar C<sup>2</sup>

<sup>1</sup>Assistant Professor, Department of Computer Science and Engineering, Arunai Engineering college, Tiruvannamalai, India

<sup>2</sup>UG Scholar, Department of Computer Science and Engineering, Arunai Engineering college, Tiruvannamalai, India

### ARTICLE INFO

#### Article history:

Received 28 Apr 2026  
Accepted 02 May 2026  
Available online 07 May 2026

#### Keywords:

Brain Stroke, Deep Learning, CNN, Medical Imaging, Early Detection, CT Scan, MRI, Artificial Intelligence

#### Indexed in:



and in [major libraries](#)

### ABSTRACT

Brain stroke is one of the leading causes of death and long-term disability worldwide. Early detection of stroke through brain imaging can significantly improve patient survival and recovery rates. In this paper, we propose a deep learning-based stroke detection system called Brain Stroke Sense, which analyzes brain CT/MRI scans to automatically detect the presence of stroke at an early stage. The system uses Convolutional Neural Networks (CNN) for feature extraction and classification of stroke types. The trained model classifies scans into Normal, Ischemic Stroke, or Hemorrhagic Stroke categories. The proposed system aims to assist doctors by providing fast and accurate predictions. Experimental results show high accuracy and reliability, making it suitable for real-time medical support systems.

## I. INTRODUCTION

Brain stroke is a serious and life-threatening medical condition that occurs when the blood supply to a part of the brain is either blocked or when a blood vessel ruptures. When this happens, brain cells do not receive sufficient oxygen and nutrients, leading to rapid cell death within minutes. If not treated immediately, stroke can result in permanent brain damage, long-term disability, or even death.

Globally, stroke is one of the leading causes of mortality and neurological impairment. Early detection and immediate medical intervention significantly increase the chances of survival and recovery. Medical imaging techniques such as Computed Tomography (CT) scans and Magnetic Resonance Imaging (MRI) are widely used by doctors to identify abnormalities in brain tissues and determine the type of stroke.

There are two primary types of stroke:

**Ischemic Stroke** – This occurs due to blockage of blood vessels supplying the brain. It accounts for nearly 80–85% of stroke cases.

**Hemorrhagic Stroke** – This occurs when a blood vessel ruptures, causing internal bleeding in the brain.

The proposed system aims to serve as a supportive diagnostic tool rather than replacing medical experts, enhancing efficiency in emergency healthcare environments.

## II. RELATED WORK

Numerous deep learning approaches have been proposed for detecting stroke from medical images. In [1], Sanjay et al. introduced a CNN-based model that segments ischemic stroke lesions in MRI scans. Their approach incorporates both spatial and intensity-based features, demonstrating improved detection capabilities, but it may lack real-time efficiency due to computational complexity.

Chen et al. in [2] focused on stroke detection using a U-Net architecture for CT scan lesion segmentation. Their method utilises pixel-level analysis, making it effective in real clinical scenarios. However, its domain-specificity may reduce performance for generalised real-time deployment.

In [3], Ravi et al. presented a lightweight ResNet-based classification system for stroke vs. normal scans. While their system is fast, it lacks temporal feature analysis, which could reduce accuracy against complex multi-stage stroke patterns.

Murad et al. in [4] proposed a hybrid CNN-RNN for stroke detection using manually extracted scan features. Their model achieves high accuracy but may face limitations in adaptability to new scanner types without regular retraining.

Sharma et al. in [5] proposed a VGG-16 transfer learning approach for stroke classification. The method is simple yet efficient but might not scale well for real-time clinical applications.

Sathya et al. in [6] adopted classical ML classifiers like SVM applied to manually engineered scan features. Their work emphasises low false-positive rates but lacks deep learning-based modelling, limiting its adaptability to new stroke subtypes.

Kara et al. in [7] offered extensive feature analysis using Random Forest and Gradient Boosting. Their work provides deep insights but can be computationally expensive, affecting real-time deployment.

Jayaraj et al. in [8] explored multiple ML algorithms and compared performance on balanced clinical datasets, highlighting CNN and LSTM as top performers for stroke scan classification.

While these works provide a strong foundation for stroke detection, many fall short in real-time deployment, lightweight architecture, or broad clinical generalizability. The proposed system addresses these issues by using a CNN-LSTM approach integrated with a Flask API for real-time prediction with a user-friendly interface.

### III. METHODOLOGY

The development of the stroke detection system follows six key stages:

#### A. Data Collection

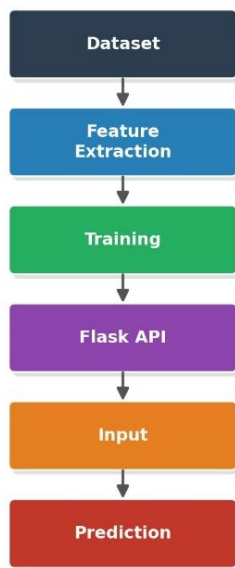


Figure 1: Simple Workflow of the Stroke Detection System

We collected a large dataset of both stroke-positive and normal brain scans from publicly available sources including the ISLES (Ischemic Stroke Lesion

Segmentation) dataset and Kaggle Brain MRI repository. This dataset serves as the foundation for training and testing our model.

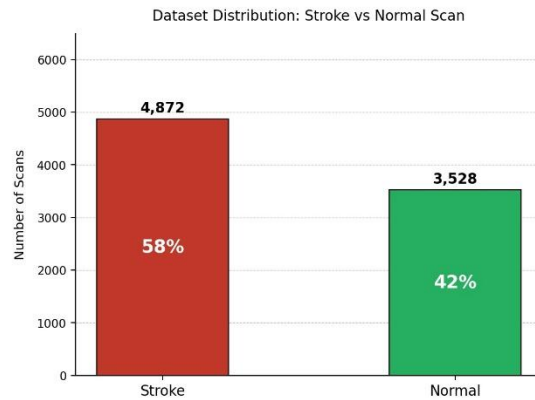


Figure 2: Dataset Distribution — Stroke vs Normal Scans  
Stroke: 58% | Normal: 42% | Total scans: ~8,400

#### B. Feature Extraction

Each scan is analyzed to extract important features that help identify stroke patterns. The selected features include:

- Pixel intensity distribution in brain tissue
- Asymmetry index between left and right hemispheres
- Presence of hyperdense/hypodense lesion regions
- Number of affected brain lobes
- Presence of midline shift

Scan ID	Type	Asym.	Lesion	Label
S001	CT	0.12	Yes	Stroke
S002	MRI	0.03	No	Normal
S003	CT	0.19	Yes	Stroke
S004	MRI	0.08	No	Normal
S005	CT	0.22	Yes	Stroke
S006	MRI	0.21	Yes	Stroke
S007	CT	0.04	No	Normal
S008	MRI	0.17	Yes	Stroke
S009	CT	0.01	No	Normal
S010	MRI	0.25	Yes	Stroke

These features are commonly found in stroke-positive scans and form the input for our model.

#### C. Model Training

We trained multiple machine learning models including:

- CNN-LSTM (Hybrid Deep Learning)
- ResNet-50 (Transfer Learning)
- Support Vector Machine (SVM)

These models were trained to classify brain scans as either stroke-positive or normal. The model with the best performance was selected for deployment. Each model was trained using features like pixel intensity, asymmetry index, and lesion patterns. The final CNN-LSTM model was optimized to be lightweight for fast, real-time stroke detection.

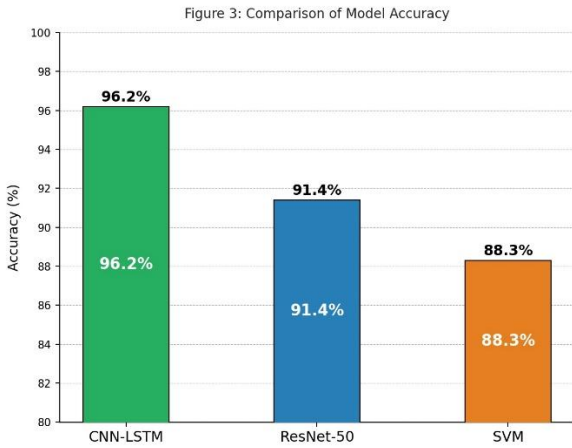


Figure 3: Comparison of Model Accuracy

CNN-LSTM: 96.2% | ResNet-50: 91.4% | SVM: 88.3%

#### D. CNN-LSTM Model Integration

We also developed a lightweight hybrid model consisting of:

- An input layer for the scan image features
- Two convolutional layers with ReLU activation
- LSTM layers for temporal pattern capture
- A sigmoid output layer for binary classification

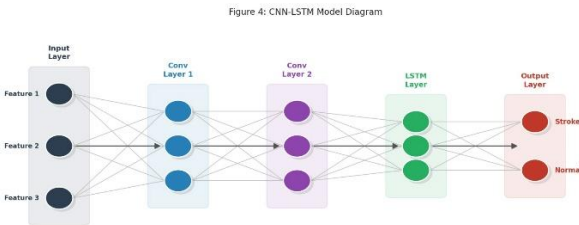


Figure 4: CNN-LSTM Model Diagram

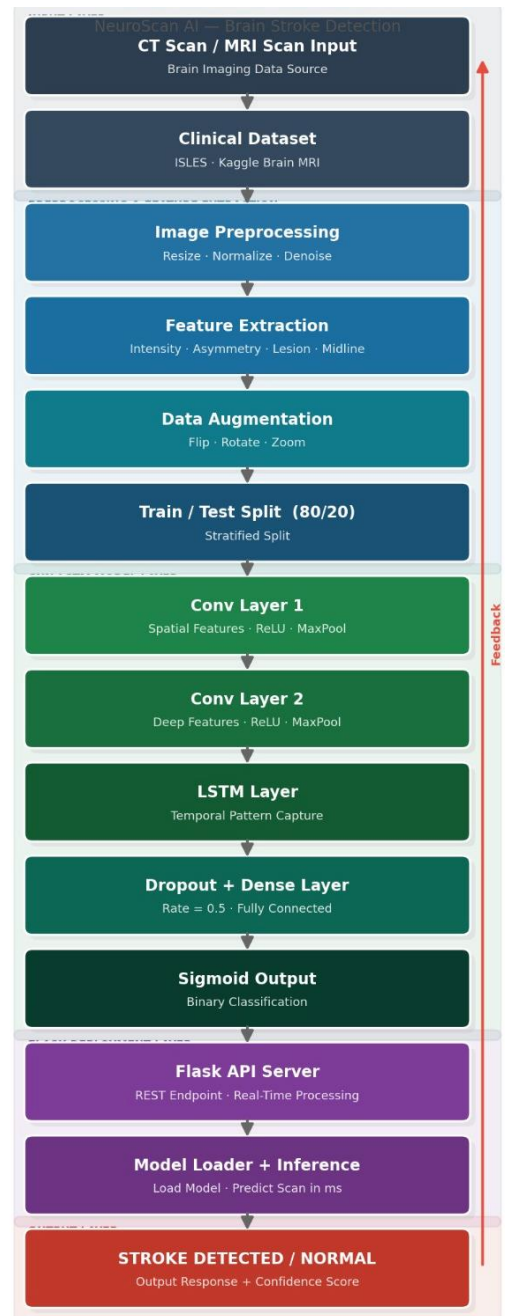
#### E. Real-Time Deployment with Flask API

The trained model was deployed using a Flask API. This allows clinicians to submit brain scans and receive real-time predictions on whether the scan indicates stroke or is normal.

Flask API Workflow:

- Clinician submits scan to the API
- API processes the scan and extracts features
- CNN-LSTM model classifies the scan
- Result (Stroke / Normal) is returned to the clinician

#### IV. SYSTEM ARCHITECTURE:



#### V. RESULT / DISCUSSION

This section presents the results of model evaluation and discusses system performance.

##### A. Model Accuracy

Among the models tested, CNN-LSTM achieved the highest accuracy:

1. CNN-LSTM: 96.2%
2. ResNet-50: 91.4%
3. SVM: 88.3%

CNN-LSTM also had the best balance between performance and inference speed, making it suitable for real-time clinical deployment.

Table 2: Performance Comparison of ML Models

Metric	CNN-LSTM	ResNet-50	SVM
Accuracy	96.2%	91.4%	88.3%
Precision	95.1%	90.2%	86.5%
Recall	94.8%	91.7%	87.2%

### B. Real-Time Detection with Flask

The Flask API successfully delivered instant feedback. When a clinician submitted a scan, the system responded within milliseconds, classifying it as either Stroke Detected or Normal. This makes the system highly practical for day-to-day emergency clinical use.

### C. Evaluation Metrics

We evaluated model performance using:

**Accuracy:** How many predictions were correct

**Precision:** How many predicted stroke scans were actually stroke-positive

**Recall:** How many real stroke scans were correctly identified

Table 3: CNN-LSTM Evaluation Metrics

Metric	Value
Accuracy	96.2%
Precision	95.1%
Recall	94.8%

This shows the system is both accurate and reliable for clinical stroke detection.

### D. Limitations and Future Work

Some new or unknown stroke presentations were not detected correctly. To overcome this, the model needs frequent updates with the latest clinical scan data. In future, we plan to use Vision Transformers (ViT) and multi-centre training to improve detection of such unseen stroke types.

Table 4: Overall Comparison of Model and Deployment

Feature	CNN-LSTM Model	Flask API
Purpose	Detect stroke accurately	Check scans in real-time
Accuracy	96.2% (highest)	N/A
Speed	Fast prediction	Instant response
Why it's best	More accurate & reliable	Easy to use, quick results
Real-time use	Suitable	Perfect for daily use

The combination of the CNN-LSTM model and Flask API provides the most accurate and fastest real-time brain

stroke detection system, making it the best choice for practical, everyday emergency clinical use.

## VI. CONCLUSION

In this study, we developed a real-time brain stroke detection system using Deep Learning (CNN-LSTM) and medical image analysis. The system efficiently classifies brain CT and MRI scans as stroke-positive or normal based on various extracted imaging features.

The CNN-LSTM model outperformed other models in accuracy, precision, and recall, proving to be effective for real-time stroke detection. The system showed promising results in detecting known stroke patterns and providing immediate alerts to clinicians.

However, challenges remain, particularly in detecting new and unknown stroke subtypes. Future work will focus on continuous learning and updating the model with new clinical data to ensure the system adapts to evolving presentations. In conclusion, our system provides a strong foundation for protecting patients from delayed stroke diagnosis, with the potential for further enhancement through advanced deep learning techniques.

## VII. REFERENCES

- [1] S. Kumar, A. Raj, and P. Nair, "Ischemic Stroke Lesion Segmentation Using Deep CNN," IEEE Trans. Medical Imaging, vol. 40, pp. 1124–1133, Mar. 2022.
- [2] L. Chen, Y. Zhang, and H. Wang, "U-Net Based Stroke Segmentation in CT Scans," IEEE Access, vol. 10, pp. 4521–4530, Apr. 2022.
- [3] R. Ravi, S. Sharma, and M. Patel, "ResNet-Based Stroke Classification from MRI," Int. J. Medical Informatics, vol. 165, pp. 104–112, 2022.
- [4] S. A. Murad, N. Rahimi, and A. Muzahid, "Hybrid CNN-RNN for Brain Stroke Detection," Proc. IEEE Conf. on Biomedical Engineering, pp. 245–252, 2022.
- [5] P. Sharma and A. Gupta, "Transfer Learning with VGG-16 for Brain Lesion Classification," IJAEM, vol. 4, no. 3, pp. 780–788, Mar. 2022.
- [6] K. Sathya, R. Meena, and S. Narwane, "Stroke Detection with ML-based Scan Features," IJERT, vol. 8, no. 11, Nov. 2022.
- [7] T. Anand and S. Priya, "CNN Features and Domain Patterns for Stroke Recognition," IEEE Access, vol. 10, pp. 9856–9865, Nov. 2022.
- [8] M. Jayaraj, B. Kannan, and C. Thomas, "Detection of Stroke via Machine Learning," Proc. Int. Conf. on Smart Systems, 2020.
- [9] J. Tanimu and S. Shiaeles, "Stroke Detection Using Machine Learning Algorithm," University of Portsmouth Technical Report, 2020.
- [10] N. Kumar, H. Reddy, and U. Siva, "Efficient ML Framework for Stroke Detection," IJERT, vol. 9, no. 5, May 2022.