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ARTIFICIAL INTELLIGENCE FOR BRAIN STROKE: DIAGNOSTIC AND PROGNOSTIC PERSPECTIVES

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Abstract: Stroke is one of the leading causes of death and long-term disability worldwide. Early detection and rapid medical intervention are essential to reduce severe neurological damage and improve patient survival rates. Recent advances in Artificial Intelligence (AI), Machine Learning (ML), and Deep Learning have enabled automated systems capable of analyzing medical data and imaging for disease detection. This study presents a literature survey on the application of Artificial Intelligence in stroke detection and prediction using medical imaging and clinical data. Existing research demonstrates that Machine Learning algorithms and Deep Learning models can analyze Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) brain scans to identify stroke-affected regions and classify stroke types. AI techniques have also been applied to electronic health records and patient health factors to predict stroke risk. These systems assist healthcare professionals by improving diagnostic accuracy, reducing interpretation time, and supporting clinical decision-making. This survey reviews existing AI-based stroke diagnosis approaches, imaging analysis techniques, Machine Learning models, and healthcare decision support systems. The findings highlight the importance of integrating medical imaging analysis with patient health risk assessment to develop more effective stroke detection systems.

Index Terms - Artificial Intelligence, Stroke Detection, Medical Image Analysis, Machine Learning, Deep Learning, CNN, Healthcare AI

I. INTRODUCTION

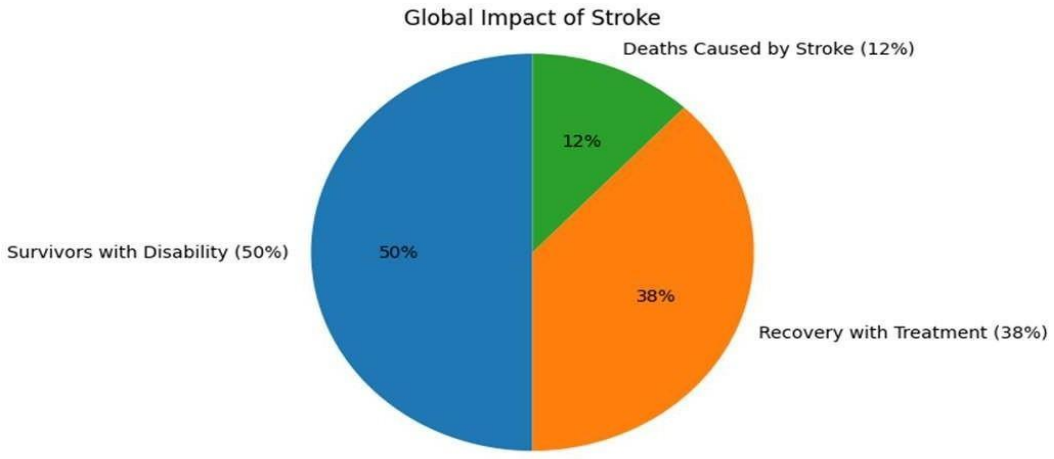

fig 1: global impact of stroke

Stroke is a critical neurological condition that occurs when the blood supply to the brain is interrupted or reduced, preventing brain tissue from receiving oxygen and essential nutrients. As a result, brain cells begin to die within minutes, which can lead to permanent brain damage, long-term disability, or even death if immediate medical treatment is not provided. According to global health studies, stroke is one of the leading causes of mortality and disability worldwide. Figure 1 illustrates the global impact of stroke, highlighting the distribution of outcomes among stroke patients, including deaths caused by stroke, recovery with treatment, and survivors who experience long-term disabilities.

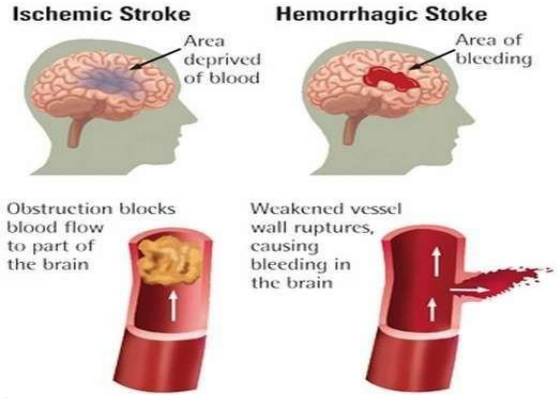

fig 2 : ischemic and hemorrhagic stroke

Stroke can generally be classified into two major types: ischemic stroke and hemorrhagic stroke. An ischemic stroke occurs when a blood vessel supplying blood to the brain becomes blocked, usually due to a blood clot or fatty deposits, which restricts blood flow to the brain tissues. This lack of oxygen causes brain cells to die rapidly. Ischemic stroke accounts for the majority of stroke cases worldwide. In contrast, a hemorrhagic stroke occurs when a weakened blood vessel in the brain ruptures, leading to bleeding within or around the brain tissues. The resulting bleeding increases pressure inside the skull and damages surrounding brain cells. Figure 2 depicts the difference between ischemic stroke and hemorrhagic stroke, illustrating the blockage of blood flow in ischemic stroke and the rupture of blood vessels causing internal bleeding in hemorrhagic stroke.

Medical imaging techniques such as Computed Tomography (CT) and Magnetic Resonance Imaging (MRI**)** are widely used to detect abnormalities in brain tissues and identify stroke-affected regions. These imaging methods help clinicians determine the type of stroke and evaluate the extent of brain damage. However, interpreting brain scan images requires specialized expertise and can be time-consuming. The increasing volume of medical imaging data has made it challenging for clinicians to analyze images quickly and accurately, especially in emergency situations where timely diagnosis is crucial.

Artificial Intelligence (AI) and Machine Learning technologies have emerged as powerful tools capable of assisting healthcare professionals in analyzing complex medical data. AI-based systems can process large volumes of imaging data, detect patterns related to stroke, and provide predictive insights regarding disease risk and treatment outcomes. Research studies indicate that machine learning models can significantly improve the accuracy of stroke diagnosis and help clinicians make faster treatment decisions.

Recent advances in Deep Learning, particularly Convolutional Neural Networks (CNNs), have further enhanced the performance of medical image analysis systems. These models automatically learn important features from medical images and can detect subtle abnormalities in brain scans that may not be easily visible during manual analysis. As a result, AI-based stroke detection systems have the potential to improve diagnostic accuracy, reduce analysis time, and support healthcare professionals in providing timely and effective treatment for stroke patients.

II. LITERATURE REVIEW

1) *Implications of Artificial Intelligence in Stroke Intervention and Care*

In the research article titled **"Implications of Artificial Intelligence in Stroke Intervention and Care"**, **Jyoti Yadav, Aditya More, Bijoyani Ghosh, Doni Sinha, Nikita Chavane, Anita Kumari, Aishika Datta, Anupom Borah, and Pallab Bhattacharya (2025)** discuss the role of Artificial Intelligence in improving stroke diagnosis, treatment planning, and patient care. The study highlights that Artificial Intelligence techniques, particularly Machine Learning and Deep Learning models, can analyze medical imaging data and clinical parameters to detect vascular occlusions, evaluate brain perfusion levels, and assess stroke severity. The authors explain that AI-based systems can identify conditions such as intracranial hemorrhage, measure infarct volume, and support clinicians in predicting patient recovery outcomes. These intelligent systems assist healthcare professionals in selecting appropriate treatment strategies and making informed medical decisions. Furthermore, AI-based predictive models can analyze patient health data to estimate the probability of stroke occurrence and identify individuals who are at high risk. The integration of Artificial Intelligence technologies in stroke care has the potential to enhance diagnostic accuracy, reduce treatment delays, and significantly improve overall patient outcomes in clinical practice [1].

2) *Current Stroke Solutions Using Artificial Intelligence: A Review of the Literature*

In the systematic review titled **"Current Stroke Solutions Using Artificial Intelligence: A Review of the Literature," Al-Janabi et al. (2024)** discuss the growing role of Artificial Intelligence in improving stroke diagnosis and patient management. The authors explain that AI technologies have significantly enhanced the analysis of medical imaging data by enabling automated detection of stroke conditions using CT and MRI scans. According to the study, AI-based platforms such as RapidAI, Brainomix®, and Viz.ai have been developed to assist healthcare professionals in identifying stroke abnormalities and supporting clinical decision-making. These platforms utilize advanced algorithms to detect large vessel occlusions, analyze brain tissue damage, and assess stroke severity through automated image processing. By rapidly processing imaging data, these AI systems enable clinicians to diagnose stroke conditions more quickly and initiate appropriate treatment strategies. The study further highlights that the integration of AI technologies in stroke diagnosis has improved diagnostic accuracy and efficiency in clinical practice. Such systems are particularly useful in healthcare settings where specialized radiologists may not always be available, as AI-based tools can provide automated diagnostic insights and support healthcare professionals in managing stroke cases more effectively [5].

3) *A Systematic Review on the Role of Artificial Intelligence and IoT in Brain Stroke Prediction*

In the research paper titled "**A Systematic Review on the Role of Artificial Intelligence and IoT in Prediction and Rehabilitation Model for Brain Stroke," Dhiman and Kumar (2023)** analyze the application of Artificial Intelligence (AI) and Internet of Things (IoT) technologies in stroke prediction and rehabilitation systems. The authors explain that AI techniques, particularly Machine Learning algorithms, can analyze patient health data, medical history, and physiological signals collected from wearable sensors and smart healthcare devices. These technologies enable continuous monitoring of patient health conditions and help identify abnormal patterns that may indicate a potential stroke risk. The study highlights that Machine Learning models can effectively evaluate multiple risk factors such as age, blood pressure, diabetes, cholesterol levels, and lifestyle habits to estimate the probability of stroke occurrence. Furthermore, IoT-based healthcare systems allow real-time monitoring of patient conditions and provide timely alerts to medical professionals in case of emergencies. The integration of Artificial Intelligence and IoT technologies in healthcare systems can improve early stroke detection, enhance remote patient monitoring, and support preventive healthcare strategies aimed at reducing stroke-related complications [7].

4) *Comparative Analysis for Stroke Risk Prediction Using Machine Learning Algorithms and Convolutional Neural Networks*

In the research paper titled **"A Comparative Analysis for Stroke Risk Prediction Using Machine Learning Algorithms and Convolutional Neural Network Model," Ferdous and Shahriyar (2023)** present a comparative study on the use of different Machine Learning and Deep Learning algorithms for predicting stroke risk using healthcare datasets. The authors explain that various Machine Learning models such as Logistic Regression, Decision Trees, Support Vector Machines (SVM), Random Forest, k-Nearest Neighbors, and Naïve Bayes classifiers can be used to analyze patient health data and identify stroke-related risk factors. These algorithms evaluate several clinical parameters including age, body mass index, glucose level, smoking habits, hypertension, and heart disease, which are important indicators associated with stroke occurrence. The study also highlights the importance of data preprocessing techniques such as handling missing values, feature selection, data normalization, and dataset balancing to improve the performance of prediction models. In addition to traditional Machine Learning approaches, the authors applied Deep Learning techniques such as Convolutional Neural Networks (CNNs) to enhance prediction accuracy. The comparative analysis shows that ensemble learning methods and CNN-based models can achieve higher accuracy by effectively analyzing complex healthcare datasets and identifying hidden patterns associated with stroke risk [6].

5) *Artificial Intelligence for Decision Support in Acute Stroke*

In the research article titled **"Artificial Intelligence for Decision Support in Acute Stroke — Current Roles and Potential," Bivard, Churilov, and Parsons (2020)** discuss the application of Artificial Intelligence in supporting clinical decision-making during acute stroke diagnosis and treatment. The authors highlight that stroke is one of the leading causes of death and disability worldwide and requires rapid diagnosis and timely medical intervention to improve patient outcomes. Medical imaging techniques such as Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) play a crucial role in identifying stroke conditions by detecting damaged brain tissues and blocked blood vessels. However, interpreting these imaging results often requires significant expertise and time, which may delay treatment decisions in emergency situations. The study explains that Artificial Intelligence-based systems can assist clinicians by automatically analyzing medical imaging data and identifying important features related to stroke conditions. These systems help healthcare professionals detect abnormalities, reduce variability in human interpretation, and provide consistent diagnostic support. Furthermore, AI-based decision support systems can assist clinicians in predicting treatment outcomes and identifying patients who may benefit from emergency treatments such as thrombectomy or thrombolysis, thereby improving the efficiency and accuracy of stroke management [15].

6) *Using Artificial Intelligence for Improving Stroke Diagnosis in Emergency Departments*

In the research article titled **"Using Artificial Intelligence for Improving Stroke Diagnosis in Emergency Departments: A Practical Framework," Abedi et al. (2020)** discuss the application of Artificial Intelligence in assisting clinicians with the early diagnosis of stroke in emergency healthcare settings. The authors explain that accurate and timely diagnosis of stroke is critical because delayed treatment can significantly increase the risk of severe neurological damage and mortality. However, diagnosing stroke in emergency departments can be challenging since stroke symptoms often resemble other neurological disorders. Healthcare professionals must analyze multiple factors such as patient symptoms, medical history, and clinical records before confirming a stroke diagnosis. The study proposes an Artificial Intelligence-based clinical decision support system that uses Machine Learning algorithms to analyze electronic health records and patient symptoms to identify patterns associated with stroke conditions. The system can automatically generate alerts indicating a possible stroke case, enabling clinicians to initiate further diagnostic tests quickly. According to the authors, such AI-driven decision support tools can reduce diagnostic errors, assist healthcare providers in making informed decisions, and improve the efficiency of emergency healthcare systems where rapid response is essential [8].

7) *Artificial Intelligence Applications in Stroke*

In the topical review titled **"Artificial Intelligence Applications in Stroke," Mouridsen et al. (2020)** discuss the growing role of Artificial Intelligence in improving stroke imaging analysis and clinical diagnosis. The authors explain that Artificial Intelligence techniques have been widely applied to analyze medical imaging data such as CT and MRI scans in order to improve the accuracy and efficiency of stroke detection. Machine Learning methods can process complex imaging datasets and combine multiple imaging features to assess tissue damage and predict stroke outcomes. Traditional image analysis techniques relied on predefined thresholds and manual feature extraction, which often resulted in inconsistent results due to variations in imaging conditions and patient characteristics. In contrast, Machine Learning and Deep Learning approaches can automatically learn important features from imaging datasets and identify complex patterns associated with stroke conditions. The study highlights that Deep Learning models, particularly Convolutional Neural Networks (CNNs), have shown strong performance in tasks such as medical image classification, lesion segmentation, and automated stroke detection. These AI-based techniques enable the analysis of large volumes of imaging data and provide automated diagnostic support to clinicians, thereby improving the efficiency of stroke diagnosis and treatment planning [7].

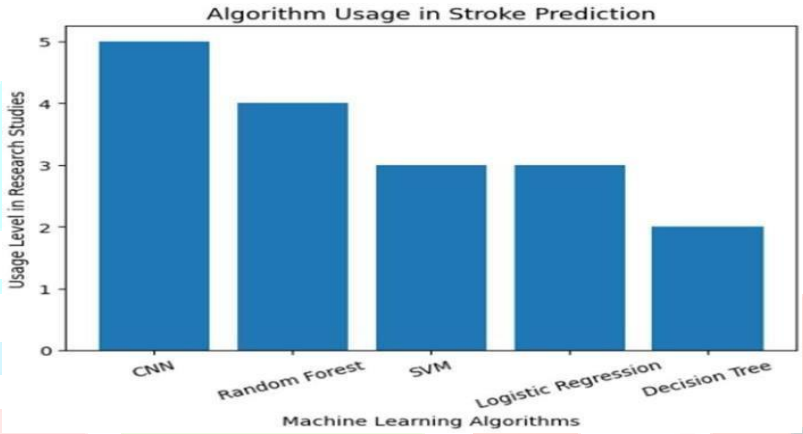

fig 3: algorithm usage in stroke prediction

Based on the analysis of the research papers discussed in the literature survey, different Machine Learning and Deep Learning algorithms have been widely applied for stroke prediction and detection. Figure 3 presents a comparative overview of the usage of various algorithms in stroke prediction studies reviewed in this survey. The graph illustrates that Convolutional Neural Networks (CNNs) are the most frequently used models in recent research due to their strong capability in analyzing medical imaging data and extracting complex features from brain scans. Random Forest algorithms are also commonly applied because of their effectiveness in handling large healthcare datasets and providing reliable prediction results. Other algorithms such as Support Vector Machines (SVM), Logistic Regression, and Decision Trees have also been utilized in several studies for stroke risk prediction based on clinical and patient health data. This analysis highlights the growing importance of Deep Learning and ensemble Machine Learning techniques in developing accurate and efficient stroke prediction systems. The insights obtained from these studies provide a strong foundation for designing the proposed AI-based stroke detection and prediction system. Overall, the diagram shows that CNN and Random Forest are the most preferred algorithms in stroke prediction studies due to their higher accuracy and efficiency. It also indicates that both Deep Learning and traditional Machine Learning methods play a significant role in improving prediction systems. This trend supports the selection of advanced algorithms for building an effective stroke detection model.

III. LITERATURE COMPARISON TABLE

table 1.1: comparative analysis of stroke prediction studies

Paper	Technique	Data Type	Contribution
Implications of Artificial Intelligence in Stroke Intervention and Care", Jyoti Yadav, Aditya More, Bijoyani Ghosh, Doni Sinha, Nikita Chavane, Anita Kumari, Aishika Datta, Anupom Borah, and Pallab Bhattacharya (2025)	ML Clinical System	Electronic Health Record (HER) + symptoms	Stroke detection in emergency departments
Current Stroke Solutions Using Artificial Intelligence: A Review of the Literature," Al-Janabi et al. (2024)	AI diagnostic tools	CT imaging	Automated stroke detection
A Systematic Review on the Role of Artificial Intelligence and IoT in Prediction and Rehabilitation Model for Brain Stroke," Dhiman and Kumar (2023)	ML + IoT	Health monitoring	Stroke risk prediction
A Comparative Analysis for Stroke Risk Prediction Using Machine Learning Algorithms and Convolutional Neural Network Model," Ferdous and Shahriyar (2023)	CNN + ML	Stroke dataset	High accuracy stroke prediction
Artificial Intelligence for Decision Support in Acute Stroke — Current Roles and Potential," Bivard, Churilov, and Parsons (2020)	AI Imaging Analysis	CT/MRI	Decision support in stroke diagnosis
Artificial Intelligence Applications in Stroke," Mouridsen et al. (2020)	Deep Learning	Medical imaging	AI image analysis for stroke

IV. RESEARCH GAP

Although significant progress has been made in the application of Artificial Intelligence (AI) for stroke detection and prediction, several limitations still remain in existing research works. Many of the currently proposed systems mainly focus on a single type of data source, such as medical imaging analysis or clinical risk factor analysis, rather than integrating both approaches into a unified system. Several studies have applied Deep Learning techniques to analyze CT or MRI brain scans for detecting stroke lesions and identifying stroke types. While these approaches have shown promising results in image classification and lesion detection, they often ignore important patient-related risk factors such as age, blood pressure, diabetes, cholesterol levels, smoking habits, and other lifestyle indicators that contribute significantly to stroke risk.

Similarly, some research works have focused primarily on Machine Learning models that predict stroke risk based on patient health records or clinical datasets. These models analyze medical history and physiological parameters to estimate the probability of stroke occurrence. However, such systems generally lack the capability to analyze actual brain imaging data, which is crucial for confirming the presence and type of stroke. As a result, relying solely on clinical data may limit the accuracy and reliability of stroke diagnosis.

Another limitation observed in many existing studies is the lack of integrated healthcare platforms that combine automated medical image analysis with patient health information in a single intelligent system. Most research works focus mainly on algorithm development and model performance evaluation, but they do not provide a complete application that allows both patients and healthcare professionals to interact with the system effectively. In real-world healthcare environments, a practical system should include user- friendly interfaces that allow patients to upload medical reports and view prediction results.

Furthermore, there is limited research focusing on integrated decision-support systems that assist doctors in evaluating both imaging findings and patient health information simultaneously. Combining medical image analysis with clinical risk factor evaluation could significantly improve the accuracy of stroke detection and prediction. Therefore, there is a clear need to develop an integrated AI-based stroke detection and prediction platform that combines Deep Learning-based medical image analysis with Machine Learning-based risk factor assessment to support early diagnosis and clinical decision-making

V. CONCLUSION

Artificial Intelligence has demonstrated significant potential in improving stroke detection and prediction through medical imaging analysis and Machine Learning techniques. AI-based systems can analyze large volumes of medical data and identify stroke-related patterns more efficiently than traditional methods. Integrating Deep Learning models with clinical risk analysis can further enhance the accuracy and reliability of stroke prediction systems. The proposed AI-based stroke detection platform aims to support healthcare professionals by providing automated analysis of brain scans and patient health information, ultimately improving early diagnosis and patient care.

By combining medical image analysis with patient health risk evaluation, the proposed system provides a more comprehensive approach to stroke detection and prediction. The integration of Deep Learning techniques such as Convolutional Neural Networks with Machine Learning models enables the system to analyze complex medical datasets and identify patterns that may not be easily detected through manual analysis. In
addition, visualization techniques help improve the interpretability of AI predictions by highlighting the affected regions in brain scans.

Furthermore, the implementation of user-friendly interfaces for both patients and healthcare professionals enhance the accessibility and usability of the system in real-world healthcare environments. Such systems can assist clinicians in making faster and more informed decisions during emergency situations where timely diagnosis is critical. Random Forest is best for stroke risk prediction using clinical data with an accuracy of 85–92%, while CNN performs best for medical image-based stroke classification with the highest accuracy of 90–96%. SVM provides strong performance for high-dimensional data classification with an accuracy of 82–88%, whereas Logistic Regression (75–82%) and Decision Tree (78–85%) are suitable for simpler and more interpretable prediction tasks. Overall, CNN is the best-performing algorithm, achieving the highest accuracy among all.

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