StrokeAlert: Early Detection of Minor Strokes

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***Abstract*—Stroke is a critical global health issue, with minor strokes often going undetected due to subtle symptoms. These minor events are key indicators of potential major cerebrovascular issues and, if untreated, can lead to severe health deterioration. This paper presents StrokeAlert, a mobile application for the early detection of minor strokes using the FAST criteria (Face, Arms, Speech, Time). The app employs image analysis, speech recognition and arm weakness detection technologies to detect stroke symptoms in real time using deep learning algorithms. Testing demonstrated an 83.84% accuracy in facial drooping detection, 96.33% in speech difficulty evaluation and 88% in arm weakness detection. StrokeAlert offers an accessible, user-friendly solution that could significantly enhance early intervention and reduce stroke-related complications.**

Keywords— Stroke Detection, Mobile Health Technology, Early Intervention, Telemedicine Integration, Cerebrovascular Health, FAST Criteria

I. INTRODUCTION

Stroke remains a global public health challenge, with minor strokes often going undetected due to their subtle symptoms. Despite their transient nature, minor strokes are critical warning signs of more severe cerebrovascular events. When left undiagnosed, they can have lasting effects on physical and cognitive health and increase the risk of recurrent, life-threatening strokes.

Public awareness and prompt detection of minor strokes are essential for improving patient outcomes. However, awareness remains low, especially among high-risk groups such as the elderly and those in underserved communities. This delay in recognition often leads to preventable complications due to delayed medical intervention.

The StrokeAlert app addresses this gap by providing a mobile-based solution for early detection of minor strokes. Using the FAST criteria (Face, Arms, Speech, Time), the app facilitates real-time user assessments and encourages immediate action when stroke symptoms are detected. With a user-friendly interface and integrated technologies such as image analysis and speech evaluation, StrokeAlert empowers individuals to identify stroke symptoms independently, helping to prevent escalation and enhance the state of health.

The main objective of this research is to create and validate a tool that expands access to stroke detection, making it widely available to the general public. By providing early intervention capabilities without requiring clinical visits or specialized equipment, StrokeAlert contributes to ongoing efforts in improving public health through proactive stroke management.

II. LITERATURE REVIEW

Recent advancements in stroke detection technology have showcased the potential of portable devices and machine learning techniques in aiding early diagnosis and prediction. Portable tools, as reviewed by Chennareddy et al. [1], are increasingly being explored for prehospital stroke detection. These devices promise to reduce the critical time to treatment, but their real-world efficacy depends on overcoming challenges in standardizing accuracy metrics and ensuring their broader clinical adoption.

Parallelly, machine learning (ML) has emerged as a potent force in improving stroke outcomes. Mainali et al. [2] illustrate the strengths of ML in stroke diagnosis and outcome prediction, yet they note that variability in patient-specific factors creates obstacles in scaling these models effectively. Tusher et al.[8] add to this narrative, demonstrating how early brain stroke prediction using machine learning can offer new insights into patient risk stratification. However, as both studies highlight, the heterogeneity of clinical data and patient characteristics remains a significant hurdle to achieving highly accurate and scalable predictions. Similarly, Gupta et al. [3] emphasize that while IoT-enabled deep learning frameworks show promise in stroke prediction, inconsistencies in data collection and quality present a major barrier to their widespread implementation.

Mobile applications further expand the horizon of stroke management, with significant strides made in early detection. Studies by Pirani et al. [5] and Dedin et al. [6] illustrate the utility of mobile applications for detecting early stroke symptoms. Despite their potential, these apps frequently face hurdles related to clinical validation and real-world efficacy. For instance, Bonura et al. [7] stress that mobile applications must undergo more rigorous validation before they can become reliable tools in stroke management.

The existing solutions, while promising, often focus on diagnosing major strokes and require expensive equipment or clinical visits, limiting their accessibility. The detection of minor strokes, which carry substantial risks of escalating into major health issues, remains underserved. This is the gap that the StrokeAlert app aims to address. StrokeAlert simplifies stroke detection by focusing on minor strokes using widely recognized diagnostic criteria such as FAST (facial drooping, arm weakness, speech difficulties, time to call emergency services). Unlike many machines learning-based models that

require extensive technical infrastructure, StrokeAlert is designed for ease of use and accessibility without specialized equipment.

A growing body of research advocates for the integration of mobile solutions into healthcare. Studies such as those by Heron et al. [9] and Sharma et al. [4] demonstrate that mobile apps can improve patient education, post-stroke care, and minor stroke detection. However, continuous validation and refinement of these tools in clinical settings are essential to ensure their impact on stroke prevention and management.

In conclusion, while significant advancements have been made in stroke detection technology, a clear need persists for more accessible, validated tools tailored to detecting minor strokes. The StrokeAlert app seeks to fill this gap by offering a user-friendly platform that leverages established diagnostic methods to enable early intervention. Through continuous updates and validation, StrokeAlert stands poised to significantly influence the landscape of stroke prevention.

III. Methodology

The app is designed to provide a systematic approach for the early detection of minor strokes. The app utilizes a multi-module system, each dedicated to assessing different stroke symptoms based on the FAST (Face, Arms, Speech, Time) criteria.

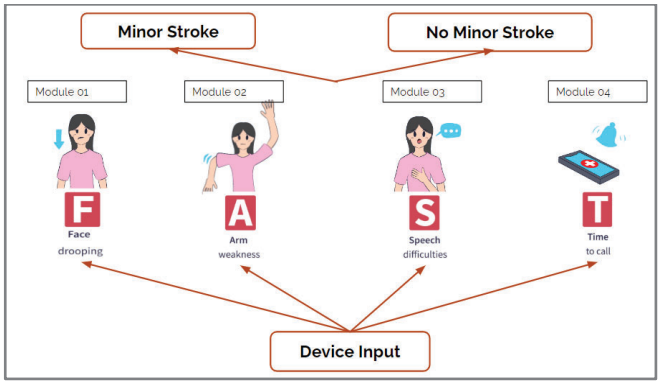

Fig. 1. System Workflow

The FAST diagram shown in Fig.1 is a quick reference tool for identifying stroke symptoms, emphasizing:

1) F for Face Drooping: Check for facial asymmetry.
2) A for Arm Weakness: Observe if one arm drifts when raised.
3) S for Speech Difficulties: Listen for slurred or unusual speech.
4) T for Time to Call: Stressing the urgency to call emergency services if symptoms are present.

It distinguishes between signs of a minor stroke and their absence, underscoring the importance of immediate action and seeking medical advice.

A. User Interface and Input:

The app's workflow begins by presenting users with an intuitive interface that guides them through a series of tasks to evaluate potential stroke symptoms. The system is divided into four modules, each focused on assessing a specific aspect of stroke-related conditions.

1) Module 01 - Facial Drooping Detection:

The facial detection feature prompts users to smile or show their teeth. The app captures and analyzes the user's facial structure to check for asymmetry—an early indicator of stroke. The detection relies on a visual comparison of facial features to identify any signs of drooping.

2) Module 02 - Arm Weakness Assessment:

In this module, users are instructed to raise both arms and maintain them in an elevated position for a set period. The app monitors the user's arm position and strength by tracking movements to determine if one arm drifts or drops—a possible sign of arm weakness associated with strokes.

3) Module 03 - Speech Difficulty Evaluation:

The app asks users to repeat simple phrases, which are then evaluated for clarity and pronunciation. The system checks for slurred or abnormal speech patterns that may indicate stroke-related speech difficulties.

4) Module 04 - Emergency Response Activation:

The app streamlines emergency response by detecting stroke symptoms and offering a direct call button for immediate dialing. This feature highlights how technology can shorten the gap between detection and action, potentially saving crucial time and improving stroke outcomes.

B. Data Analysis and Feedback

Each module within the app is designed to offer clear instructions and real-time feedback to users. This ensures that even those with limited technical knowledge can navigate the app easily and perform the required tasks for stroke detection. The system emphasizes user engagement, with clear prompts guiding each step of the assessment process.

C. Privacy and Security

All user data, including images and speech inputs, is processed directly on the user's device. The app maintains strict data privacy standards, ensuring that no personal information is stored or transmitted without the explicit consent of the user. The app complies with relevant data protection guidelines, safeguarding user confidentiality.

D. Continuous Monitoring

The app includes a feature for continuous monitoring, where users can periodically assess their symptoms. Regular updates are provided to refine the detection process based on user feedback and evolving best practices in symptom assessment.

This systematic methodology ensures that the app offers a straightforward and accessible tool for minor stroke detection, allowing for timely identification of symptoms and encouraging users to seek immediate medical attention when necessary.

Fig.2 shown below depicts a flowchart of a systematic methodology, starting with loading the page and input, and moving through various decision points and processes. It outlines a step-by-step approach on how the app works.

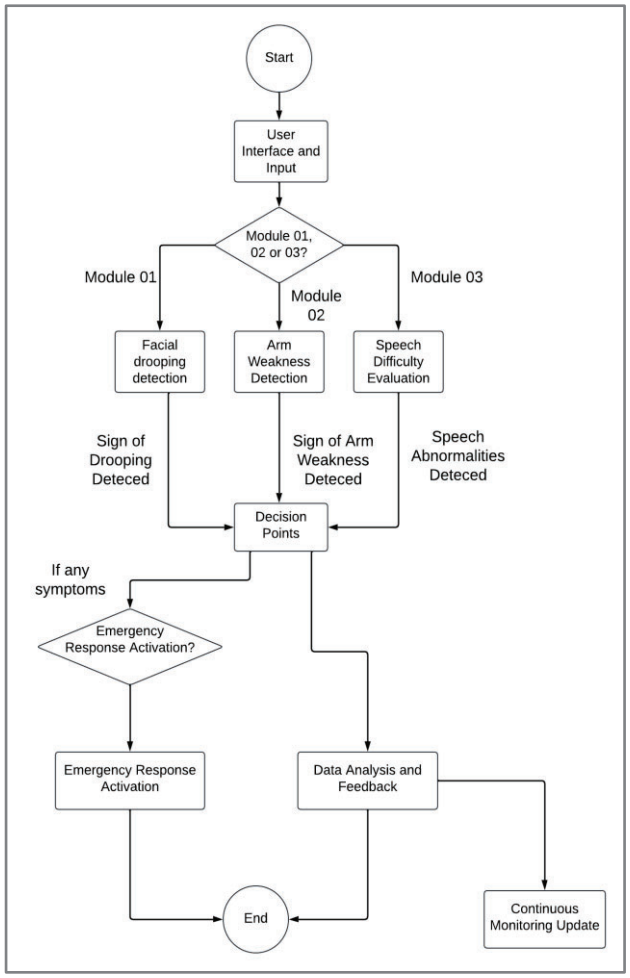

Fig. 2. Methodology

IV. Features And Functionality

The app provides a user-friendly interface for symptom input and guides users through tasks to identify stroke indicators like facial drooping, arm weakness, and speech difficulties using real-time image and speech recognition technologies. If stroke symptoms are detected, the app immediately advises contacting emergency services with an accessible emergency button. It also includes continuous monitoring and regular updates to improve algorithm accuracy. This application is compatible with both Android and iOS platforms.

Additionally, the app serves as an educational tool, increasing public awareness about stroke symptoms and prevention, making it an essential healthcare companion for improving outcomes and potentially saving lives through timely intervention.

V. Implementation

The StrokeAlert app is developed to provide an efficient and accessible tool for real-time detection of minor strokes, focusing on a simple yet effective user experience. Its implementation emphasizes leveraging native device capabilities while ensuring high responsiveness and ease of use across different devices.

Fig. 3, which is a homepage, is adorned with a striking brain image, which invites users to engage via a prominent 'Get Started' button, setting the stage for a user-friendly experience. The symptoms page is equally intuitive, listing key symptoms reflecting the app's focus on swift user assistance.

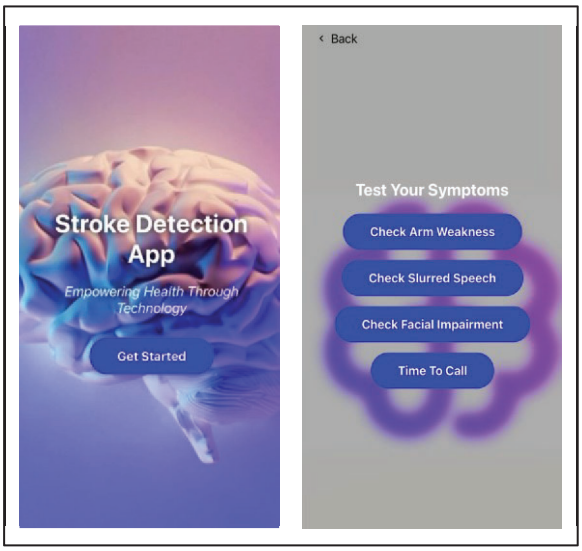

Fig. 3. Overview of UI Design - Home and Symptoms Page

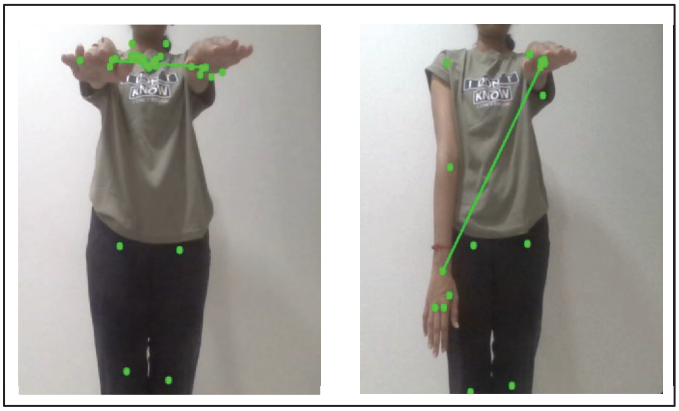

Fig. 4. Arm Weakness Detection

Fig. 4, demonstrates the Arm Weakness Detection framework TensorFlow's Pose Detection model to track the user's arm positions in real-time through the device's camera. It calculates the distance between the user's wrists and if the distance is greater than the threshold, it indicates potential arm weakness and alerts the user. The detected arm positions are also displayed on the camera feed.

Fig. 5 illustrates slurred speech detection, which analyzes acoustic properties of speech. By recording and processing a user's voice, the system identifies characteristics like prolonged vowels or imprecise consonants. If these traits align with predefined patterns, the system flags potential slurred speech, offering real-time feedback for early detection and management.

Fig. 6 shows the app's "Facial Impairment" feature, which allows users to upload or capture an image for analysis. The system checks for facial asymmetry that could indicate paralysis and provides a simple result: "Facial impairment detected" or "Facial impairment not detected." This feature serves as an initial screening tool, prompting users to seek further medical evaluation if impairment is detected.

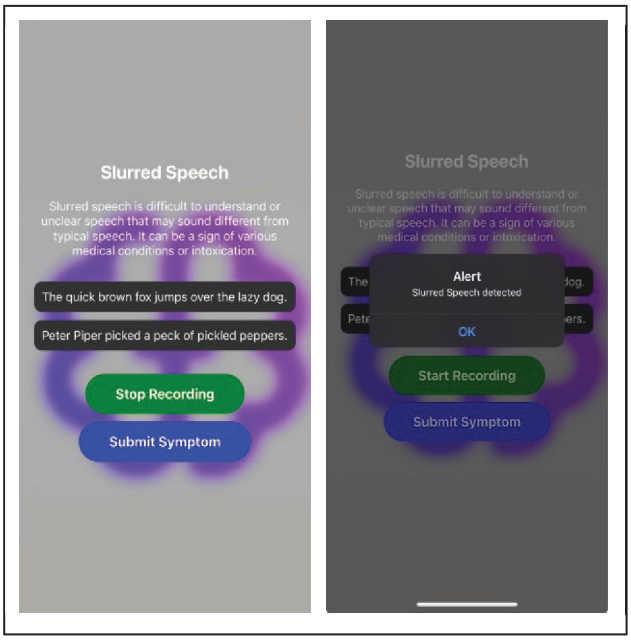

Fig. 5. Slurred Speech Detection

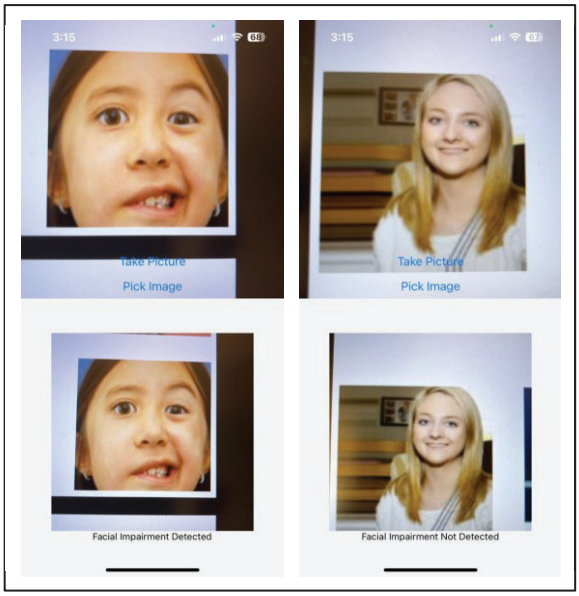

Fig. 6. Facial Impairment Recognition [11]

VI. Discussions

The app has demonstrated promising results for the testing set, highlighting its potential as an accessible tool for early stroke detection.

A. Symptom Detection Accuracy

Using simulated data, the accuracy of the app's individual symptom detection modules varied slightly across different criteria. As shown in Table 1, the facial drooping detection module achieved an accuracy of 83.84%, while the speech difficulty module showed accuracy of 96.33%. These results suggest that the app performs reliably in detecting stroke symptoms.

The Arm Weakness detection module was tested 50 times with healthy individuals simulating weakness, achieving 44 correct detections, indicating promising accuracy of 88% in controlled tests

TABLE I.

Sr. No.	Symptom Detection Accuracy				
	Symptom Detection Module	*Test Dataset*	*True Positives (%)*	*False Positives (%)*	*Accuracy (%)*
01	Facial Drooping Detection	960	830	160	83.84
02	Speech Difficulty Evaluation	300	289	11	96.33

B. Public Health Impact

From a public health perspective, the widespread adoption of the app could significantly reduce the incidence of severe strokes. By promoting awareness and facilitating early detection, the app addresses two crucial aspects of stroke prevention—education and timely medical intervention. Moreover, the app's data collection capabilities could provide valuable insights into stroke prevalence and outcomes, informing future public health policies and interventions.

VII. Conclusion

The StrokeAlert app introduces a novel approach to minor stroke detection by leveraging mobile technology to provide real-time assessments based on the widely recognized FAST criteria. With its user-friendly interface and accessibility across both Android and iOS platforms, the app stands to significantly improve early detection and prompt intervention, particularly for individuals who might not have immediate access to clinical care. By empowering users to assess stroke symptoms independently, StrokeAlert has the potential to enhance public awareness and contribute to better health outcomes.

While the app has demonstrated promising results for testing sets, further validation in real-world clinical environments is essential to ensuring its accuracy and reliability. Nevertheless, StrokeAlert serves as an important step forward in the integration of mobile health technology into stroke prevention and care, offering a practical, widely accessible solution for early stroke detection.

The app's impact on reducing stroke-related complications through early identification highlights its importance as a tool for proactive healthcare management. As the app progresses toward deployment, it represents a valuable contribution to the ongoing efforts in public health to minimize the burden of strokes and improve patient outcomes.

VIII. Future Scope

The StrokeAlert app holds significant potential for further development and expansion. As the app moves toward full deployment, several key areas of future work could enhance its capabilities and broaden its impact:

A. Deployment Considerations:

Future work will involve real-world deployment, clinical validation, and further refinement to ensure effectiveness across diverse scenarios. Further refinement will be necessary to validate its effectiveness and performance across diverse scenarios.

B. Telemedicine Integration:

Adapting the app for telemedicine platforms to enable remote diagnosis and consultations, providing a critical service for patients in distant or underserved areas.

C. Advanced Diagnostics:

Investing in the ongoing development of sophisticated machine learning models to enhance the app's diagnostic precision and speed, thereby improving patient outcomes.

These potential developments aim to not only refine the app's capabilities but also broaden its application to address a wider spectrum of healthcare challenges, ultimately contributing to the global effort in stroke care and prevention.

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