# AN INTELLIGENT ALERT SYSTEM FOR FACIAL PARALYSIS DIAGNOSIS

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***Abstract:*** *Facial paralysis is a medical condition that can significantly impact a patient's quality of life, and timely diagnosis is critical for effective treatment and rehabilitation. However, in many clinical and remote settings, early detection remains a challenge due to limited access to specialists and diagnostic resources. This project addresses the need for accessible and rapid screening by proposing an intelligent alert system for facial paralysis diagnosis. The proposed solution comprises a cross-platform mobile application developed using Flutter, coupled with a backend that employs deep learning techniques—specifically convolutional neural networks (CNNs), with ResNet-50 as the backbone architecture—to analyze facial images for signs of paralysis. Users can select existing facial images from the device's storage through the mobile app, which are then processed by the backend to detect potential indicators of facial paralysis. Upon detection, the system delivers real-time alerts to users via WebSocket communication, ensuring prompt notification and response. This system is designed to support multiple healthcare scenarios. In clinical practice, it assists medical professionals by automatically flagging suspected cases, thereby expediting diagnosis and intervention. In telemedicine and mobile health contexts, it enables remote screening and monitoring, making it especially valuable in underserved or resource-limited environments. The application features push notifications and an intuitive interface for reviewing alerts, providing an efficient, scalable, and user-friendly solution to enhance the early detection and management of facial paralysis.*

***Keywords: Facial paralysis, Deep learning, ResNet-50, Real-time alerts, Mobile application***

## 1. Introduction

The healthcare sector faces a critical shortage of specialized personnel, particularly in intensive care and neurology, where continuous patient monitoring is essential. Traditional reliance on manual observation limits caregivers to one patient, increasing the risk of overlooking early signs of time-sensitive conditions like facial paralysis. Delays in detecting facial muscle dysfunction, common in strokes or Bell's Palsy, can lead to long-term complications and reduced recovery rates. This highlights the urgent need for automated systems providing real-time, scalable monitoring to complement human oversight. Prior to technological integration, healthcare systems struggled with fragmented diagnostics, delayed communication, and geographic barriers, especially in rural and resource-limited areas. The advent of intelligent diagnostics and connected platforms has transformed care by enabling remote image analysis, instant alerts, and data-driven decision-making, bridging gaps between clinical expertise and patient needs.

The proposed Intelligent Alert System for Facial Paralysis Diagnosis combines mobile health technologies with deep learning to analyze facial images for paralysis indicators. The system processes images through convolutional neural networks (CNNs) to detect asymmetries in facial movements, a key diagnostic criterion for conditions like Bell's palsy. Suspected cases trigger instant alerts via WebSocket protocols, delivering results, timestamps, and image references to healthcare providers. This approach eliminates reliance on synchronous evaluations, allowing asynchronous triage in clinical, telemedicine, and field settings.With a Flutter-based interface, the system ensures cross-platform accessibility, supporting environments from urban hospitals to remote clinics. The real-time notification system enables proactive interventions, addressing diagnostic delays and misdiagnosis issues.

By automating early detection, the platform enhances resource allocation, reduces clinician workload, and expands access to timely care, especially in areas lacking specialists. This integration of responsive technology with clinical workflows advances precision medicine for neurological conditions.

## 2. Literature Survey

Aparna Sanapala and Milind Talele both explored the use of deep learning, specifically ResNet-50, in medical imaging and facial analysis. Sanapala's research demonstrated ResNet-50's effectiveness in diagnostic tasks, achieving high accuracy in pneumonia detection (97.65%) and Parkinson's disease diagnosis (93.4%). Talele, in his comparison of CNNs and ResNet-50 for facial emotion recognition, found ResNet-50 outperformed CNNs with an accuracy of 85.75% on the FER2013 dataset. Both studies highlighted ResNet-50's robust performance but noted the high computational cost and lack of real-time implementation, which are critical for applications like facial paralysis detection.

In contrast, Parra-Dominguez, S Raji, and Barbosa focused on classical machine learning methods for facial paralysis detection, utilizing facial symmetry analysis and landmark-based feature extraction. Parra-Dominguez employed a 68-point facial landmark model and traditional classifiers like SVM and decision trees, but the approach lacked real-time alert capabilities. Raji's review of SVM, KNN, and MLP models found SVM to be the most effective but highlighted challenges like natural facial asymmetry. Barbosa's paraFaceTest system used HOG features and ensemble regression trees, achieving good accuracy on a small dataset but also lacked deep learning techniques and real-time alerting.

These studies collectively suggest that while classical ML methods provide foundational insights, their limitations in real-time processing and accuracy emphasize the need for more advanced approaches. A hybrid system combining the strength of ResNet-50 with classical ML methods could overcome these limitations, offering an effective real-time facial paralysis detection solution. This research aims to address the challenges of real-time video input, mobile device deployment, and timely alerts for practical facial paralysis monitoring.

## 3. Proposed System

The Intelligent Alert System for Facial Paralysis Diagnosis is implemented as a mobile application that enables patients or caregivers to upload facial images directly from their devices. These images are analyzed by an intelligent deep learning model integrated within the system, which accurately classifies whether signs of facial paralysis are present. Upon detection, the system immediately sends real-time alerts to healthcare providers or concerned stakeholders, facilitating timely medical intervention. The application operates asynchronously, meaning it does not require continuous user interaction and functions autonomously in the background. This ensures uninterrupted monitoring and prompt delivery of notifications as soon as the analysis is completed, making it especially useful for remote healthcare scenarios and enhancing the overall responsiveness of facial paralysis diagnosis and management.

# 4. Methodology

This study employs a structured deep learning approach for facial paralysis detection using static images. It involves data collection, preprocessing, augmentation, and model training to ensure accuracy, reliability, and reproducibility of the proposed alert system.

## 4.1. Data Collection and Preprocessing

This research utilized two Kaggle datasets to develop a machine learning model for detecting stroke-related facial paralysis. The first dataset, containing 5,029 images of acute stroke and non-stroke cases, was augmented to improve model robustness. The second, comprising 80×80-pixel images across seven emotional expressions, was cleaned and preprocessed to remove noise and standardize inputs.

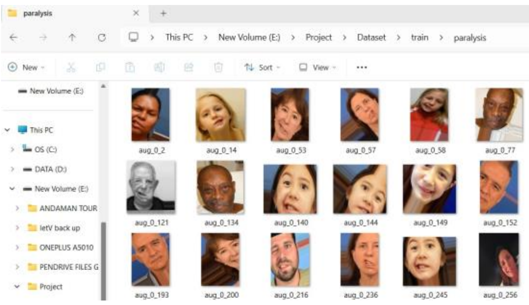

**Figure 1. Paralysis data used for training the model**

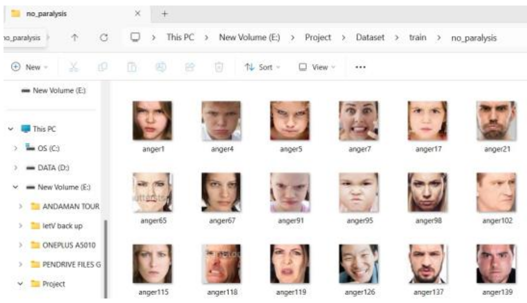

**Figure 2. Non-Paralysis data used for training the model**

A balanced dataset was created with stroke-affected images as the positive class and healthy emotional expressions as the negative class, enabling effective generalization and accurate detection of facial paralysis symptoms.

## 4.2. Class Balance and Diversity

To ensure fairness and prevent class imbalance, the dataset was constructed with a 1:1 ratio of stroke (paralysis) to non-stroke (healthy) samples. The non-stroke class was further balanced by including equal images from each emotion category.

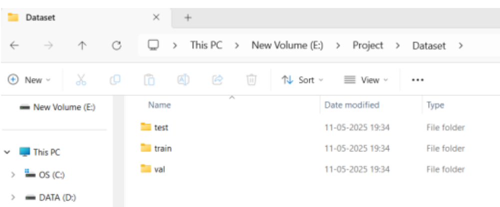


**Figure 3. Dataset divided into training, testing and validation data**

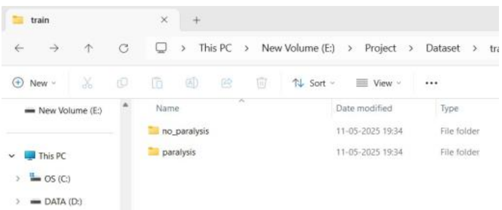


**Figure 4. Paralysis and Non- Paralysis data to train the model**

This approach aimed to improve classification accuracy, distinguish normal expressions from stroke-induced anomalies, and enhance model generalization across varied real-world facial scenarios.

### 4.3. Feature extraction

Feature extraction is essential for facial paralysis detection. This study employs ResNet50, a deep CNN, for automated feature extraction from facial images, eliminating the need for manual landmark-based methods. ResNet50 captures complex patterns and textures, enhancing generalization and reducing preprocessing effort. The system classifies images as “Paralysis” or “No Paralysis” using a Python-FastAPI backend, which processes images and sends real-time alerts via WebSockets to a Flutter-based mobile application, enabling timely and asynchronous user notifications.

### 4.4. Model Selection

ResNet50, a 50-layer deep convolutional neural network, is designed for complex image classification tasks. It employs residual blocks to overcome the vanishing gradient problem, enabling deep feature learning. The architecture includes convolutional and pooling layers, followed by global average pooling and a fully connected layer for final classification using softmax or sigmoid activation. Its ability to detect subtle facial asymmetries makes it effective for facial paralysis detection. With high accuracy, robustness, and support for transfer learning, ResNet50 is well-suited for real-time, automated healthcare applications.

### 4.5. System Architecture

The Facial Paralysis Detection System is designed as a modular solution combining deep learning, real-time communication, and user interfaces. The system captures facial images, either from stored data and analyzes them using the pre-trained ResNet50 model. Upon detecting facial paralysis symptoms, the system generates an alert with metadata such as the patient ID, timestamp, and severity score.

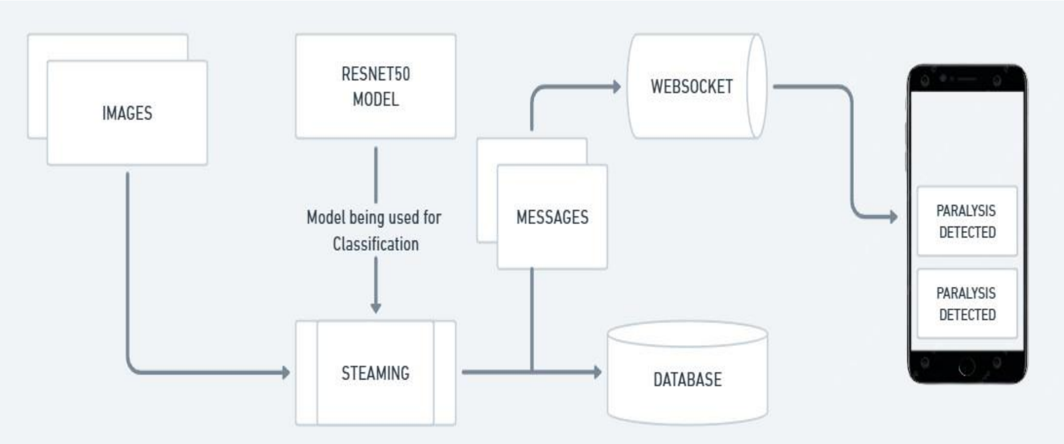


**Figure 5. Architecture of Facial Paralysis and Alert System**

Detection results are stored in a centralized database for tracking and analysis. Real-time alerts are delivered to mobile clients via WebSocket communication, ensuring immediate notifications. The Flutter-based mobile app provides caregivers and healthcare professionals with real-time alerts, scan histories, and easy access to critical information.

### 4.6. Real-Time Alerts and Mobile Integration

Detection results are stored in a centralized database for tracking and analysis. Real-time alerts are sent to mobile clients via WebSocket communication, enabling immediate notifications. The mobile application, developed using Flutter, provides caregivers and healthcare professionals with access to real-time alerts, historical scan data, and other critical information, allowing for timely interventions.

## 5. Result and Analysis

The Intelligent Alert System for Facial Paralysis Diagnosis, utilizing a ResNet50 deep learning model, was evaluated on a balanced test set of six images, achieving an overall accuracy of 83% by correctly classifying five out of six cases. The model demonstrated strong performance, with a precision of 1.00 and recall of 0.67 for the "No Paralysis" class, and a precision of 0.75 and perfect recall of 1.00 for the "Paralysis" class, resulting in a weighted F1-score of 0.83. Trained over 20 epochs, the model reached a training accuracy of 93.53% and a best validation accuracy of 91.45%, reflecting good generalization to unseen data. Integrated with a Flutter-based mobile app, the system offers real-time alerts, instant image analysis via a "New Scan" feature, and a "Scan History" section that flags positive cases—enabling prompt diagnosis and supporting clinical decision-making.

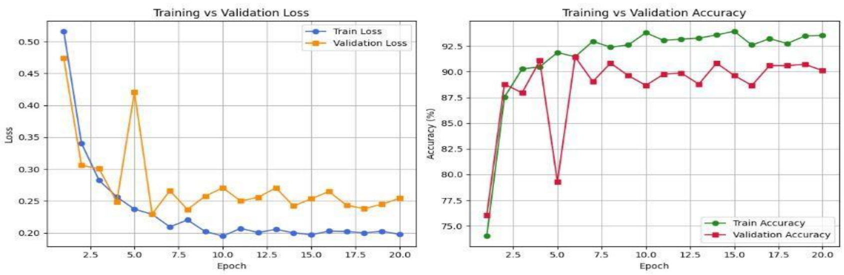


**Figure 6. Model Performance Evaluation**

### 5.1. Home Screen

The mobile application for facial symmetry detection, illustrated in Figure **7**, is developed to monitor facial paralysis effectively.


**Figure 7. Home Screen Overview**

Key features include a New Scan option for uploading images from media, Scan History for viewing past results and tracking progress, and an Alerts section for real-time health notifications. An Information section is also provided, offering educational resources on facial paralysis, its causes, and symptoms—enabling users to stay informed and proactive about their condition.

### 5.2. New Scan

The New Scan feature as shown in figure 8 allows users to select an image of the face for analysis. Once the image is provided and the Start Analysis button is clicked, it is sent to the model. The model processes the image and determines whether there are signs of facial paralysis. Based on the analysis, the app displays a result indicating either Positive (suggesting possible facial paralysis) or Negative (no signs detected) as shown in figure 9, helping users understand their condition quickly and easily.

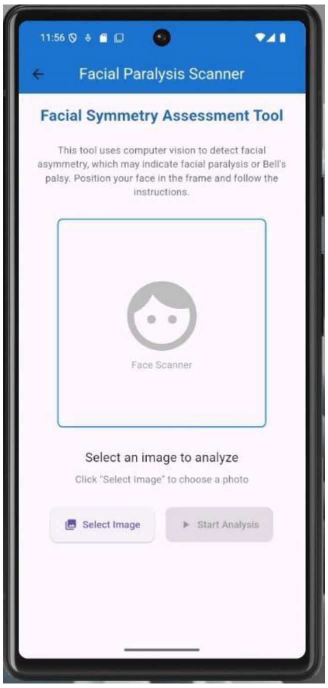


**Figure 8. Facial Paralysis Scanner**

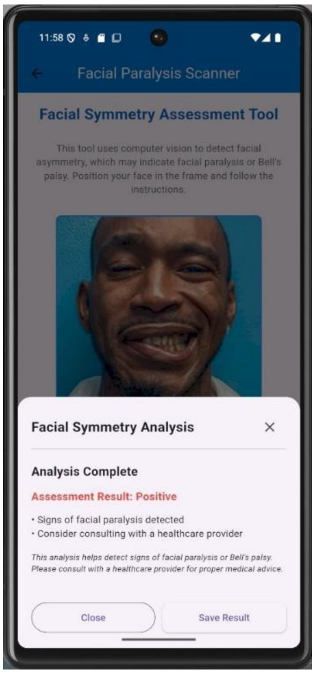


**Figure 9. Facial Symmetry Assessment Result**

### 5.3. Scan History

The Scan History section provides a detailed log of all past facial scans as shown in figure 10, including the date and time of each scan, the detection result, and the name of the referring physician if available. Scans identified as positive for facial paralysis are highlighted in red, allowing for quick recognition and prioritization. This organized history helps users, caregivers, and medical professionals track changes in facial health over time, identify recurring symptoms, and support better clinical decisions.

### 5.4. Real Time Alerts

The real-time alert system is designed to provide immediate notifications to users through the connected mobile application whenever facial paralysis is detected in an image. Each alert includes the diagnostic image that triggered the detection, the exact time the detection occurred, and the name of the referring doctor, ensuring that users have access to critical information without delay. This prompt notification system enhances responsiveness, allowing caregivers or medical professionals to take timely action. As illustrated in figure 11, the alert layout is structured to present all essential details clearly, supporting faster decision-making and improving the overall effectiveness of the facial paralysis monitoring process.

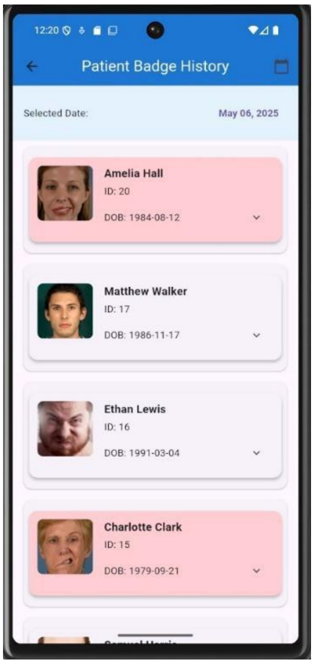


**Figure 10. Patient Badge History**

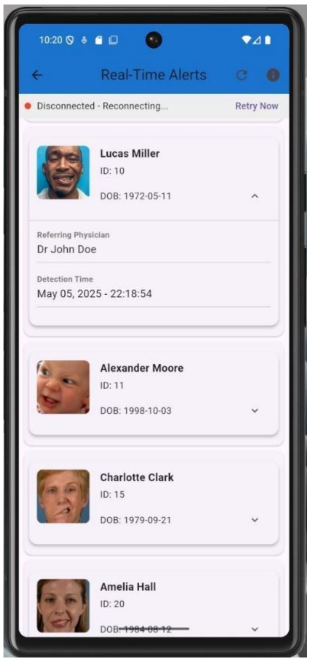


**Figure 11. Real Time Alerts Overview**

Hence, the real-time alert system ensures that users are promptly informed of any facial paralysis detection, enabling swift response and timely medical attention. By providing immediate access to essential details such as the diagnostic image, detection time, and referring doctor's name, the system enhances user awareness and supports continuous, proactive health monitoring.

## 6. Conclusion

This This project advances AI in healthcare with an intelligent facial paralysis detection system using a ResNet50 model and WebSocket for real-time alerts. It autonomously analyzes facial images with 93.53% training accuracy, enabling rapid diagnosis without manual intervention. Integrated with a Flutter-based mobile app, supporting remote patient monitoring and telemedicine. The lightweight system is ideal for rural or resource-limited areas, delivering timely alerts and detailed patient data to enhance diagnosis and early intervention. Overall, it improves clinical workflows and patient outcomes through accessible, AI-driven medical support.

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