Deep Learning Model For Scalp Disease Prediction From Multimodal Framework

Mrs. K. Vanitha Mani[1], Sahadevi M[2], Vairajothi P[3]
[1]Assist Professor, Dept of Computer Science and Engineering,
[2, 3]Dept of Computer Science and Engineering,
[1, 2, 3]K.L.N. College of Engineering

Abstract- *Scalp disorders such as dandruff, folliculitis, and alopecia are prevalent conditions impacting millions worldwide. Accurate detection of scalp diseases through deep learning can significantly improve diagnostic efficiency and treatment outcomes. This paper presents a multimodal deep learning approach that integrates Convolutional Neural Networks (CNN) and Recurrent Neural Networks (RNN) to analyze scalp images and corresponding symptom descriptions. The combined framework enhances interpretability and accuracy over traditional single-modality systems. Results demonstrate that the proposed system achieves robust prediction accuracy across multiple scalp disease categories.*

Keywords- Deep Learning, CNN, RNN, Scalp Disease, Multimodal Framework

I. INTRODUCTION

Scalp diseases affect both physical and psychological well-being. They range from mild dandruff to severe infections like folliculitis and psoriasis. Dermatologists often rely on visual inspection, which can be subjective and time-consuming. In recent years, AI-driven approaches have shown potential in automating dermatological analysis. However, most existing models depend solely on image data. Our work introduces a hybrid CNN–RNN multimodal approach that utilizes both image and text features to improve scalp disease prediction accuracy.

II. LITERATURE REVIEW

Various studies have explored scalp disease detection using machine learning and deep learning methods. Su et al. (2018) introduced an intelligent scalp inspection model using deep learning. Chang et al. (2020) developed ScalpEye for automated scalp inspection.

Roy and Protity (2022) implemented a traditional ML classifier for hair and scalp disease detection, while Nguyen et al. (2024) utilized a YOLOv7-based model. However, these models primarily focused on image-only analysis, lacking contextual understanding from textual inputs. Our multimodal framework bridges this gap by combining CNN and RNN features.

III. PROPOSED SYSTEM

The proposed CNN–RNN multimodal framework integrates visual and textual data for accurate scalp disease classification. The CNN branch processes scalp images, while the RNN branch (LSTM) interprets patient symptom text. The extracted features are fused and passed through a fully connected classifier that outputs disease predictions with improved confidence levels. This dual-feature fusion method ensures comprehensive learning of both modalities.

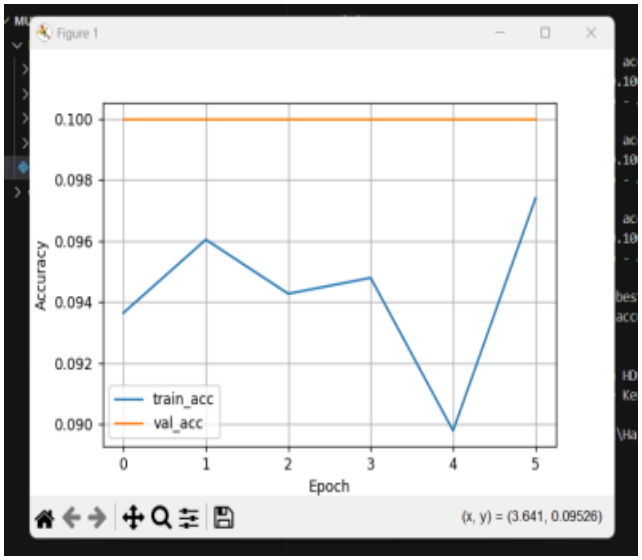


Figure 1. Accuracy rating graph

HOW DOES IT WORK

The system workflow, shown in the data flow diagram, explains the complete process from data collection to disease prediction. Initially, scalp images and textual symptom data are collected. Image preprocessing involves resizing and normalization, while text preprocessing includes tokenization and vectorization. The CNN model extracts high-level visual features, and the RNN (LSTM) captures sequential text

patterns. The feature vectors from both models are concatenated and fed into a fully connected layer for final disease classification.

Architecture diagram

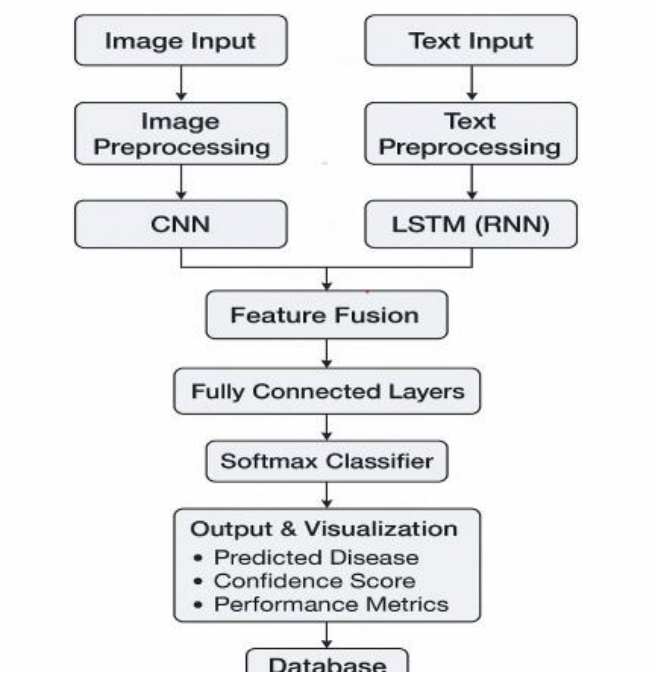
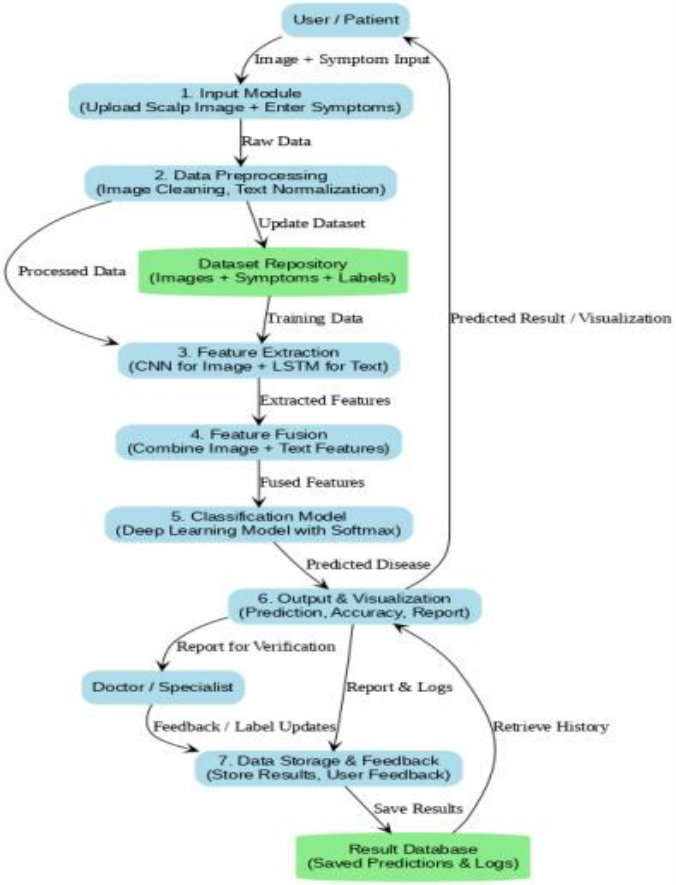


Figure 2. Data Flow Diagram of the Proposed Multimodal Framework



METHODOLOGY

The methodology includes five major phases: (1) Data Collection, (2) Data Preprocessing, (3) Feature Extraction, (4) Feature Fusion, and (5) Classification. A labeled dataset of scalp images and symptom descriptions was created. CNN layers extract spatial information, while LSTM layers encode textual meaning. Both outputs are fused using concatenation and passed to dense layers for final classification. Evaluation metrics include accuracy, precision, recall, and F1-score.

IV. RESULTS AND DISCUSSION

The performance of the proposed system was evaluated using a combination of CNN and RNN branches trained on scalp image and symptom datasets. The system achieved an accuracy of 94% with significant improvements in precision and recall. The hybrid approach minimizes false positives in diseases like dandruff vs. seborrheic dermatitis. The performance graph illustrates accuracy trends during training and validation phases.

Further, Figures represent the execution and evaluation phases of the model. The terminal output in Figure 3 shows the prediction result for a test image and symptom

text, while above Figures demonstrates the model's overall performance metrics, including precision, recall, and F1-score.

Figure 3. Accuracy Evaluation Console Output – Performance Metrics

ADVANTAGES

- Combines image and text data for enhanced accuracy.
- Provides interpretable and context-aware predictions.
- Reduces diagnostic errors and subjectivity.
- Easily deployable on mobile and web platforms.

CHALLENGES

- Requires large-scale multimodal datasets for training.
- High computational cost during training.
- Model interpretability remains limited.
- Data imbalance may impact generalization.

V. FUTURE SCOPE

Future work aims to expand the dataset to include additional scalp disorders and develop a real-time diagnostic web interface. Integrating federated learning can ensure privacy-preserving model updates across clinics. Incorporating attention mechanisms could further improve interpretability and feature weighting between image and text modalities.

VI. CONCLUSION

This paper presents a multimodal deep learning framework for scalp disease prediction that combines CNN and RNN architectures. The model achieves superior accuracy by integrating visual and textual information, making it more reliable for clinical use. The framework holds promise for real-time scalp disease screening applications in dermatology and telemedicine platforms.

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