National Conference on Recent Trends in Artificial Intelligence and Data Science (NCRTAIDS-26)
Sri Vasavi College, Erode, Tamil Nadu, India

International Journal of Science, Engineering and Technology
ISSN: 2348-4098, P-ISSN: 2395-4752

Deep Learning Based Intelligent Framework for Early Detection of CF Using CNN

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Abstract - Cystic Fibrosis (CF) is a genetic disorder that severely affects the lungs and digestive organs. Timely identification of the disease can significantly enhance treatment effectiveness and patient survival. This work introduces a deep learning-based framework that utilizes Convolutional Neural Networks (CNN) to identify early signs of Cystic Fibrosis from medical images and clinical indicators. The proposed model automatically extracts discriminative features and performs classification between CF and non-CF cases. Experimental findings demonstrate strong performance and reliability, highlighting the usefulness of artificial intelligence in supporting early clinical diagnosis and healthcare decision systems.

Keywords - Cystic Fibrosis, Deep Learning, CNN, Early Diagnosis, Medical Imaging, Artificial Intelligence.

I. INTRODUCTION

Cystic Fibrosis is an inherited disorder caused by mutation in the CFTR gene, resulting in thick mucus formation in respiratory pathways and digestive organs. This leads to persistent infections and breathing problems. Early detection is essential for preventing disease progression and improving life expectancy. Recent advances in deep learning have enabled automated analysis of medical images with high precision. This research focuses on developing a CNN-based model for identifying early-stage CF using medical imaging and clinical data.

II. PROPOSED METHODOLOGY

The proposed system includes data collection, preprocessing, feature extraction, and classification. Medical images are normalized and enhanced before being fed into the CNN model. The deep learning network learns hierarchical features and performs binary classification to detect CF at an early stage.

Mathematical Model

Convolution: $F(i,j) = \Sigma \Sigma I(i-m, j-n) * K(m,n)$

ReLU: $ReLU(x) = \max(0, x)$

Softmax: $P(y=i) = e^{zi} / \Sigma e^{zj}$

Loss Function: Cross Entropy

Algorithm

Step 1: Acquire medical dataset
Step 2: Perform preprocessing and augmentation
Step 3: Initialize CNN architecture
Step 4: Train model using labeled samples

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Step 5: Extract deep features
Step 6: Classify CF and Non-CF
Step 7: Generate prediction and decision support

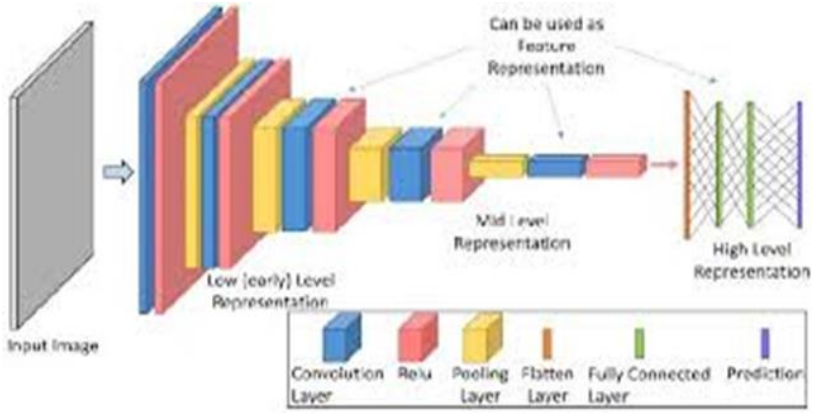

Figure 1: CNN Architecture

The architecture consists of convolution, activation, pooling, and fully connected layers followed by Softmax classification.

Experimental Results

The model achieved strong performance across evaluation metrics. The CNN model outperformed traditional machine learning algorithms in early detection capability.

Table 1: Performance Comparison

Model	Accuracy (%)
SVM	84
Random Forest	88
CNN (Proposed)	95

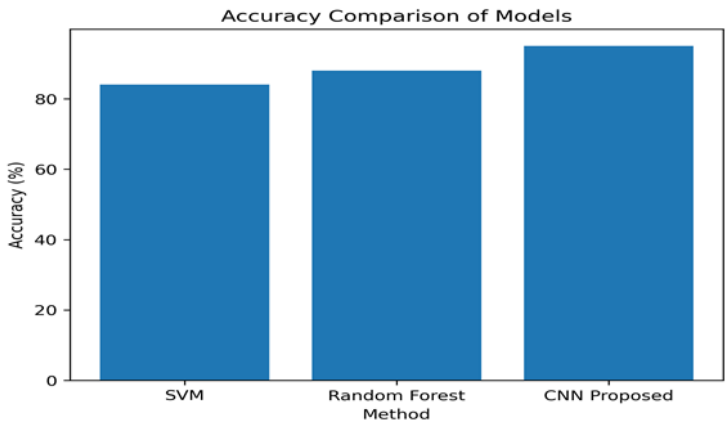

Figure 2: Accuracy Comparison Graph

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Discussion

The deep learning model effectively identifies early indicators of CF and reduces diagnostic delay. Integration of imaging and clinical features improves predictive performance and robustness. The system can be extended to other genetic and respiratory disorders.

III. CONCLUSION

This paper presented a CNN-based deep learning framework for early detection of Cystic Fibrosis. The system achieved high accuracy and demonstrated its usefulness in assisting healthcare professionals. Future work will focus on integrating genetic biomarkers and deploying real-time clinical systems.

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