Findings

Notification No.: 588/2025
Date of Award: 24 -10-2025

Name of the Scholar: Sapna Yadav
Name of the Supervisor: Prof. Syed Afzal Murtaza Rizvi
Name of the Department: Department of Computer Science
Topic of the Research: **“Severity Identification for Pulmonary Infectious Diseases with Deep Learning”**

The thesis titled “Severity Identification for Pulmonary Infectious Diseases with Deep Learning” presents an advanced deep learning framework aimed at automating the detection and severity assessment of pulmonary infectious diseases such as tuberculosis, pneumonia, COVID-19, fibrosis etc. These diseases pose a major threat to global health, especially in low- and middle-income countries where diagnostic infrastructure and medical expertise are limited. To address these challenges, the research leverages radiographic imaging and genomic sequence data to design robust AI-driven diagnostic techniques that ensure early detection, accurate classification, and reliable severity grading.

The study introduces several novel hybrid models, including **Pulmo-ViT-SVM**, which combines Vision Transformers for global feature extraction with Support Vector Machines for precise classification, and **DeepGRU-CNN**, which integrates GRUs and CNNs for efficient genomic sequence analysis. Additionally, a **Brixia score-based Deep learning pipeline (PulmoSevNet)** is proposed to segment lung regions, compute severity levels (mild, moderate, and severe), and provide explainable results using **Grad-CAM** visualizations. These innovations improve diagnostic accuracy, interpretability, and computational efficiency, making them suitable for real-world clinical and low-resource healthcare settings.

By integrating imaging, genomics, and explainable AI, this research contributes a unified framework that enhances disease understanding and supports clinical decision-making. It emphasizes model transparency, reproducibility, and real-world applicability while setting a new benchmark for AI-based medical diagnostics. **The thesis is structured into seven chapters, summarized as follows:**

Chapter 1 lays the foundation for the research by discussing the motivation, background, and challenges related to detecting and identifying the severity of pulmonary infectious diseases (PIDs). It explains the significance of diseases such as tuberculosis, pneumonia, COVID-19, and influenza, along with current diagnostic methods and their limitations. The chapter emphasizes the importance of early detection and accurate severity grading, particularly in resource-limited settings, and clearly defines the research objectives and scope of the study.

Chapter 2 provides a comprehensive literature review of 98 recent and relevant studies published in reputed journals. It examines traditional and deep learning-based techniques for disease detection and severity estimation, outlining their strengths and limitations. The chapter also describes the selection methodology and identifies major research gaps, including limited interpretability, dataset imbalance, and lack of multiclass and severity-oriented models—thereby justifying the novelty and direction of the proposed research.

Chapter 3 discusses the research methodology, tools, and techniques used. It details data acquisition and preprocessing steps to ensure high-quality inputs for model training, covering both imaging (X-rays, CT scans) and genomic data. The chapter outlines standard pipelines for machine learning and deep learning approaches, key evaluation metrics, and methods to handle issues like data imbalance and generalizability, ensuring robust experimental design.

Chapter 4 presents the experimental analysis using deep and machine learning models for PID detection. It evaluates various CNN architectures—VGG16, ResNet50, InceptionV3, MobileNetV2, and Xception—on chest X-ray datasets to detect diseases such as COVID-19 and pneumonia. The chapter introduces hyperparameter optimization with Keras Tuner and explores transfer learning and image resolution effects on model performance. These findings help identify the most effective architectures for accurate and efficient detection.

Chapter 5 explores multiclass classification using hybrid models that integrate imaging and genomic data. It introduces Pulmo-ViT-SVM, combining Vision Transformers with SVMs for X-ray classification, and DeepGRU-CNN, which merges GRUs and CNNs for genomic sequence analysis. These models show superior accuracy and generalization in classifying multiple lung diseases and viral subtypes like H1N1, H3N2, H7N9, and SARS-CoV-2, emphasizing their potential for clinical deployment.

Chapter 6 focuses on severity detection using PulmoSevNet, a model based on the Brixia scoring system integrated with deep learning. It segments lungs using UNet, extracts relevant features, and classifies severity into mild, moderate, and severe categories. The model demonstrates high reliability and interpretability through explainable AI techniques like Grad-CAM, supporting clinical decision-making and treatment prioritization.

Chapter 7 concludes the thesis by summarizing the major findings, contributions, and limitations. It highlights advancements in detection, classification, and severity grading of Pulmonary Infectious Diseases, while addressing challenges such as dataset diversity and model interpretability. Future directions include incorporating multimodal clinical data, expanding real-world validation, and enhancing explainability.