Improving Early Diagnosis and Treatment Monitoring of Tuberculosis With Novel Machine Learning Cough Analysis

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Tuberculosis (TB), a bacterial disease mainly affecting the lungs, is the leading infectious cause of mortality worldwide before COVID-19. To prevent TB from spreading within the body, which causes life-threatening complications, timely and effective anti-TB treatment is crucial. Cough, an objective biomarker for TB, is a triage tool that monitors treatment response and regresses with successful therapy. Current gold standards for TB diagnosis are slow or inaccessible, especially in rural areas where TB is most prevalent. In addition, current machine learning (ML) diagnosis research, like utilizing chest radiographs, is ineffective and does not monitor treatment progression. To enable effective diagnosis, I developed an ensemble model that analyzes, using a novel ML architecture, coughs' acoustic epidemiologies from smartphones' microphones to diagnose TB. The architecture includes a 2D-CNN and XGBoost that was trained on 724,964 cough audio samples and demographics from 7 countries. After feature extraction (Mel-spectrograms) and data augmentation (IR-convolution), the model achieved a 94% sensitivity and 87% specificity, surpassing WHO's requirements for screening tests. The bi-directional LSTM utilizes periodic cough history and the 2D-CNN confidence score to predictively monitor response to TB therapy with the treatment-irregularity algorithm (TIA). The LSTM and TIA effectively (AUC<0.28) monitor the body's reaction to anti-TB drugs through changes in cough patterns, allowing the ML model to predict a high risk of treatment or dosage irregularity. This early detection of drug irregularity can avert TB relapse, drug-induced liver injury, and drug-resistant strains. This research helps to improve TB diagnosis while predictively monitoring treatment.

Awards Won:

Fourth Award of $500

University of Texas at Dallas: Scholarship of $5,000 per year, renewable for up to four years