RADIA: Novel Assessment Through a Unified AI-Driven Embedded Respiratory Health System Integrating 3D Airway Modeling for Rapid Screening, Monitoring, and Rehabilitation

Siriphant, Poowit (School: Bangkok Christian College)
Thongpitaktarvorn, Poonyapath (School: Bangkok Christian College)

Obstructive and restrictive respiratory diseases are major global health challenges and are associated with prolonged exposure to smoke and air pollution. Among these conditions, Chronic Obstructive Pulmonary Disease (COPD) persists as one of the most prevalent, affecting over 400 million people worldwide and imposing substantial health and economic burdens. Because many respiratory diseases share similar symptoms, accurate differentiation remains difficult. Despite advances in diagnostic systems and tools, they remain fragmented, lack integrated multi-respiratory disease screening, and rely on multiple steps, costly technologies, and separate tools for comprehensive assessment. To solve these problems, we developed RADIA, an integrated embedded respiratory health assessment system that unifies screening, monitoring, and rehabilitation. For screening, recorded acoustic signals are processed into MFCC and Mel-spectrogram features and subsequently analyzed using a deep learning model to classify eight respiratory conditions. For monitoring, a 3D airway model is reconstructed using acoustic features via Helmholtz resonance to detect airway abnormalities. For rehabilitation, the system integrates pulmonary function testing and guided breathing exercises to support long-term care. Our results showed that the 1D-CNN outperformed baseline methods in respiratory condition classification (ACC = 95.98% and F1-score = 0.94). RADIA also reduced the time to detect respiratory symptoms by up to 85% compared with traditional guidelines. Moreover, the system has the potential to reduce dependence on expensive, time-consuming screening techniques, such as CT scanning. Overall, RADIA offers a new approach to improve healthcare accessibility and support long-term respiratory management.

Awards Won:
Third Award of $1,200