Electronic Nose-Based Breath Analysis for Early COPD

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Abstract

Chronic Obstructive Pulmonary Disease (COPD) is a chronic respiratory disease characterized by persistent inflammation and lung tissue damage. According to the World Health Organization (WHO), COPD causes approximately 3 million deaths annually. Early diagnosis remains challenging because symptoms are often mild and non-specific, while spirometry, the current standard diagnostic method, is limited by its cost, inconvenience, and invasiveness. To address these limitations, this study developed a preliminary COPD screening device based on an electronic nose (E-nose) integrated with a real-time mobile application. Volatile organic compounds (VOCs) in exhaled breath collected from a total of 60 participants at Mae Sot Hospital, including COPD patients and healthy participants, were analyzed using MQ gas sensors, and seven machine learning models were developed and compared using Weka and Orange Data Mining. Breath from COPD patients showed higher levels of acetone, decane, and p-xylene, but lower levels of benzene and cyclopentane, than that of healthy individuals. Among the eight models, XGBoost achieved the highest performance, with an accuracy of 96.67%, sensitivity of 97.06%, specificity of 96.15%, and precision of 97.06%, followed by Random Forest (93.33% accuracy). These findings demonstrate that the proposed E-nose system has strong potential as a rapid, non-invasive preliminary screening tool for COPD, improving access to early detection in community healthcare settings while reducing the burden on the healthcare system.

Keywords: Chronic Obstructive Pulmonary Disease (COPD), Electronic Nose, Machine Learning, Volatile Organic Compounds (VOCs)