ABSTRACT

Respiratory diseases are one of the most common health problems worldwide. Diseases such as Chronic Obstructive Pulmonary Disease (COPD), Acute Respiratory Tract Infection (ARTI), pulmonary fibrosis, and ARDS can cause significant shortness of breath and affect patients' quality of life. The purpose of the respiratory system is to ensure effective gas exchange in the bloodstream through the process of inhaling and exhaling. If there is damage to the lungs or an infection, oxygen cannot reach the bloodstream or carbon dioxide can accumulate. Each heartbeat is created by the movement of electrical impulses from the heart muscle. Electrocardiography (EKG) measurements are commonly used methods to measure human heart performance through cardiac electrical activity. Therefore, this study designed a heart activity monitoring system utilizing the AD8232 sensor and Arduino Uno microcontroller. This system displays physiological parameters such as Heart Rate (HR), Respiratory Rate (RR), and Heart Rate Variability (HRV) directly on an OLED screen. The scope of this research is limited to signal acquisition, filtering stages, R-peak detection, calculation of primary parameters, and simple classification of heart conditions into “Normal” or “Abnormal” categories.

The research stages were simulated from the acquisition of ECG signals using an AD8232 sensor connected to an Arduino Uno. The recorded data was then processed through filtering using baseline wander removal, bandpass filter, and moving average techniques to reduce artifacts and interference. Next, R peak detection is performed to obtain the RR interval used in HR estimation. HRV is calculated using the SDNN method, while RR is determined through baseline wander-based signal fluctuation analysis. Sampling is performed at a frequency of 250 Hz to ensure data resolution meets signal analysis standards. All processing results are displayed in real-time on an OLED screen to show the participant's current heart condition. The obtained data was then reprocessed using linear regression to obtain the R^2 value and determine the MAE. The linear regression method was compared with Support Vector Regression (SVR) to determine which method yielded better results.

System testing showed that the device was able to display ECG signals and calculate HR, RR, and HRV quite well. The HR values obtained were within the normal physiological range for adults, which is 60-100 BPM, and were close to the oximeter measurement results used as a comparison for HR. For respiratory rate, it was compared with manual respiration. HRV calculations using the SDNN method successfully demonstrated heart rate variability reflecting the participant's physiological condition. Additionally, the system can automatically output information on whether the heart status is normal or abnormal.

Keywords: Heart rate analysis, respiration rate, heart rate variability, respiratory disorder patients or normal individuals, electrocardiogram, Support Vector Regression (SVR), respiratory monitoring.