Cardiac Self-Monitoring Tool (CS-M Tool) for Monitoring Cardiovascular Disease With Heart Sounds From a Stethoscope Utilizing a Mobile Application, Using a Neural Network Algorithm To Classify Heart Disease and Detect the Heartbeat

Charunworaphan, Tanapat (School: The Prince Royal's College)
Cosh, Matt (School: The Prince Royal's College)
Tharakittikirati, Noppawit (School: The Prince Royal's College)

CS-M: Monitoring Cardiovascular Disease (CVDs) with Heart Sounds. CVDs are the number 1 cause of mortality worldwide and claim more than 17.9 million lives annually. But 80% of these mortalities are from the lack of prior diagnosis. We aim to reduce the mortality rates with one of the first self-early-heart screening, "CS-M Tool: Cardiac Self-Monitoring Tool," which utilizes a novel algorithm for heart sound segmentation with Convolutional Long Short-Term Memory (CLSTM), achieving an accuracy of 97.03%. It then extracts the features based on improved Mel-frequency cepstral coefficients (MFCCs) optimized for extracting the unique characteristics from heart sounds. Then use, the CS-M hybrid model, which utilized Recurrent Neural Network (RNN), Convolutional Neural Network (CNN), and Transformers to classify heart sound abnormalities; Bradycardia, Tachycardia, Atrial fibrillation, Murmur, and Normal from 6,482 cardiologist-verified datasets with an accuracy of 98.17%. The initial murmur detection algorithm for distinguishing distinct types of Murmurs, including Systolic, Diastolic, and Continuous Murmurs, achieved a high accuracy of 96.30%. To make it practical, we have innovatively incorporated an engineering design with a stethoscope that connects to a smartphone and provides results through an application. Moreover, a novel noise cancellation was developed with an RNN active noise canceling technique that achieved the best average RMSE of 0.0023 dB and SNR of 4.98 dB. The clinical trials involved a team of cardiologists and 125 participants, achieving an accuracy of 97.6%. The CS-M Tool can break through the problem of no prior diagnosis, allowing everyone, especially those in remote areas, to access early detection, potentially saving millions of lives.

Awards Won: