Abstract

Cardiac irregularity detection commonly occurs from consultation with medical practitioners. Given the prevalence of mobile devices capable of heart sound recording, this project implements and investigates digital signal processing techniques, based on intrinsic characteristics of heart sounds, for on-device heart analysis.

The project implements systems to complete S1/S2 ('Lub'/‘Dub’) segmentation and heart sound category classification utilizing the PASCAL Heart Sounds Challenge, as the testing dataset. Mobile device heart recordings are completed by positioning the mobile's microphone against a suitable heart auscultation location. Successful completion of automated heart analysis, based on these recordings, would provide earlier detection tooling for cardiac irregularities, without the initial need for a medical practitioner.

For S1/S2 segmentation, the project utilizes Harmonic Percussive Source Separation, in combination with Onset Detection and 12 Chroma features inputted into a Support Vector Machine (SVM), of 31.7 KB in size, to complete S1/S2 segmentation from mobile recorded heart sounds. The proposed solution for S1/S2 segmentation performed with ≈ 23% less Total Error than the challenge winning SLAC Stanford solution, on the provided mobile dataset.

For heart sound classification, an individual classification solution is proposed for each testable category. To classify heart murmurs, 6 parameters of summarised tonnetz based on the harmonics of each test heart audio, are inputted into an SVM of 4.1 KB in size. To classify extra heart sounds (double S1/S2), prior S1/S2 segmentation is utilized. To classify extrasystoles (irregular extra heart sounds), a heart rate variability metric for root mean square of successive differences (RMSSD) between heartbeats is evaluated. To classify artifacts (non-heart) sounds, autocorrelation and Durbin Watson statistics are utilized along with S1/S2 detection within a minimum expected heartbeat range. The proposed heart sound classification within the mobile test dataset achieved the highest F-Score for Heart Problem irregularities (Murmurs and Extra Heart Sounds) compared to prior winners, for other metrics within the dataset the solution performed near par.

The dissertation also evaluates the limitations, challenges and testing criteria utilized, contributing to a discussion of the viability for medical usage of mobile recorded heart sounds and subsequent automated heart analysis of mobile recordings.