Development of 3D-printed Electronic Stethoscope and Open-Source Android-Based Platform with Automated Diagnosis of Cardiac Conditions

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Three quarters of cardiovascular disease (CVD) associated deaths occur in resource-poor medical regions. The conventional stethoscope remains the primary tool used to diagnose CVD in these settings; however, low accuracy rates and the difficulty of cardiac auscultation paired with inexperienced and overburdened medical personnel make this outdated device ineffective to address growing cardiovascular health burdens. Our solution is a low-cost 3D printed electronic stethoscope specifically adapted for the needs of resource-poor settings. This device is modular, disposable and inexpensive (<$15). Using frequency response analysis, we show that it is comparable in performance to the Littman stethoscope, a gold standard. Our device integrates with an open-source Android-based platform which allows medical personnel to easily gather, store, and analyze heart sounds (HS). On our platform, possible diagnoses are suggested by our state-of-the-art machine learning algorithms. Using a logistic-regression based Hidden Markov Model, we segment samples into S1/systole/S2/diastole. We use a novel combination algorithm which analyzes results from multiple models to classify HSs. This algorithm achieves an extremely impressive 92% accuracy rate for normal HSs and 97% accuracy rate for abnormal HSs. This is the highest accuracy achieved in published literature on the tested dataset which is the most comprehensive HS dataset released to date. Our research presents novel innovations in the fields of medicine, computer science and product design. These innovations are used to develop the first holistic stethoscope based technology to address the needs of the undeserved and resource-poor medical community.

Awards Won:
Samvid Education Foundation: Agni Award of $1000 honoring the services of Dr. Abdul Kalam, former Hon. President of India
Acoustical Society of America: First Award of $1,500