A signal processing algorithm to mitigate LVAD noise in sound recording of LVAD recipients

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Publication(s)

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External Link(s)

• From the lab of Dr. Leslie Collins
• From the lab of Dr. Boyla Mainsah
• From the lab of Dr. Ravi Karra
• From the lab of Dr. Priyesh Patel
• Classification and Characterization of Heart Sounds to Identify Heart Abnormalities (Master's thesis, Duke University, 2019)

Unmet Need

Left ventricular devices (LVADs) are surgically implanted pumps that improve survival in patients with advanced heart failure. While lifesaving, LVAD therapy is also associated with high morbidity, in part due to difficulties identifying an LVAD complication before an adverse event occurs. Current monitoring for LVAD complications in users requires frequent clinical assessments at specialized LVAD centers. There is a need for real-time and remote monitoring of LVAD users for early detection of complications. Additionally, acoustic biomarkers, while they have the potential to improve quality of life following LVAD implementation, their data quality is limited by background noise.

Technology

Duke inventors have developed an adaptive filter with noise cancellation architecture in order to enhance underlying sounds of interest in digital sound recordings. This is intended to be used to facilitate the analysis of underlying diagnostically relevant sounds in LVAD recipients. Specifically, the inventors have achieved adaptive filtering with or without a noise reference signal, and the filter and/or noise reference parameters are able to be specified *a priori* or self-tuned. Application of this filtering technique allows the inventors to mitigate LVAD sounds and identify low-frequency sounds that are high correlated with intrinsic heart sounds. This has been demonstrated *in vivo* with data obtained from LVAD-supported individuals. The work developed by the inventors has led to a signal processing pipeline to extract and analyze heart sounds in LVAD-supported individuals. The authors show the potential for acoustic analysis to be a relatively low-cost diagnostic tool for remote and real-time monitoring of heart function in LVAD patients.

Other Applications

This technology could also be applied to the presence of other physiological sounds such as lung sounds and sounds that can be generated due to pump-heart interactions. The ability to extract clinically relevant features from complex sound mixtures and identify an acoustic biomarker of quality of life in LVAD recipients can be applied to various therapeutic solutions, such as pacemakers and implantable cardioverter defibrillators, with increased testing and sample sizes.

Advantages

- Proof-of-concept evidence for further exploration of heart sound analysis in LVAD patients
- An adaptive filtering method to remove sounds generated by the LVAD and isolate underlying heart sounds
- Acoustic signatures of heart sounds provide better quality of life for LVAD individuals