19 Biomedical sound analysis utilizing physical characteristics

Telestethoscope: Looking into Body by Listening

Abstract

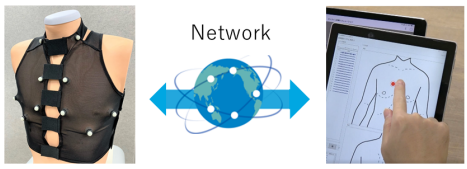
As a basic research toward providing a person with an enhanced sense of well-being, such as early detection of diseases, we developed a wearable acoustic sensor array system that can collect sounds from various parts of the human body and send the signals remotely to a receiver terminal, which is equipped with 18 acoustic sensors inside an examination vest. When the system comes into practical use for medical care, a medical practitioner will be able to listen to sounds from various locations on the patient's body without having to make direct physical contact with the patient or use of a traditional stethoscope, which will be useful in online medical examinations. This system is also expected to play a role, potentially in combination with other information sources, in the research and development of new medical techniques such as the visualization of physical states and direct translation from body sounds into explanatory sentences.

Tele-auscultation / AI auscultation

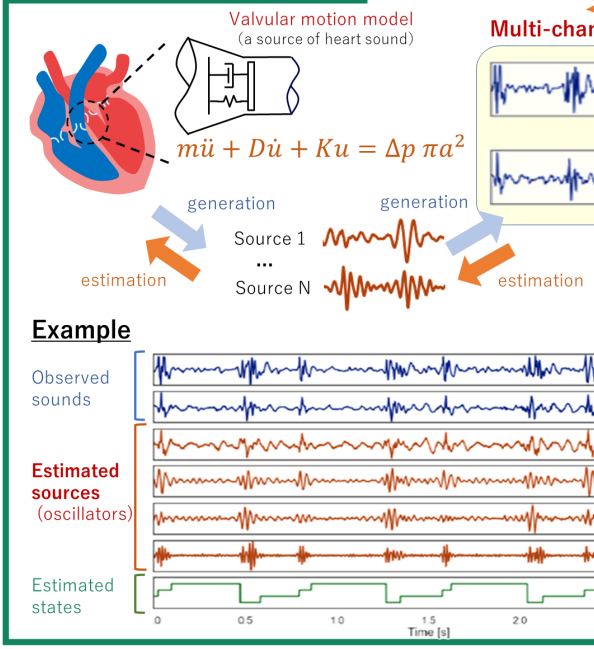
We developed a wearable sensor array system, named telestethoscope, equipped with 18 acoustic sensors that can collect sounds from various parts of the human body and send the signals remotely to a receiver terminal.
We aim for its applications to:

- Tele-auscultation (by medical personnel)
- AI auscultation (by computers, that is, automatic estimation and prediction of physical condition based on the sounds and other sources of information)

Our approach is characterized by attempts to exploit physical properties and laws.

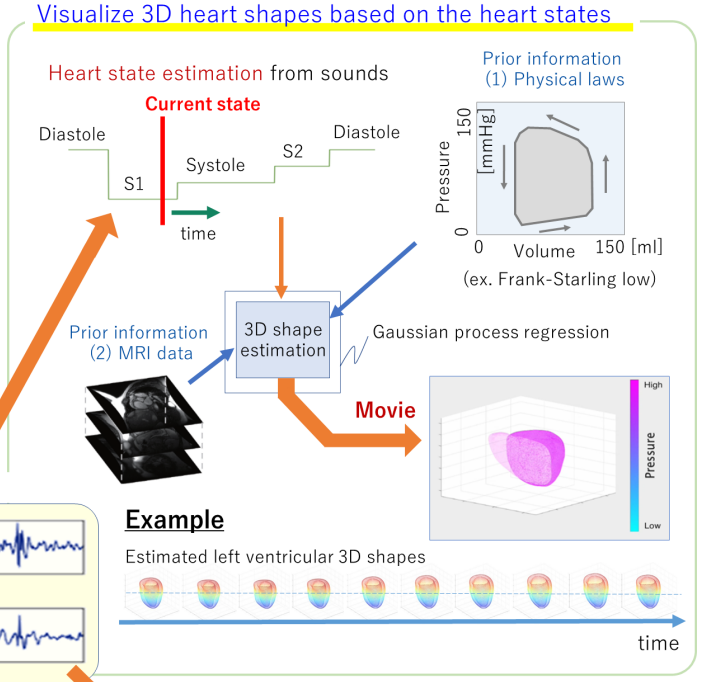


Sound source estimation

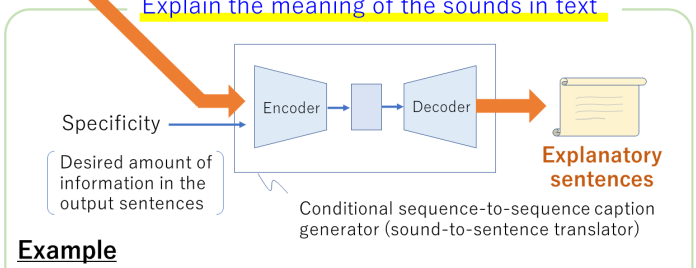


Sound-based visualization and explanation

Visualize 3D heart shapes based on the heart states



Explain the meaning of the sounds in text



Example

Specificity	Generated sentence
Low:	The heart sounds are abnormal.
High:	The heart sounds are abnormal. There may be a problem with one of the heart valves. The 1st sound is normal, and the 2nd sound is split.

References

[1] S. Ikawa, K. Kashino, "Neural audio captioning based on conditional sequence-to-sequence model," in *Proc. Workshop on Detection and Classification of Acoustic Scenes and Events (DCASE)*, 2019.
[2] M. Nakano, R. Shibue, K. Kashino, S. Tsukada, H. Tomoike, "Gaussian process with physical laws for 3D cardiac modeling," in *Proc. European Signal Processing Conference (EUSIPCO), pp. 1452-1456*, 2020.

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