

SPATIAL AUDIO BIOFEEDBACK OF HAND MOVEMENT FOR STROKE PHYSICAL REHABILITATION

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Motivation: Stroke Rehabilitation

- Stroke (also known as cerebrovascular accident) leads to visual field defects and impairments in the motion of the upper extremities [1].
- To enhance movement awareness and reproduction in stroke rehabilitation, sonification of motion data is used. This technique transforms motion data into sound [2].
- Most sonification methods involve carrying spatial motion information in the form of changes in temporal, amplitude, and frequency characteristics of the signal through a mono or stereo signal.
- This can be limiting as decoding the information this signal carries, still takes time and effort on the rehabilitation patient.

Proposal

- The use of **spatial audio in the sonification of motion data** to increase the spatial awareness of stroke survivors during rehabilitation
- Spatial audio is any audio which gives you a sense of space beyond conventional stereo.

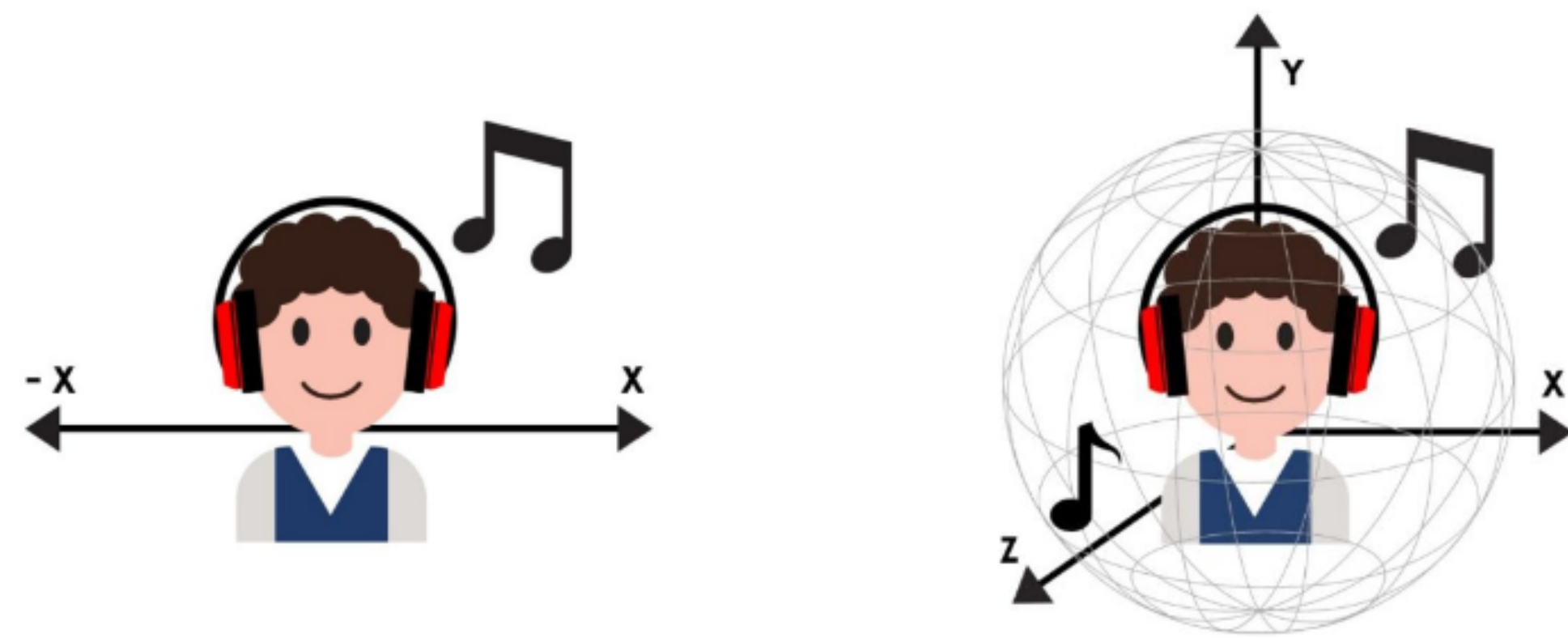


Fig. 1: Stereo audio vs. Spatial audio

- Head Related Transfer Function (HRTF) captures sound localization cues created by how sound is filtered by the geometry of a person's head, face, and pinna before entering the ear canal [3].

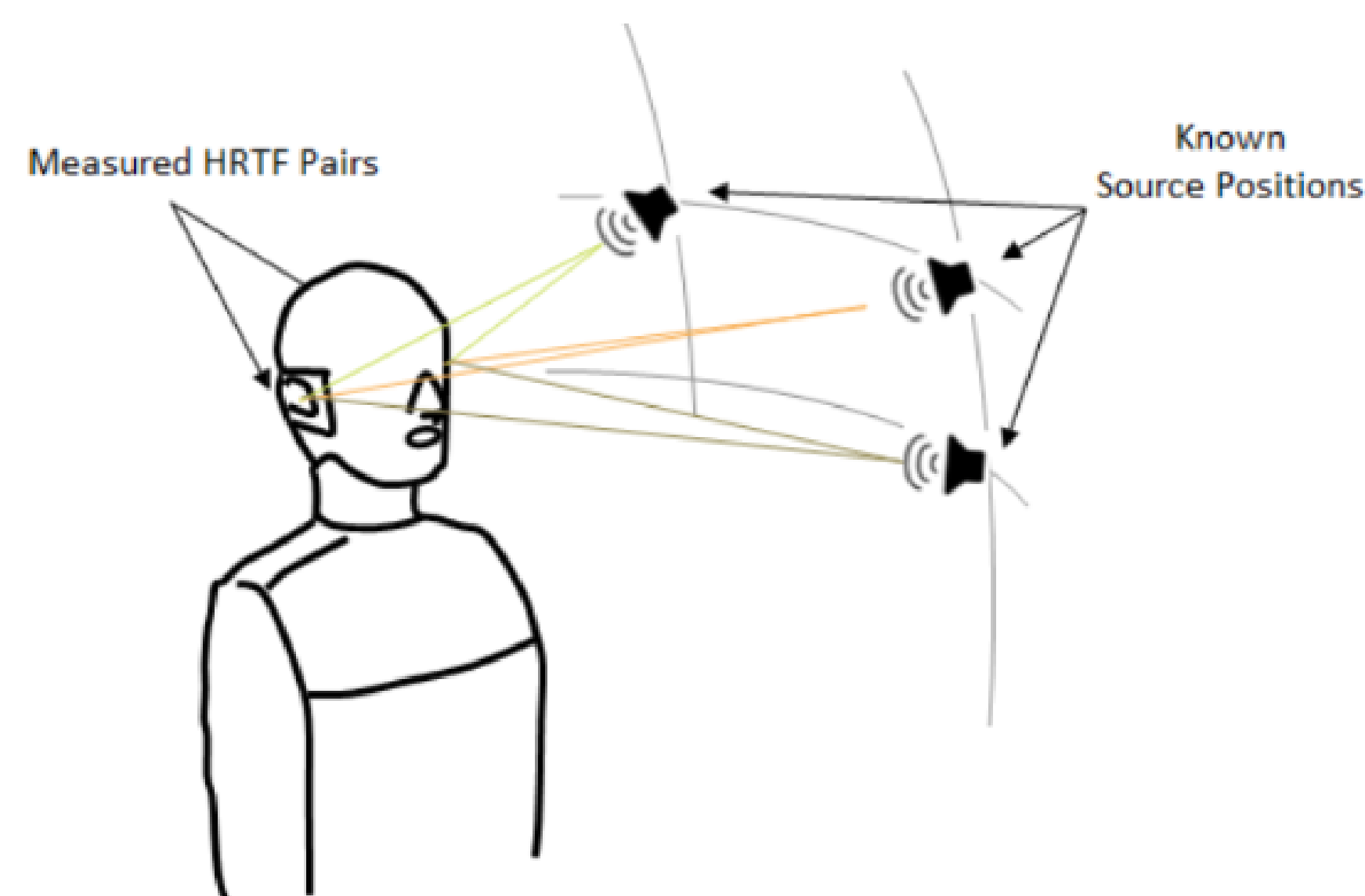
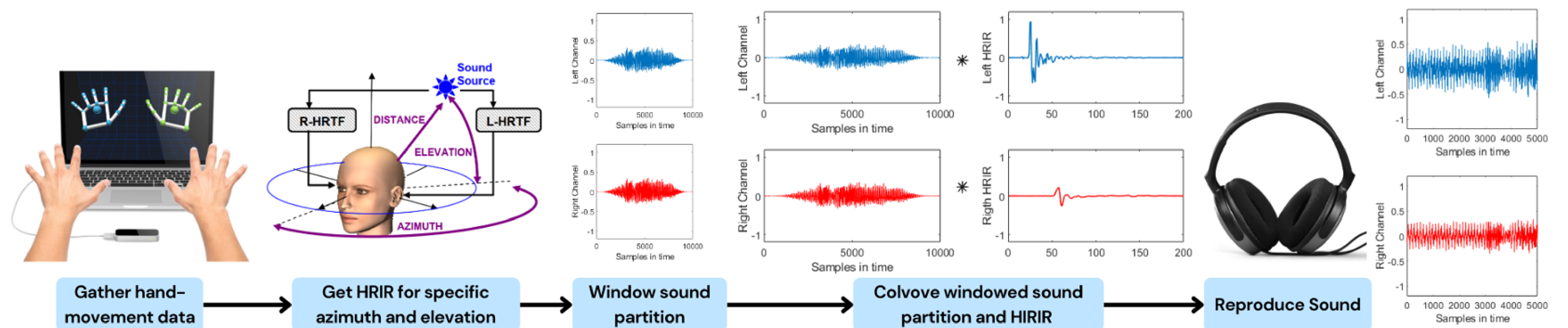
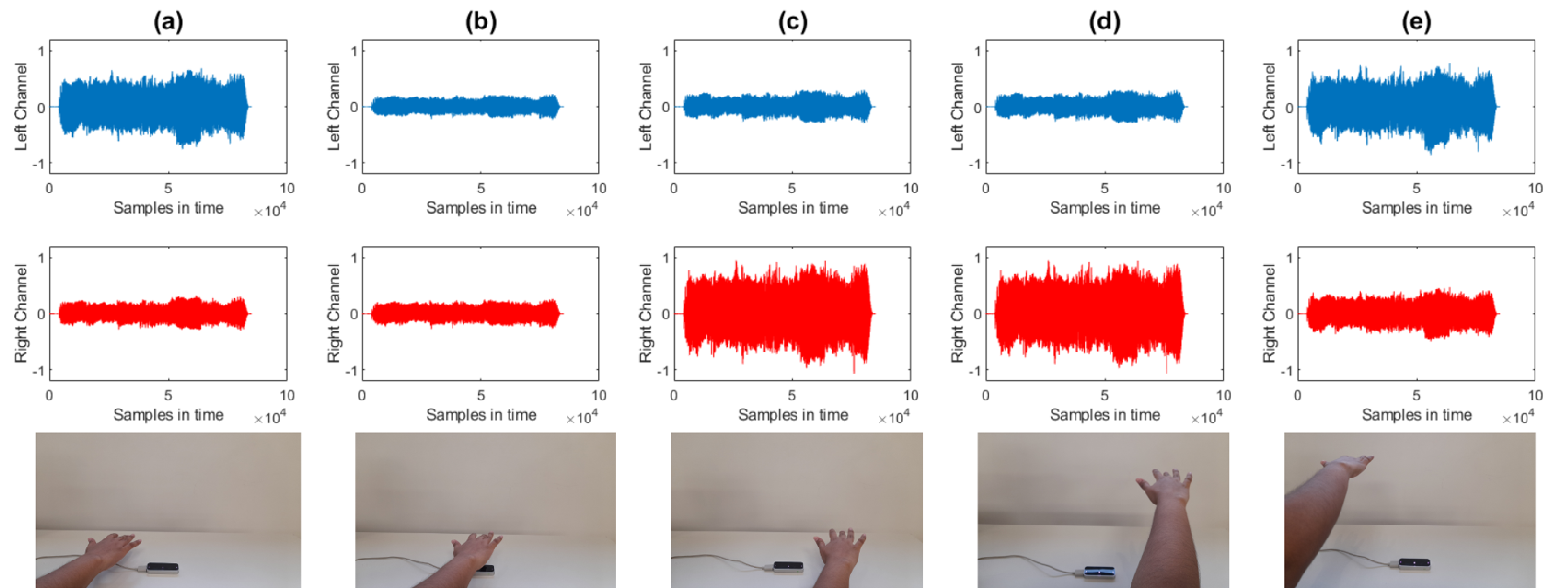


Fig. 2: HRTF measurements [4]

Methodology per frame



Real-time evaluation of the algorithm



References

- [1] Michael Black, Wenzhi Wang, and Wei Wang. "Ischemic stroke: From next generation sequencing and GWAS to community genomics?" In: *OMICS: A Journal of Integrative Biology* 19.8 (2015), pp. 451–460.
- [2] Daniel S Scholz et al. "Sonification of arm movements in stroke rehabilitation—a novel approach in neurologic music therapy". In: *Frontiers in neurology* 7 (2016), p. 106.
- [3] Agnieszka Roginska and Paul Geluso. *Immersive sound: the art and science of binaural and multi-channel audio*. Taylor & Francis, 2017.
- [4] 2023. URL: <https://www.mathworks.com/products/audio.html>.

Conclusions

- Spatial audio overcomes the limitations that stereo or mono audio present for their use as biofeedback in physical rehabilitation.
- A real-time algorithm that obtains hand movement data through a high-precision sensor and converts it into spatial audio that varies according to the direction of the hand was developed in this project.