# An investigational study into the design of a low cost, adaptive hearing aid

Kayla-Jade Butkow & Kelvin da Silva — School of Electrical & Information Engineering, University of the Witwatersrand

## Introduction

Hearing loss is a prevalent problem that affects people in all parts of the world. It is caused by many factors including age, disease and trauma, and often results in a decreased quality of life [1]. Existing hearing aids are expensive, which makes them inaccessible to the majority of South Africans. It is therefore necessary to develop an inexpensive hearing aid that has all of the functionality of a high-end hearing aid.

This functionality includes:

- Amplifying specific frequency bands according to a person's audiogram
- The ability of the user to select the direction in which they wish to listen and to hear sounds in that direction louder than other directions

## Objectives

- To create a full software hearing aid simulation
- To create a hardware proof of concept of a hearing aid which demonstrates limited functionality

## Methodology

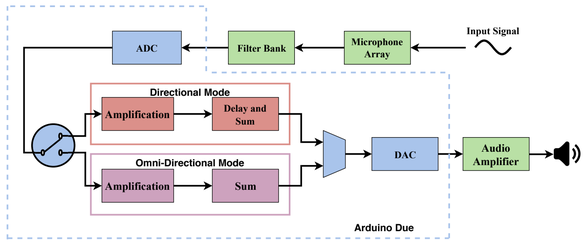


**Figure 1:** Hearing aid system overview

### Simulated vs Hardware Hearing Aid

**Table 1:** Comparison of Simulated and Hardware hearing aids

| Property | Simulation | Hardware |
|---|---|---|
| # of Microphones | 10 | 4 |
| Bandwidth | 250-8000 Hz | 2800-3500Hz and 5600-7000 Hz |
| Filter order | 14 | 2 |
| Type of filters | 1/3 Octave bandpass filters | 1/3 Octave bandpass filters |
| Number of filters | 16 per microphone | 2 per microphone |

### Testing

- Hearing aid placed on a rotating platform and rotated in $30^o$ increments with a constant direction selected on the device
- Sinusoidal signals with frequencies of 3340 Hz and 6000 Hz were played from a set direction
- Amplifications were applied to the frequency bands
- Output signals from the hearing aid were recorded

## Results

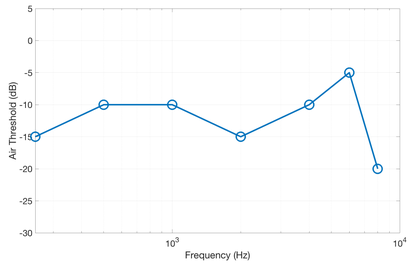


**Figure 3:** Audiogram

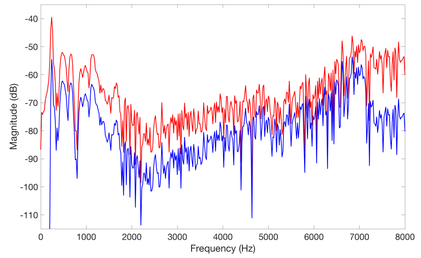


**Figure 4:** FFT Software

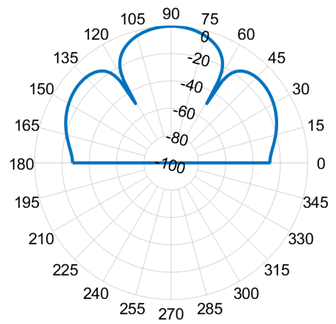

**Figure 5:** $90^o$

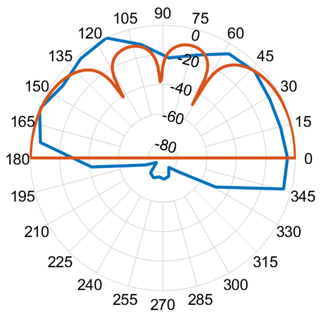

**Figure 6:** $0^o$

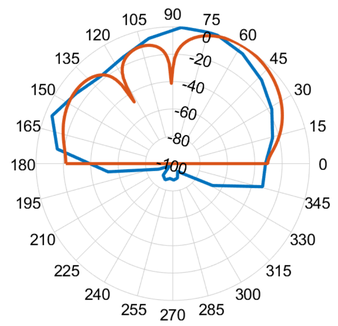

**Figure 7:** $60^o$

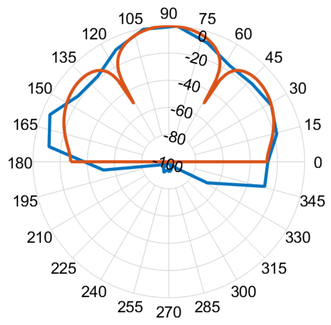

**Figure 8:** $90^o$

## Future Work

This project has been a proof of concept that an inexpensive adaptive hearing aid can be produced. For future development of the hearing aid, a number of improvements could be made including:

- Making use of higher quality omni-directional microphones
- Creating an integrated circuit chip to handle the preprocessing of the audio signals
- Making use of more microphones to improve the precision of the directionality feature

## Conclusion

## References

[1] D. V. Anderson, R. W. Harris, and D. M. Chabries. Evaluation of a hearing compensation algorithm. *1995 International Conference on Acoustics, Speech, and Signal Processing*, 5:3531–3533, 1995.