

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

SYSTEM DESIGN

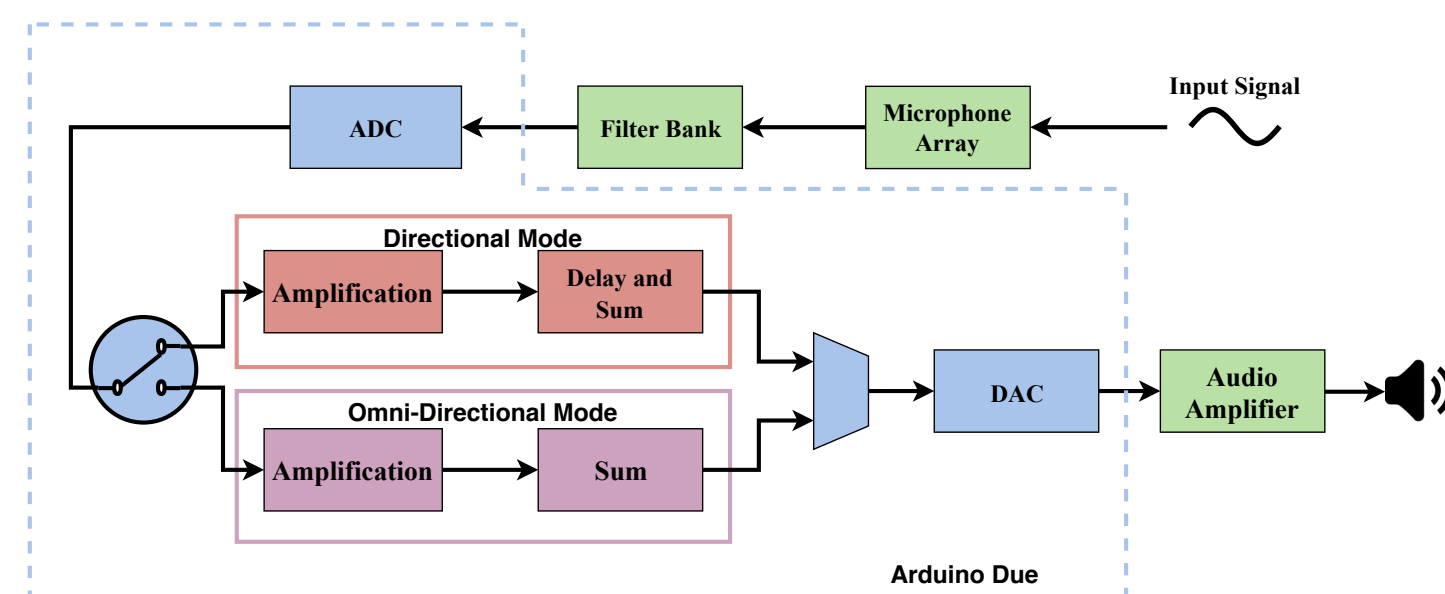


Figure 1: Hearing aid system overview

Simulated vs Hardware Hearing Aid

Table 2: Comparison of Simulated and Hardware hearing aids

| Property | Simulation | Hardware |
|-------------------|-------------------------------|-------------------------------|
| # of Microphones | 10 | 4 |
| Bandwidth | 0.25-8 kHz | 2.8-3.5kHz and 5.6-7 kHz |
| Filter order | 14 | 2 |
| Type of filters | $\frac{1}{3}$ Octave bandpass | $\frac{1}{3}$ Octave bandpass |
| Number of filters | 16 per microphone | 2 per microphone |

Testing

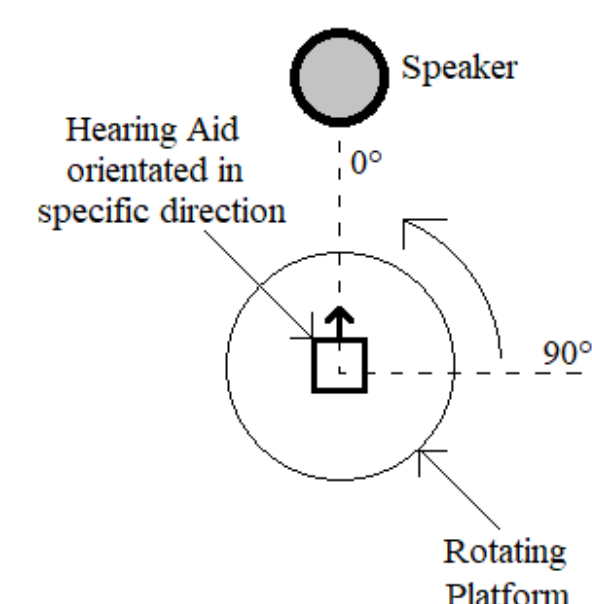


Figure 2: Procedure for testing the hearing aid

RESULTS: SIMULATION

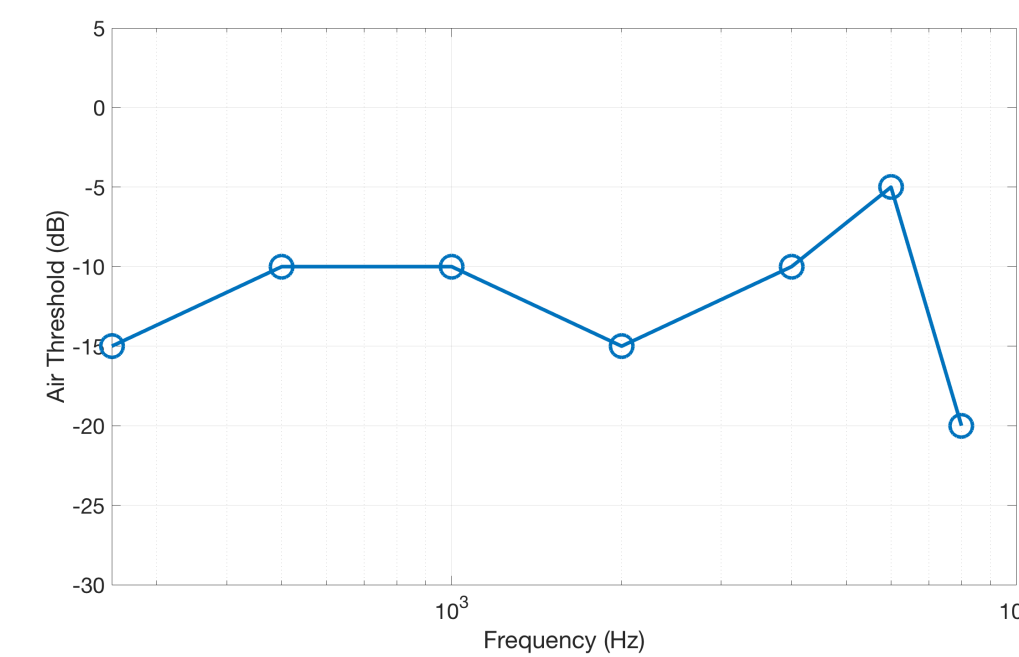


Figure 3: Audiogram

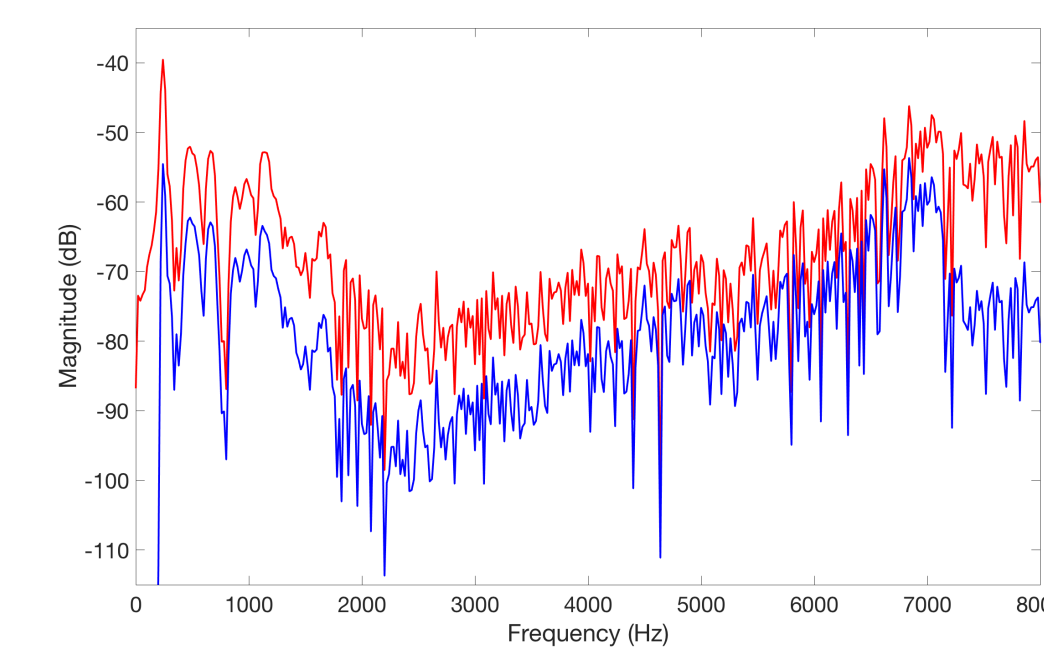
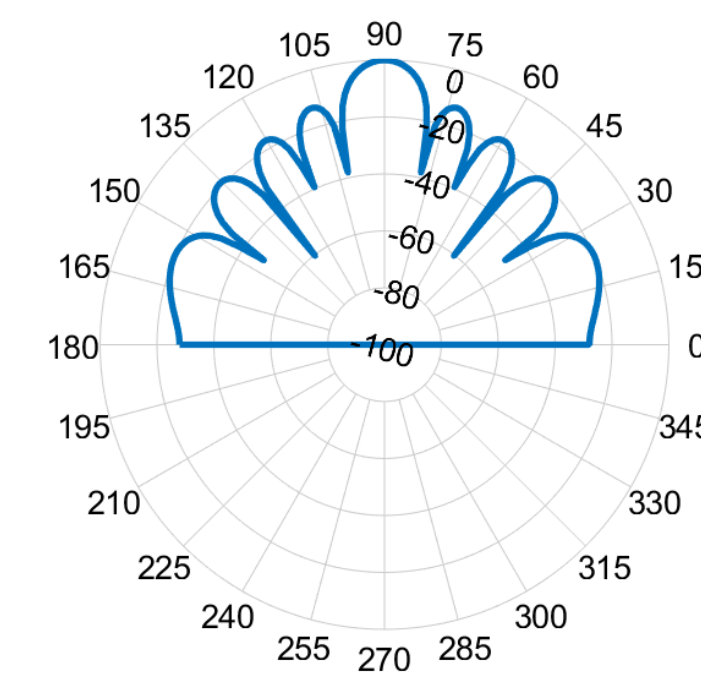


Figure 4: FFT Software

Figure 5: 90°



RESULTS: HARDWARE

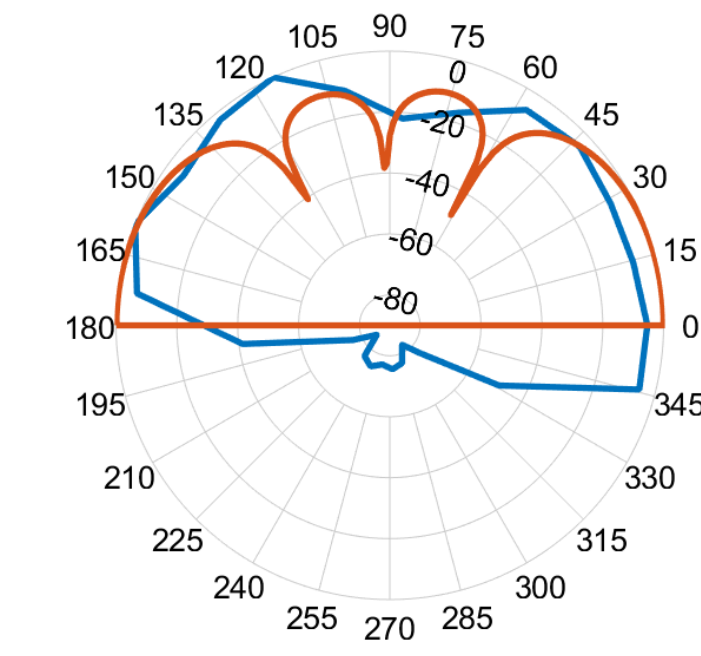


Figure 6: 0°

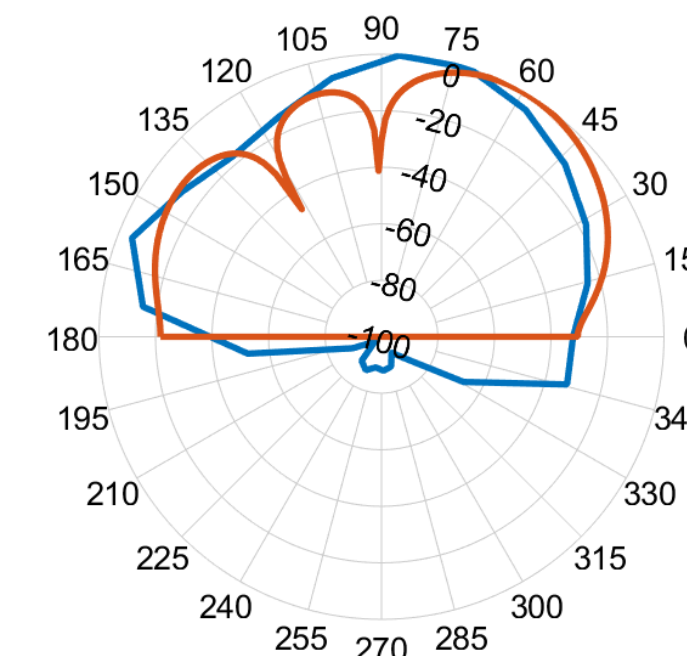


Figure 7: 60°

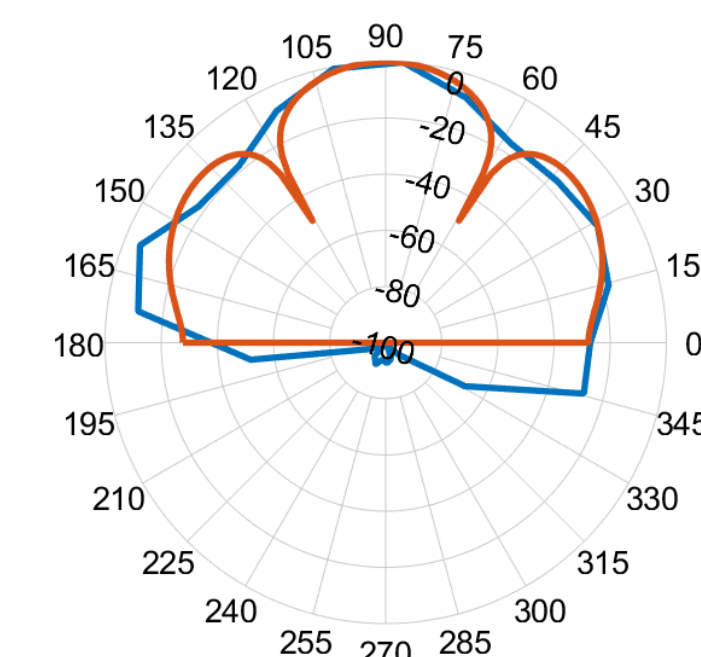


Figure 8: 90°

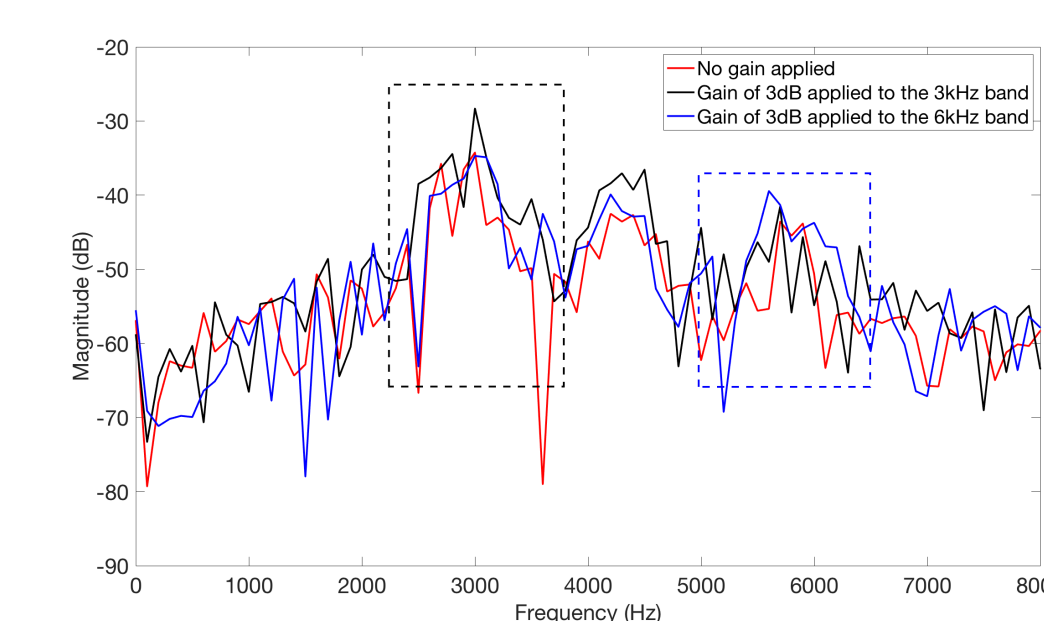


Figure 9: FFT of the output signal from the hearing aid with various amplifications

RESULTS: HARDWARE

Table 1: Error of the dir

| Angle | Average Error (%) |
|-------|-------------------|
| 0 | 46.6 |
| 60 | 30.7 |
| 90 | 12.7 |
| 120 | 22.7 |
| 180 | 51.7 |

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

- With 10 microphones,

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.