AN INVESTIGATIONAL STUDY INTO THE DESIGN OF A LOW COST, ADAPTIVE HEARING AID

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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
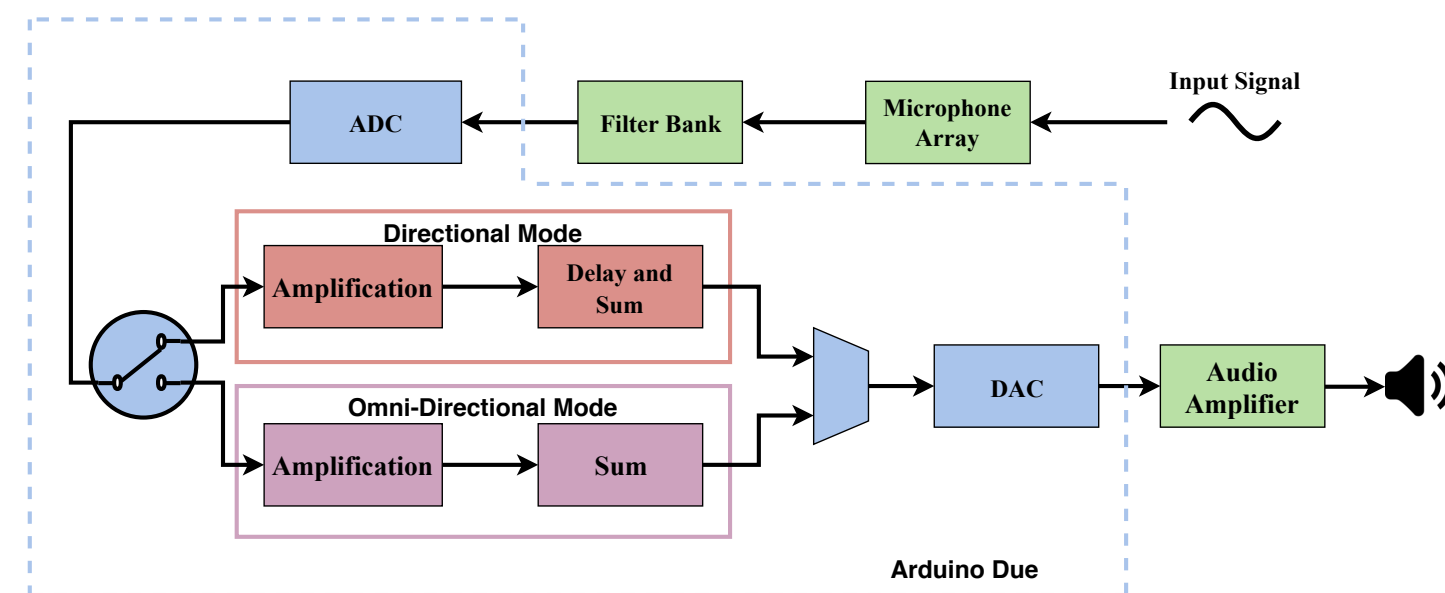
SYSTEM DESIGN

Figure 1: Hearing aid system overview

Simulated vs Hardware Hearing Aid

Table 2: Comparison of simulated and hardware hearing aids

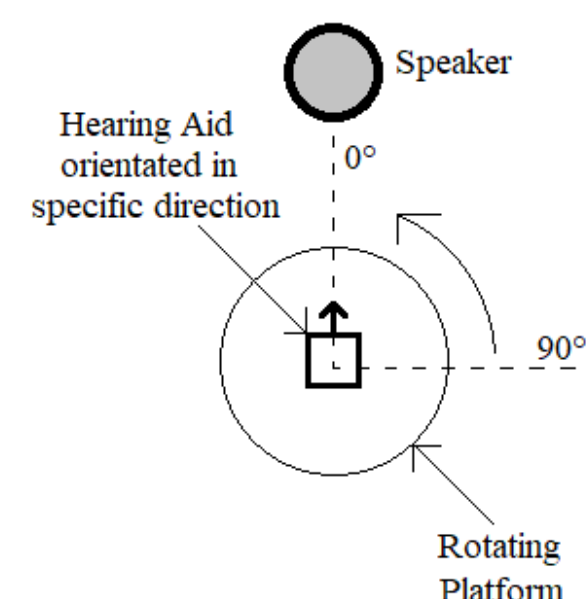| Property	Simulation	Hardware
# of Microphones	10	4
Bandwidth	0.25-8 kHz	2.8-3.5kHz and 5.6-7 kHz
Filter order	14	2
Type of filters	$\frac{1}{3}$ Octave bandpass	$\frac{1}{3}$ Octave bandpass
Number of filters	16 per microphone	2 per microphone
Number of steerable angles	19 (10° increments)	5 (0°, 60°, 90°, 120°, 180°)

Testing

Figure 2: Procedure for testing the hearing aid

RESULTS: SIMULATION
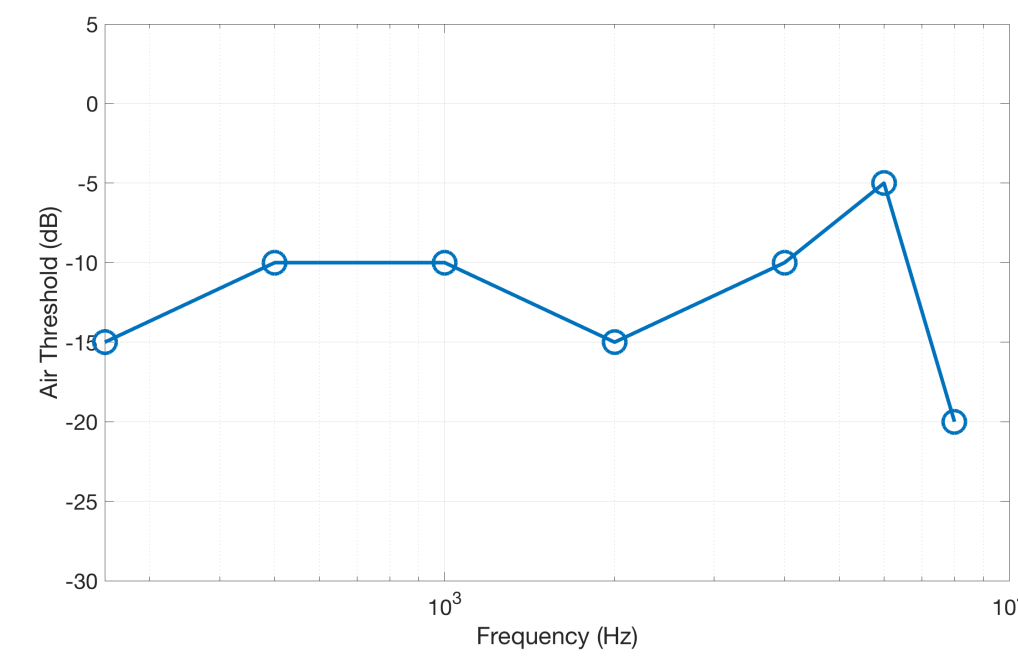
Figure 3: Audiogram
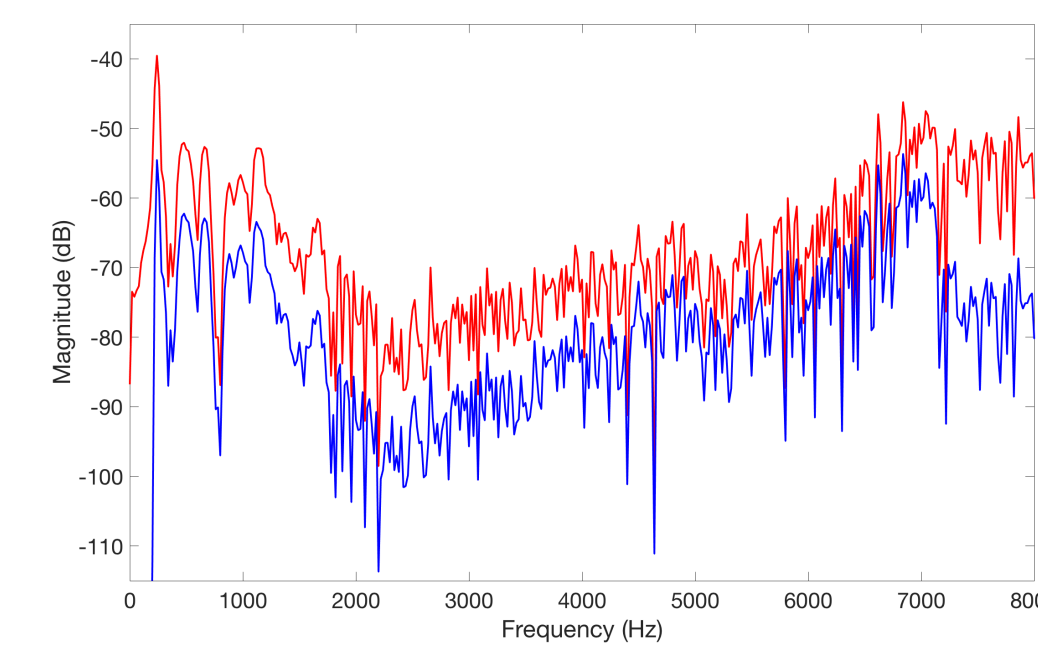
Figure 4: FFT Software
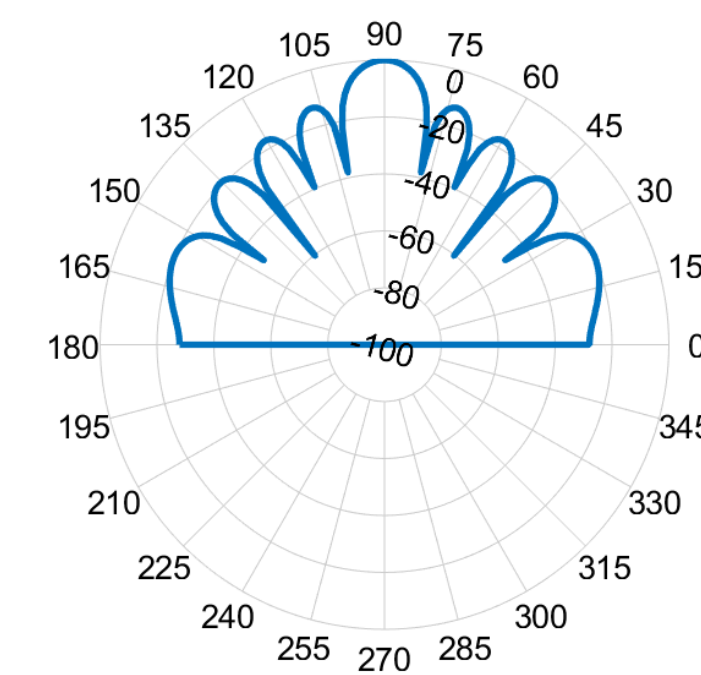
Figure 5: 90°

RESULTS: HARDWARE
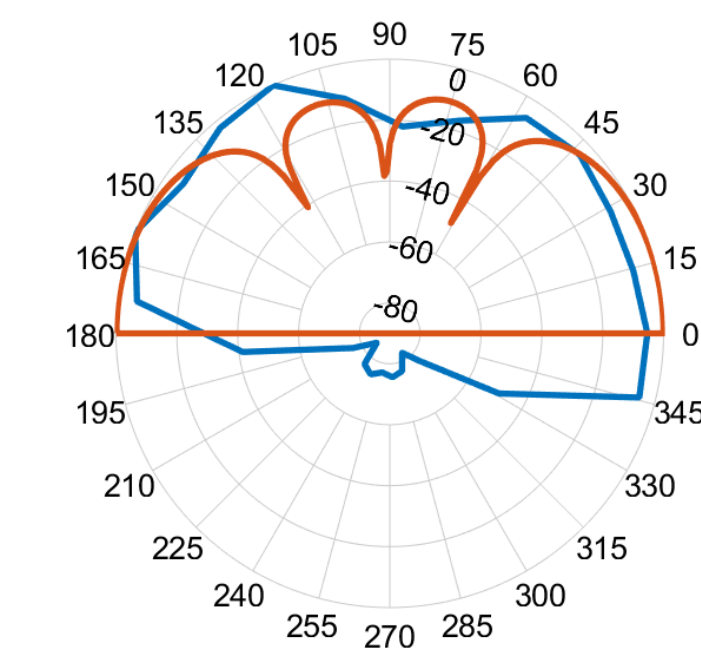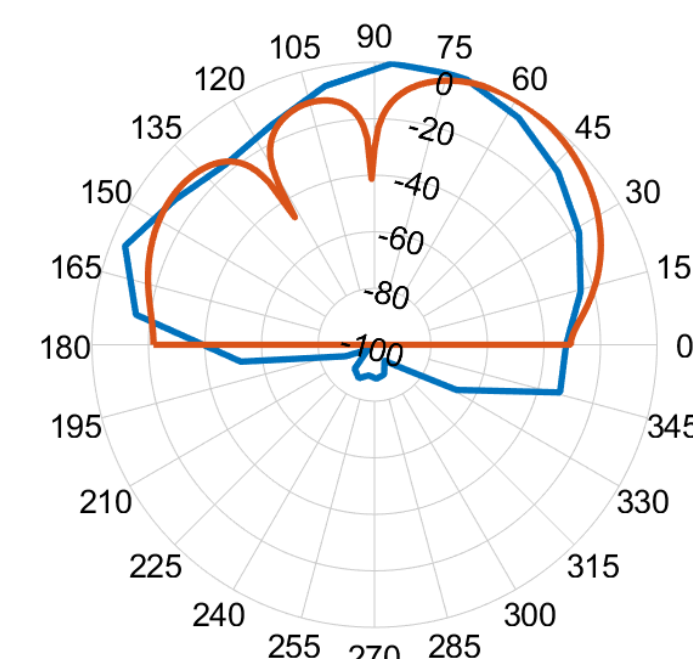

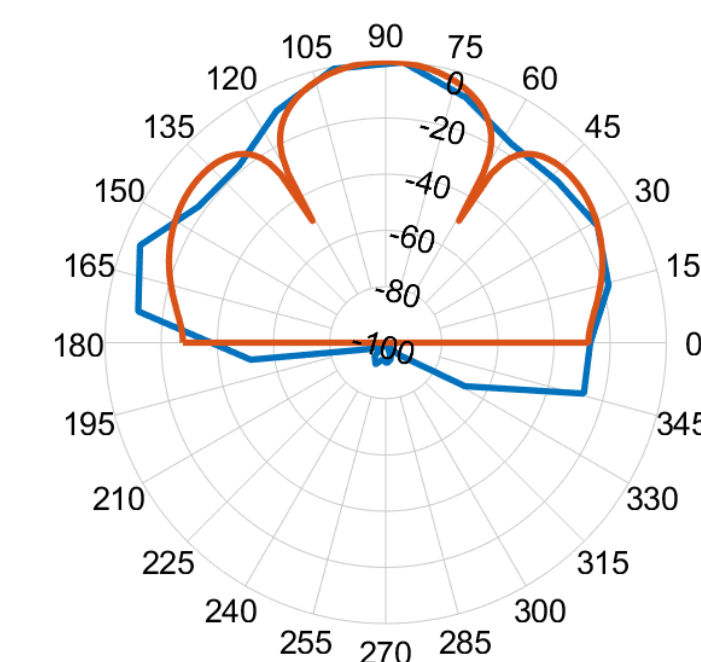**Figure 6:** 0°

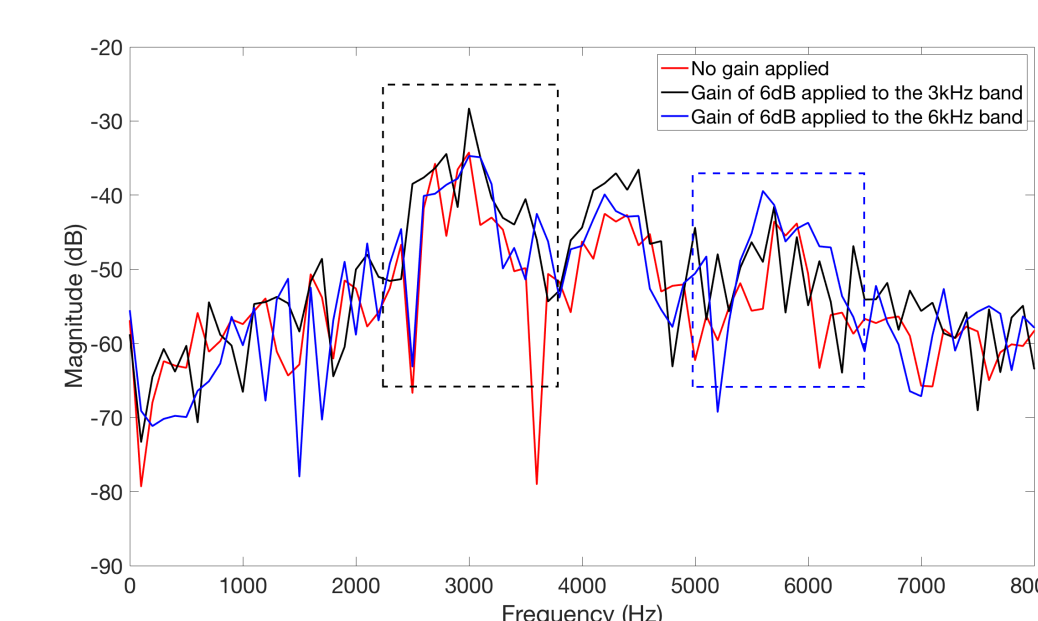**Figure 7:** 60°

Figure 8: 90°

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

RESULTS: HARDWARE

The error in the directionality feature was calculated by comparing the measured to the simulated polar plots for each steerable angle

Table 1: Average error in the directionality feature

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.