



Project Title: Design of an Adaptive Hearing Aid

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## Project Specification:

### Minimum Specifications:

The design, construction and testing of a pair of hearing aids is required. Each hearing aid is required to independently apply compensatory amplification based on the audiogram for that ear. Pre-recorded audiograms, supplied by the supervisor, will be utilized in implementing this amplification. The hearing aids also require an aspect of directionality, implying that hearing aids are required to be tuned to amplify sound in the direction that the user's head is facing. The user will not be able to choose a direction for sound amplification other than the one in which they are facing. The directionality feature must be able to be toggled on and off in order for the user to be able to hear in all directions if required. Achieving functionality in these areas would be regarded as meeting the minimum specifications for the project. All implemented features will undergo rigorous testing in order to determine the success rate of the device.

### Target Specifications:

In the target specifications, the minimum requirements will be met and improved upon. These improvements will be in the form of enhancing the performance of the filters that are used to implement the features. The enhancements will improve sound quality and thus improve the overall performance of the system.

A large improvement to the directionality feature is that it will be tuneable by the user based on real time preferences. The user, by turning a dial, will be able to decide on the direction in which they wish to hear. The resulting direction of the dial will indicate the user's desired direction.

An additional improvement is the acquiring of audiograms from human participants, using equipment supplied by the supervisor. This will allow the group to determine a success rate based on user experience as well as from hardware testing procedures.

### Testing Specifications:

The testing specifications will differ depending on whether the minimum or target specifications are achieved. The minimum requirements for testing would involve the use of a signal generator. To test the compensatory amplification for a given audiogram, a sinusoidal signal consisting of a single harmonic will be applied to the elements of the system responsible for amplification and the resulting amplification will be analysed. The frequency of these sinusoidal signals will range from the lower to the upper bounds of the frequency range of human hearing. Additionally, background noise will be added to these signals to mimic a realistic environment whereby the user would require the functionality of a hearing aid.

Testing the directionality feature will involve producing single harmonic sound waves from multiple directions relative to the hearing aid. The resulting signals, after having passed through the hearing aid, will be plotted and compared. This will allow for the visualization of the degree of amplification and attenuation of signals from the desired and undesired directions respectively.

The target requirements for testing will involve achieving all minimum testing requirements as well as obtaining results from human participants. An audiogram will be obtained from each participant without a hearing aid. Thereafter, a second audiogram will be obtained with the individual making use of the developed hearing aid. These two audiograms can then be compared in order to assess the effectiveness of the device.

## Milestones:

Date	Task
06/04/2018	Ethics clearance form final hand-in
25/06/2018	Project plan meeting with supervisor
26/06/2018 – 05/07/2018	Project research and preliminary simulations
06/07/2018 – 15/07/2018	Laboratory project plan
16/07/2018	Laboratory project plan submission
16/07/2018	Latest date for component arrival
06/07/2018 – 22/07/2018	Implementation of code for audiogram compensatory amplification
06/07/2018 – 22/07/2018	Analogue filter design and implementation
23/07/2018 – 27/07/2018	Full circuit design and implementation and ADC implementation
28/07/2018 – 08/08/2018	Implementation of directionality algorithms and hardware
09/08/2018 – 16/08/2018	Full system testing
17/08/2018	Latest date for laboratory project title changes
18/08/2018 – 26/08/2018	Report writing and poster design
27/08/2018	Staff inspection of laboratory projects
28/08/2018	Open day
29/08/2018 - 02/09/2018	Completion of reports
03/09/2018	Report submission
04/09/2018 - 12/09/2018	Conference preparation
13/09/2018	Laboratory conference

## Preliminary Budget & Resources:

The resources discussed below are divided into two sections: resources that must be purchased, and those that are pre-owned or available for use.

### Preliminary Budget:

The budget presented in this section provides cost estimates that are based on worst-case pricing per component. Once costs had been deducted for the microphones, headphone jack, miscellaneous components and import duties, all the remaining money was allocated to buying a high quality microprocessor. This is to ensure that exemplary signal processing can be performed. Miscellaneous costs include buying a PCB board and other analog components.

Resource	Price Per Unit (R)	Quantity	Total Price (R)
Microphone	50	4	200
Headphone jack	50	1	50
Miscellaneous	300		300
Microprocessor	400	1	400
Import duties	250	1	250
<b>Total</b>			1200

### Pre-owned Resources:

Resource	Quantity
Speaker	1
Earphones	1

### Available Resources:

Resource	Quantity	Obtained from
Signal Generator	1	University of the Witwatersrand
Audiogram generator	1	Emoyo

## Risks / Mitigation:

The largest risk involved with achieving the target specifications is failing to obtain ethics clearance. This clearance is required for any aspect of the project requiring human participation. As such, without ethics clearance, user feedback as a method of obtaining results will not be possible. Furthermore, specific audiograms from individuals will not be obtainable. As a mitigation of this risk, if ethics clearance is not obtained, pre-recorded audiograms will be used to tune the hearing aid and testing will be performed using electrical equipment.

Since the equipment used to obtain audiograms will need to be obtained from an external company, the group is not in control of its availability. If the equipment is not available, pre-recorded audiograms will be utilized. Furthermore, signal generators will be required for producing single harmonic sinusoidal signals for testing. These devices may not always be available from the Faculty of Electrical and Information Engineering, and as such the device will be booked long in advance to ensure availability.

High quality microphones are not available at local electronics stores. Hence, they will have to be imported which will take an extended period of time. As mitigation, these components will have to be ordered well in advance to ensure that they arrive in time for the start of the laboratory project. In a worst case scenario, lower quality, locally available microphones will have to be utilized.

The group has assumed that the earphones that are obtained with the purchase of a cell phone will be of a high enough quality to act as an effective sound conduit. If this is found not to be true, higher quality earphones will have to be purchased.