Meeting minutes: Design – Adaptive Hearing Aid 4th meeting
[08 October 2018], [10:40 am]
Wits Chamber of Mines, School of EIE, Seminar Room

Facilitator: Prof. Rubin

Note taker: Amprayil Joel Oommen

Attendees: Kavilan Nair, Iordan Tchaparov, Amprayil Joel Oommen, Arunima Pathania, Kyle Govender, William Becerra, Fiona Oloo, Boitumelo Mantji, Verushen Coopoo, Lindokuhle Mbatha, Jean Jordaan, Daniel Edwards

Agenda:
Apology for Delay in Meeting Start
Filtering
Directionality
Report-related matters
Miscellaneous

Apologies: None

Absent: None

Agenda item: Apology for Delay in Meeting Start
- Prof. Rubin had several matters that he had to attend to and was hence, delayed in getting to the meeting on time. Prof had emailed students and notified Jeannine at the reception, to inform students about the delay.

Agenda item: Filtering
- Fiona (Question):
  - Many dedicated Hearing Aid Digital Signal Processors (DSPs), have predefined filter designs (e.g. centre frequencies, bandwidths); however, this prevents designing our own system with our own considerations.
  - Hence, once decided on a design for the filter (e.g. orders, gains), are we required to design a DSP which is able to implement the filters?
- Prof. Rubin (Response)
  - Rather make use of readily available DSPs, capable of handling the filter design you would like to implement.
  - Can design your own DSP if you want, however, given the current time constraints and even looking at potential commercial South African start-ups, Prof believes it will be easier using readily-available DSPs, components, etc.
- Fiona (Question): Are we able use design considerations from literature, such as attenuation in the cut-off bands, when designing our own filters (e.g. attenuation of 40 dB outside of the passbands, resulting in sounds in those frequency ranges being softer)?
- Prof. Rubin (Response): It is a fair assumption to make.
- Joel (Question): Is the audiogram stored in the DSP? Is it sufficient to provide audiologists with the capability to adjust the gain levels between certain frequency ranges?
- Prof. Rubin (Response):

- ➢ DSPs are required to be able to store the audiogram of an individual, so that the hearing aid is adjustable for them (e.g. if the individual's hearing deteriorates as they age, then the hearing aid must be able to be adjusted to cater for that).
- ➢ An acceptable means of achieving this, is by designing the hearing aid with a discrete number of filters which operate on different frequency ranges and where its gains can be adjusted as required – this is a means of "storing and normalizing" one's audiogram.
- Lindo(Question): Last week, you had specified that we require a compression design, for our Dynamic Range Compression. Are we also required an Expansion Section, within the Compression design, which is a suggested solution for a specific psychoacoustic problem?
- Prof. Rubin (Response): You can include expansion in the design, but you do not need to go into detail about the psychoacoustic analysis behind the implementation.

Agenda item: Directionality

- Fiona (Question): With regards to focusing on sounds at a particular angle (i.e. having a main lobe focusing on a specific region), how big should the successive "next" lobes be? What must the dB difference between the main lobe and the successive lobes? Is there some sort of threshold value that we should use for that dB value?
- Prof. Rubin (Response): Use your discretion and design in accordance to what you need / require for your directionality.
- Jean (Question): Depending on the array size, the way we approximate a near-field and far-field sound will be different (i.e. characteristics such as wavelengths of the sound, speed of sound and the distance of the source from the listener). Is it ok for the rest of the design, that we make an assumption that both the near-field and far-filed are treated the same?
- Prof. Rubin (Response): Absolutely, show that you understand the problem at hand, but then move on with the design, by stating the compromises and design decisions. Such a consideration can only be tested and verified using practical experimentation, hence show that you have considered it, but move on with the design.

Agenda item: Simulations and Results

- William (Question): Is it fine to perform simulations of the system on Simulink, using predefined simulation blocks (e.g. Octave bandwidth filters)?
- Prof. Rubin (Response):
  - ➢ If elect to go this route, will have high-level system simulations.
  - ➢ Will be required to make justifications for design considerations and will need to make certain assumptions of the performance of the device, etc.
- William and Joel (Question): How do we evaluate the errors and performance of the system, seeing that this is a paper design?
- Prof. Rubin (Response):
  - ➢ First, you must decide upon design specifications for the Hearing Aid.
  - ➢ Then, go about designing and simulating the system.
  - ➢ When evaluating and critiquing the design, compare the original design specifications with the simulated design and see if the design meets requirements.

- William (Question): What results are we required to include in the report?
- Prof Rubin (Response):
  - *Filtering*: Outputs from the filters and perhaps also the compression algorithms /techniques.
  - Not practical to test the designed filters using the entire frequency range for speech. Therefore, try get a few input speech samples (of different frequencies) and obtain the outputs of the filters for those input.
  - *Directionality*: Show outputs of the directionality system (i.e. on a polar plot), when different point sources of sound are used.

Agenda item: Report-related matters

- Verushen (Question): Please could more clarification be given, pertaining to how the two partner's systems are to be integrated. Is it for example necessary to simulate a signal being inputted into one of the systems, and its subsequent output being used as the input of the second system?
- Prof Rubin (Response):
  - The report **MUST NOT** be a presentation of the hybridization of the two partner's systems – time constraints are too limiting, and this would only be required to be done in a commercial project.
  - Rather, the two systems must be able to be joined in "*principle*" – ensure that communication and thought has taken place in collaboration with your partner, taking reasonable precautions, etc. (e.g. knowing how many outputs will come out of the one system, and using those as inputs of the secondary system).
- Prof Rubin (Comment): This is a paper design, and we do not have the capability of physically testing and making subsequent changes; therefore, be reasonable and make decent design consideration and assumptions.
- Jean (Question): In the rubric, in order to achieve a "Good" or "Excellent" rating, we are required to show evidences of outstanding features in the design, etc. Please could you clarify what that means in this context?
- Prof Rubin (Response):
  - The markers of the report, understand the time constraints and the difficulty of the problem presented to students.
  - Therefore, to evidence outstanding features, show that you have thought clearly through matters (even if they present themselves as problems that are difficult to address), justifying the design, showing the compromises that have had to be made, etc. If you can evidence this clear thinking and can motivate decisions, it is likely that the markers would consider this favourably.
  - What we are more concerned is the design cycle and how you approached solving the problem, as opposed to the actual design.
- Jean and Verushen (Question): Please could you give details about the content and structure of the Appendices?
- Prof Rubin (Question):
  - *Appendix A*: The CBO mentions this must be a non-technical report of the impacts of the engineering solution, and about the improvements that can be applied in reducing the negative impacts.

- ➢ This can detail the social and economic impacts of the hearing aid on the community (both locally in South Africa and even internationally) and vice versa.
- ➢ Format of Appendix A must follow IEEE standards, as well as anything further dictated in the CBO. Can write it like an essay, can insert headings if you desire, etc. (provided the proper standards and dictated guidelines are conformed to).
- ➢ *Appendix B and C*: Previously, had mentioned that a Gantt Chart could be included as an Appendix. Furthermore, it would be valuable including a rough cost breakdown of the entire hearing aid device (you will not be marked down if you do not have one, nonetheless, it can be insightful in giving an idea of how sustainable an idea this is, thus aiding in evaluating the appropriateness of the design etc).
- Joel (Question): Please can more clarification be given on the format of the report.
- Prof Rubin (Response): Use the guidelines given in the CBO to dictate the details of the style requirements of the report (e.g. 15 pages, single column), and use the Blue Book to ensure that these details conform to the IEEE styling standard.

Agenda item: Miscellaneous

- Lindo (Question): Are we allowed to use a FPGA, instead of a DSP, if necessary?
- Prof Rubin (Response): Yes. The FPGA allows you to digitally code the device and dedicate the device for processes / operations / functionality. In addition, it allows for parallelism of operations. Can be a good alternative to the DSP if need be.

[11:35 am] Meeting adjourned.