Multisensory Navigational Aid for Visual Prosthesis Users

Computer Integrated Surgery II
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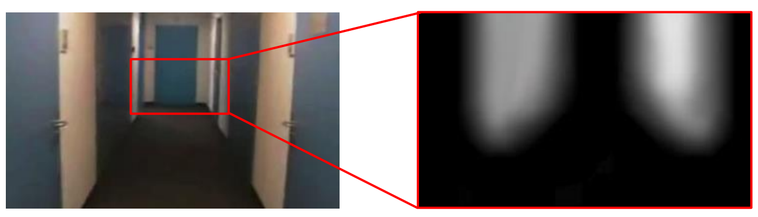
Introduction

For this project, haptic and auditory feedback systems were developed for the Argus II retinal prosthesis system. Intuitive haptic patterns were developed to relay directional instructions. Furthermore, an algorithm was created to spatialise sound to assist with object localisation. A visual feedback method was implemented with the haptic and auditory feedback systems which were then integrated with a SLAM navigational system.

The Argus II retinal prosthesis system is designed to give sight to those with late-stage Retinitis Pigmentosa – a breakdown or loss of retina cells. However, the artificial vision produced by the system is not the same as actual sight, thus this project aimed to develop supplementary systems to assist users with target navigation and obstacle localization.



Real World Scene Artificial Vision

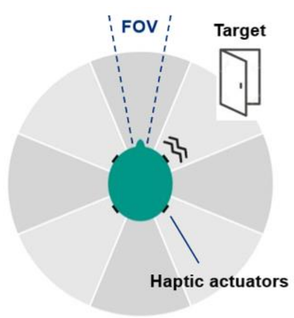
The Problem

The following limitations still exists with the Argus II system which hinder the users' ability to independently navigate a space,

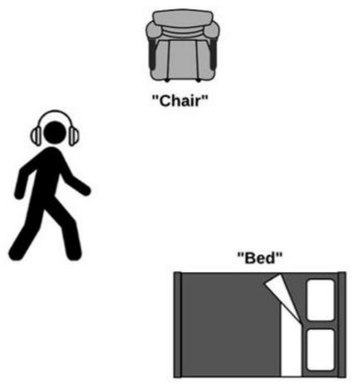
- Not the same as actual sight, only light and dark areas
- Perceived light intensities vary between users
- Limited field of view (20^o horizontal, 12^o vertical)

The Solution

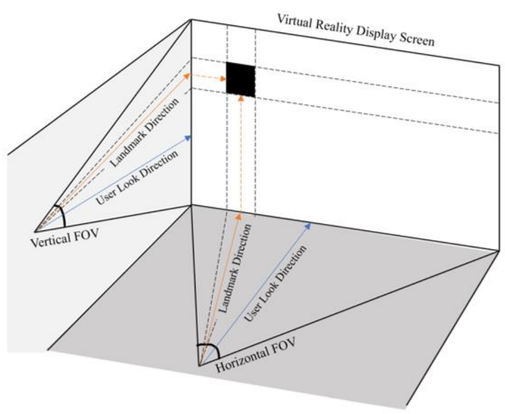
- **Haptic Feedback System**
  - Headband with 7 LRA haptic actuators
  - Dynamic and static haptic patterns
  - Feedback algorithm for gaze guidance



- **Auditory Feedback System**
  - Spatialised sound using individualized HRTFs
  - Feedback algorithm for object localisation

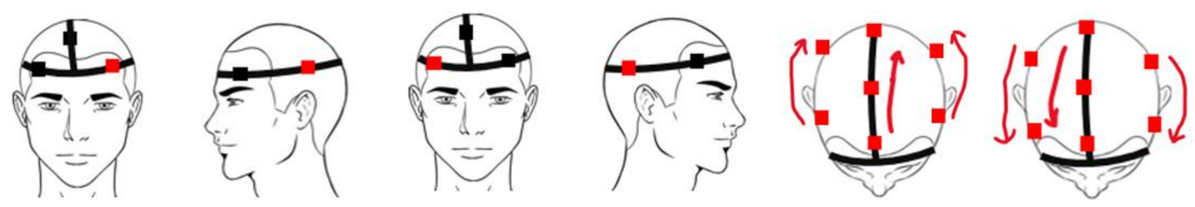


- **Visual Feedback System**
  - Map landmarks to pixels on VR display

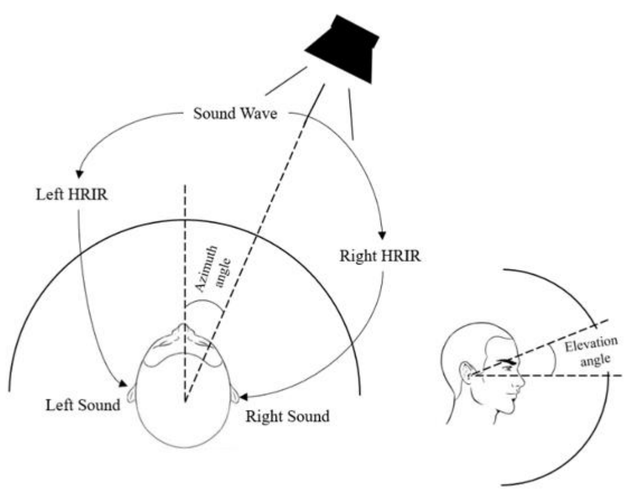


Outcomes and Results

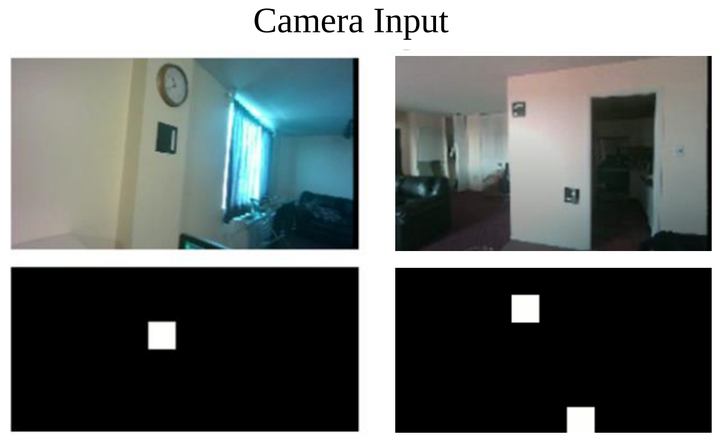
- **Haptic Feedback System**



- **Auditory Feedback System**
  - Obstacle name and distance from user announced sequentially
  - Only obstacles within 10 feet announced
  - Additional fine obstacle localization method was implemented



- **Visual Feedback System**



Future Work

- Participant testing with Argus II users
- Evaluation of system's effectiveness in target navigation and obstacle avoidance
- Robust way to individualise HRTFs (other than taking direct measurements)

Lessons Learned

- If not using direct measurements, creating accurate individualized HRTFs is a challenging task
- Placement of haptic actuators can discernably alter how it is perceived in terms of intensity and location

Credits

As the sole member on this project, An Chi completed all the work described in this poster with the foundation, such as the SLAM navigational system, provided by APL.

Support by and Acknowledgements

Thank you to my mentors, Dr Billings and Chi for their unwavering support and insight during this whole project.