SwimSense

An assistive device to guide visually-impaired swimmers

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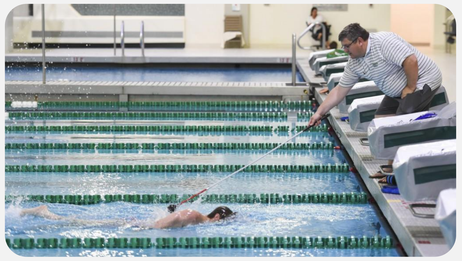
Background

- The pool environment is considered a historically inaccessible space for visually-impaired people
- Many assistive technologies (e.g., white cane, guide dog) cannot be used while swimming
- Visually-impaired individuals face the risk of colliding into barriers while swimming
- The common method of “tapping” method can be uncomfortable and relies on other individuals



Goals

- Create a device that can be used to alert blind swimmers when they are approaching a wall or the sides of a lane
- Determine the most effective way to deliver directional feedback
- Eliminate the need for tappers
- Empower visually-impaired swimmers through enabling independent navigation

User Research

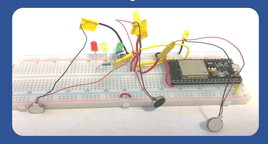
- Conducted literature reviews, interviews, as well as developed and distributed a survey to identify:
  - Assistive technologies currently in use
  - How these assistive technologies communicate with users
  - Comfortable placement of assistive device
  - Swimming habits of blind individuals
- The survey collected data from 13 representative users (i.e., legally blind individuals)
- Interviews with representative users, associated personnel (e.g., coaches for visually-impaired swimmers), and relevant academics

Design and Development

Feedback device

- Created four feedback languages
- Three use cases: approaching a wall, drifting towards the left side of lane, or drifting towards the right side of lane

Haptic



Language 1: Head vibrations

Language 2: Wrist vibrations

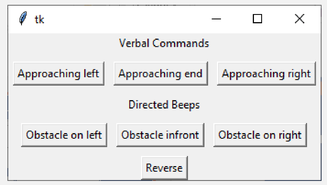
Auditory

Language 3: Verbal voice commands

Language 4: Directional beeping

Controls

- Bluetooth connectivity using PyBluez module
- GUI was built for manual control using TkInter

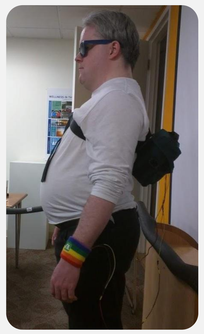


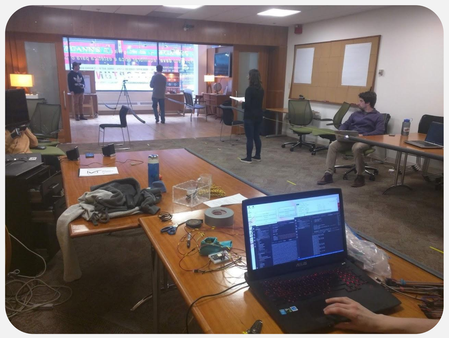
Object detection model

- Five classifications: far wall, near wall, left barrier, right barrier, swimmer

TensorFlow

Testing





- Simulated a pool environment by roping off an area with similar dimensions to a lane
- Seven visually impaired participants were asked to walk the full length of the lane and back using each feedback device as a guide
- Devices were manually triggered when participants crossed markings on the ground

Results

Key findings from testing

- Preference for informative rather than informative + directive feedback
- Haptic feedback less likely to be ignored
- Haptic sensors resulted in fewer connection failures

Final feedback device design

- Haptic feedback in swim cap prototype
- Vibration pattern simplified to trigger one of three regions (left, right, front)
- Waterproofed feedback device and associated cap

Object detection model

- Unfinished
- Detects swimmers
- Inadequate training data and time

Future work

- Minimize size of components
- Integrate the device directly into a swim cap
- Improve the object detection model
- Test auditory feedback using bone conduction
- Build indicators so users are alerted in case the device fails (device is damaged, Bluetooth connection is lost)

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