FingerSight: A Vibrotactile Wearable Ring to help the Blind Locate and Reach objects in peripersonal Space

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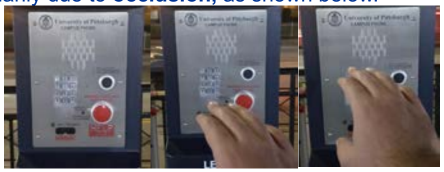
Introduction

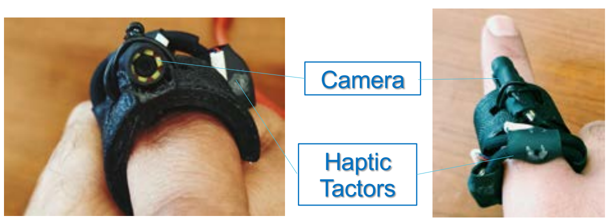
- Visually impaired people need a solution to compensate for the lack of visual information.
- 20 Million adults suffer from high visual impairment according to the 2012 NIH survey.
- Available technologies are only useful to navigate in the environment.
- These do not help the blind to grab, grasp or reach objects primarily due to **occlusion,** as shown below.



- Goal of our research:
  Develop a wearable device that can help visually impaired persons reach and grasp target objects in peripersonal space e.g. grab a cup of coffee placed on a table, pressing buttons on elevators or any other appliances or grasp/touch target objects in the reach or even manipulate a tool

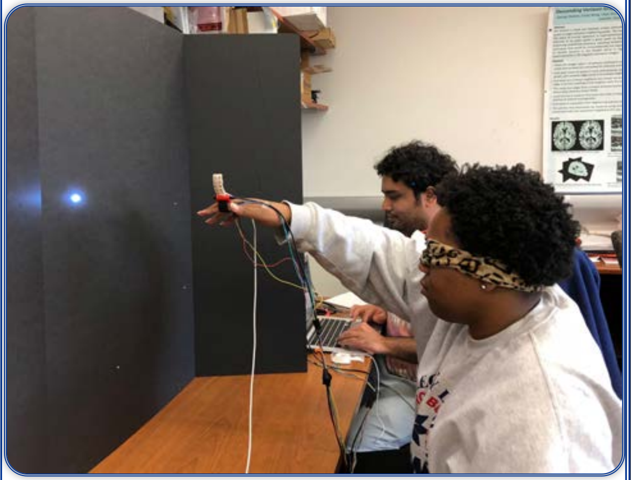
Design

- FingerSight consists of a 3D printed ring that can be worn on the index finger, into which we have embedded an array of haptic tactors and a small cylindrical camera



- The tactors are controlled by an Arduino Uno, which generates haptic instructions by vibrating the correct tactor to guide the hand towards the target object.
- The camera is used to detect the target object at the rate of 2 frames per second.
- A computer vision algorithm was developed to detect a blob or an LED on a back board which served as the target object.
- The co-ordinates (x,y) i.e. the center target object and it's radius were extracted from the algorithm to provide necessary haptic instructions to reach the target.

Methods



30 sighted volunteers were recruited to test functionality

Participants wore FingerSight and were blindfolded

One of the four LEDs inserted into a cardboard was randomly selected as target object

Additional hardware was added to FingerSight for housing IR-LED markers that enabled motion tracking

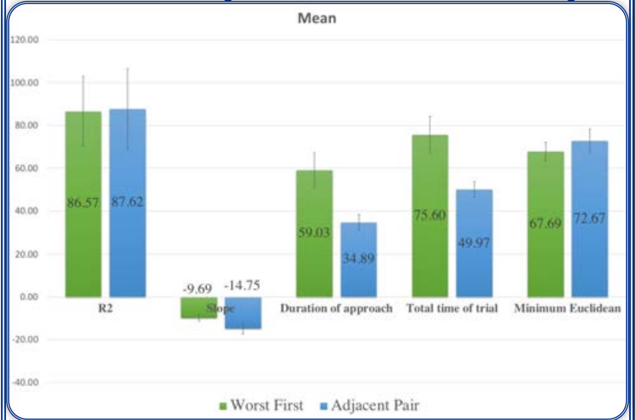
Two different guidance strategies used and compared for efficiency:

- Worst Axis First': Correction provided only in worst direction, either horizontal or vertical
- Adjacent Pair': Correction in both horizontal and vertical directions by alternating signals

Results

Activated Reported	1	2	3	4	5	Total Errors (n=90)	Error %
1 (top)		0	0	1	3	4	4%
2 (right)	1		9	4	2	16	18%
3 (bottom)	4	2		0	2	8	9%
4 (left)	7	5	0		1	13	14%
5(straight)	5	0	1	1		7	8%

- When assessed how well participants could distinguish between different haptic instructions, the error percentage was about 11% on average with less than 5 minutes of training.



- Both the guidance strategies were successful at leading the participant to reach the target
- **Adjacent Pair guidance strategy was significantly quicker**
- While half a minute to reach an object is admittedly slow, more training and experience will likely increase efficiency.
- Future work will address the capability of FingerSight to detect real-life objects, be interfaced with a phone and receive audio commands

Acknowledgement

We would like to thank the Center for Medical Innovation at the University of Pittsburgh for supporting this work.