PGTE 5585 : Physical Computing
Final Project Proposal

Conceptual Description

The idea of sensory substitution was pioneered by Paul Bach-Y-Rita in 1969 in his experimental project, Vision Substitution by Tactile Image Projection. Sensory substitution can be defined as a change of characteristics and of one sensory modality into stimuli of another sensory modality. Let's consider brain a general-purpose computational device that processes electrochemical signals coming from different sensing peripherals such as eyes(sight), nose(smell), skin(touch), ears(sound), and tongue(taste). All of these senses have in common is that they perceive the different characteristics of the environment and then send it to the brain in the form of electrochemical signals. The brain processes this information. It looks for patterns to distinguish between different sensory perceptions, for example, identifying a soft material and a hard material through touch. In a similar approach, by conveying haptic patterns with varying intensities, a substitute sense is intended to occur in the user.

According to the *cortical homunculus*, hands dominate the sensory homunculus as compared to other parts of the body. Hence, they are more sensitive to haptic feedback and has a better spatial perception as compared to other body parts.

Narrative Description

A haptic glove will be designed to act as a sensory substitution or extension of the human body. It will be designed to look-alike a regular glove but delivering haptic feedback to the user. The user will experience static, spatial, and sweep haptic feedback. The haptic feedback will also vary in intensity from soft feedbacks to hard feedbacks relaying different kinds of information to the user. This haptic glove is intended to give a new experience to the user. The glove will act as a sensory perception working in the background and wouldn't require the user's focus to perceive data. This can be described as you're wearing a shoe and you won't feel it unless you walk on a rough surface, this will give you a sensation of rough surface without your primary attention being distracted.

Technical Description

The glove will incorporate a 4x4 haptic feedback matrix consisting of circular vibrating motors. The matrix will be laid out in a pattern that relays information to the user requiring minimal attention of the user. Arduino Nano will be responsible for controlling the 4x4 vibration motor matrix. The data will be communicated from Processing to Arduino using Serial Communication.

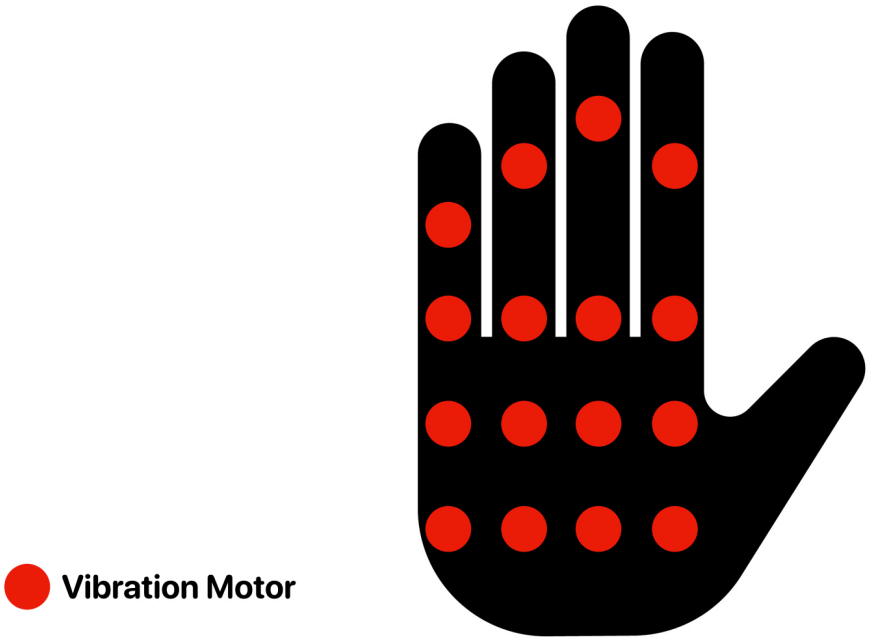

Figure 1. Layout of Vibration Motor Matrix

The intent is to create a user experience to extend the sensory system and relay information. A few applications can be listed as -

- Navigation Device
- Data Perception
- Haptic Feedback Display for the blind
- Audio Visualiser
- Haptic Feedback device for Virtual Reality

Related Work

1. WeWalk

With WeWalk, a user can fully plan their route with the help of Google Maps, replete with features that make the application more accessible to those without sight. After pairing the cane with their smartphone, users can swipe left or right on the cane's touchpad, to roll through a list of features — voice assistant, "where am I," navigation, microphone speaker, and so on. It also houses an ultrasonic sensor and vibration motors to alert about obstacles above the waist level.

2. eSight

eSight enables those with central vision loss to see more clearly. eSight is used by many living with macular degeneration, diabetic retinopathy, and a host of other conditions, in helping them live an active and independent life. It uses a Time of Flight depth sensing camera, and puts video directly in front of your eyes allowing you to see what is in front of you, near or far, in real time. It uses algorithms to distinctly show near and far objects.

3. Sound of Vision

Sound of Vision enables a sense of vision by audio and haptic feedback. It uses Intel RealSense, a 3D Depth sensing camera that translates the 3D data to audio and haptic feedback. It intends to replace the universally used white canes used by the visually impaired people.

References

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2. Marco Catani, A little man of some importance, *Brain*, Volume 140, Issue 11, November 2017, Pages 3055– 3061, https://doi.org/10.1093/brain/awx270

3. Graham Wilson, Thomas Carter, Sriram Subramanian, and Stephen A. Brewster. 2014. Perception of ultrasonic haptic feedback on the hand: localisation and apparent motion. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '14). ACM, New York, NY, USA, 1133-1142. DOI: https://doi.org/10.1145/2556288.2557033