Intelligent Glove For Group Conversation For Deaf-Blind Users

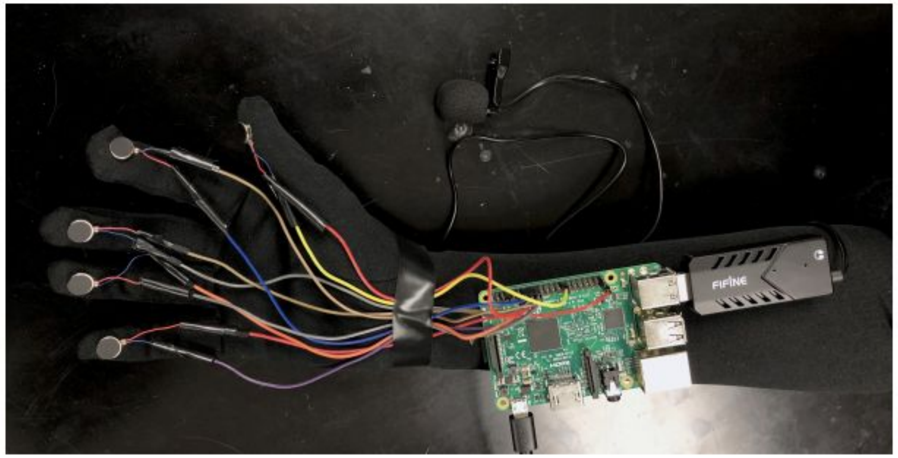
Collaborative Design & Research -CSCI-5020G

Members : Aryan Asadian- Jude Arokiam- Noopa Jagadeesh

OntarioTech UNIVERSITY

Proposal Recap

- Deaf-blindness is a combination of visual and hearing impairment
- 368, 412 people in Canada (2016)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Problems with Existing Solutions

- Difficult for non-deaf-blind people to learn to use
- No real time communication
- Unnatural way of communicating
- Group conversation not considered

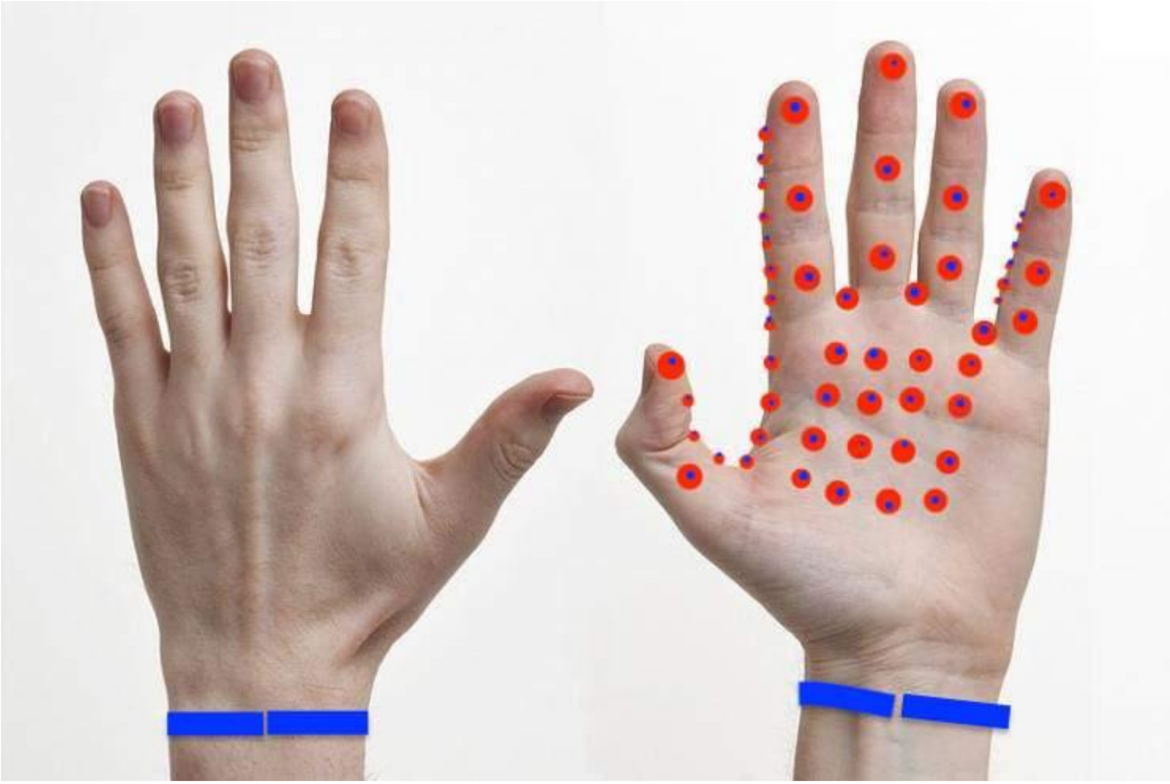
Hardware Design

✓ **Modules**

1. Sensors
2. Vibrators
3. Central processing unit
4. Microphone/Speaker

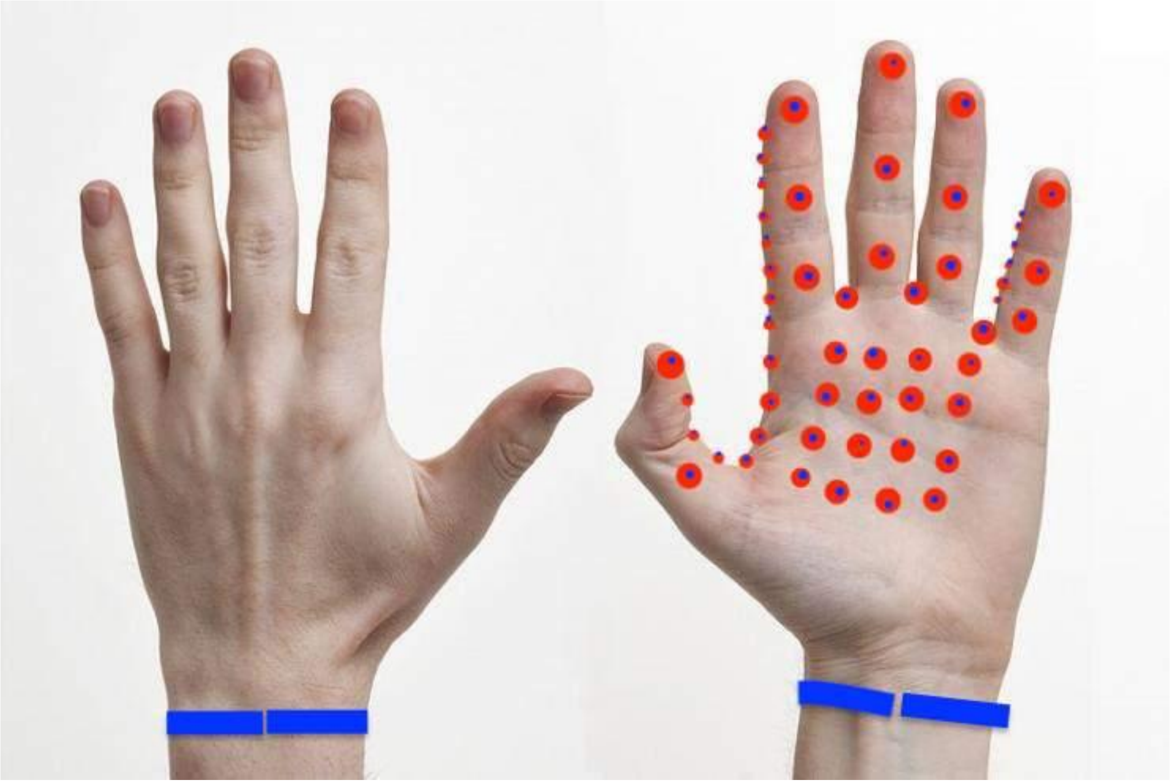
Hardware Design- Sensors

- Fabric coin-shaped sensors (•)
- Touch, pressure, and motion detection
- End of message ⇒ time slot ✓



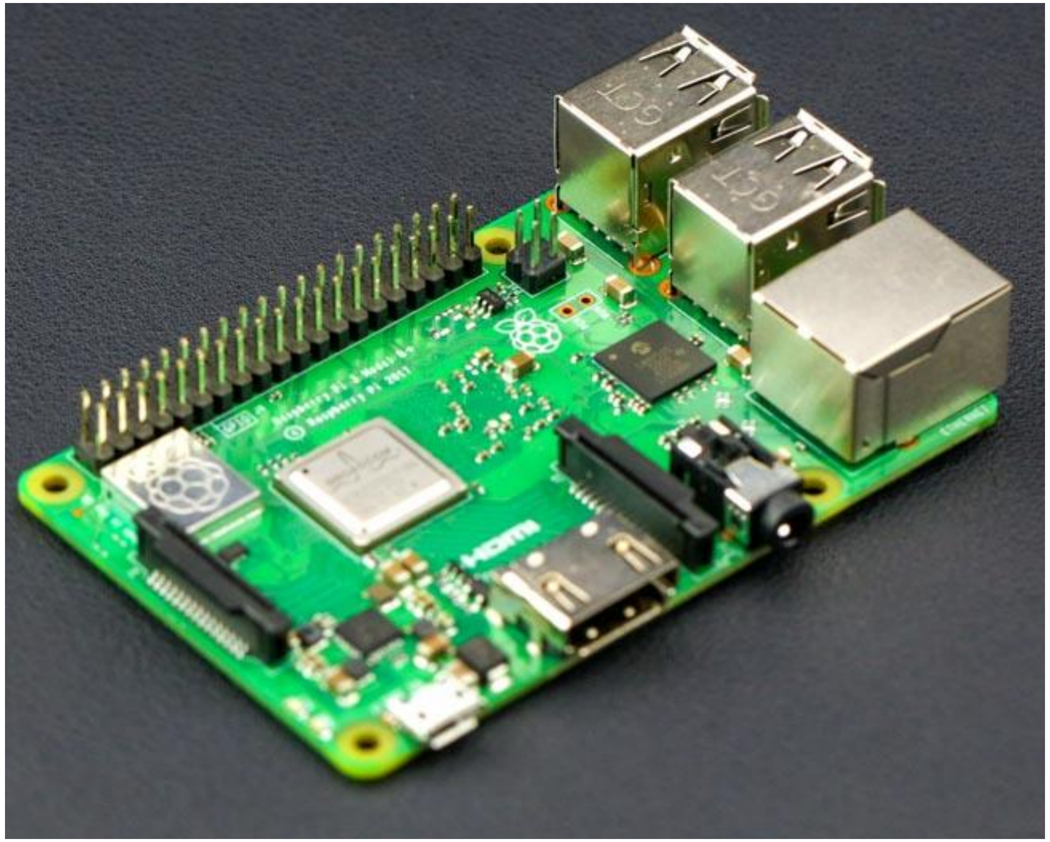
Hardware Design- Vibrators

- Same locations as sensors(•)
- 4 rectangular wrist vibrator
- Back-side ⇒ client-defined phrases, tasks
- Funneling Illusion
- High customizability ✓
- Minimum modifications to the existing tactile language ✓



Hardware Design- Central Processing Unit

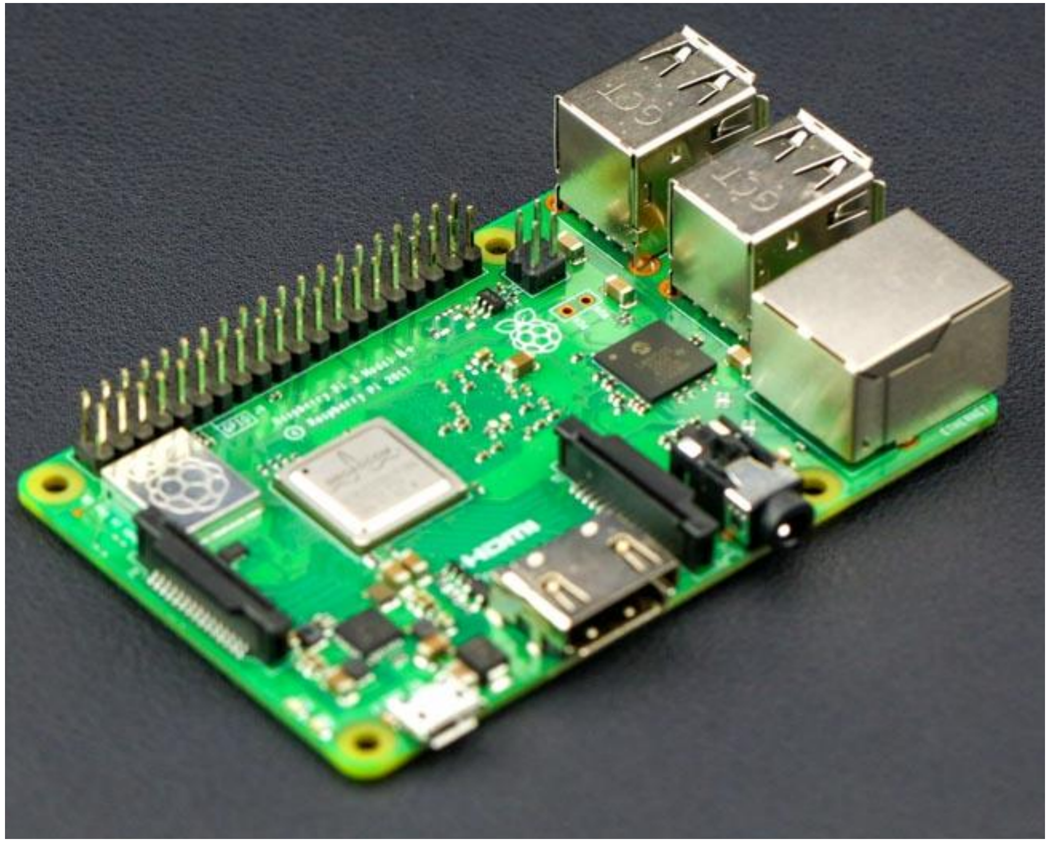
- **Raspberry pi 3 b+**
  - Wireless 802.11 b/g/n/ac
    - Internet Access ✓
  - Bluetooth
    - Compatible with Smartphones ✓
  - 1 Gb RAM
  - 1.4 GHz processor
    - Speech to text processing ✓
  - Operating system
    - Raspbian OS
    - Windows 10 IoT Core



Credit : raspberrypi.org

Hardware Design- Central Processing Unit-Cont.

- **Python -SpeechRecognition**
  - Offline speech recognition ✓
  - Google assistant
  - IBM Watson
  - Alexa
  - Multilingual conversations ✓



Credit : raspberrypi.org

Hardware Design- Microphone/Speaker

- External microphone/speaker ✓
- Smartphones, smart glasses ~~✓~~

Credit: Amazon

Evaluation

- Evaluate the efficacy of our prototype as a bi-directional communication tool.
- Evaluate the efficacy of our prototype as a one-to-many communication tool.
- Analyze the efficiency of our prototype as a real-time speech recognition.

Evaluation

- A total of 20 individuals will be recruited for the experimental studies.
- Utilize two different groups of users for task 1 and 2, because the objective is to evaluate the input and output features separately.
- Participants have normal vision and hearing, and no prior knowledge of any tactile languages.
- The experiment will be realized in noisy environments to reproduce the condition of real-life scenarios, though they will be allowed to comfortably sit in front of a desk with the equipment.
- Subjects will be provided with short briefing about deaf-blindness, and they will be instructed about the tasks before starting the experiment.
- They will have 15 minutes to get familiar with the device and explore it, before the beginning of the task.

Evaluation

Task 1

- In task 1, participants will be delivered tactile stimulations at different intensities over the palm of the hand, and they will be asked to identify the area in which the stimulation occurred.

- Trials involve 3 sets of simulations each consisting of 5 pressure cues at different intensities, and on different sensitive areas.

- Both intensity and location will be chosen randomly, ensuring that each trial included different intensities and areas, in order to deliver at least one stimulus for each sensitive area.

- In each trial, motors will be activated according to a specific pattern

Evaluation

Task 2

- In task 2, participants will be provided with an informative leaflet displaying the deaf-blind alphabet manual for 10 min before the beginning of the test.

- Then, they will be presented with random letters on the display, and they have to touch the area of the device representing the letter.

- The objective of the test is to evaluate the effectiveness of the device in recognizing input from the user, in terms of sensitivity of the actuators, and thresholds for avoiding spurious signals.

- In each trial, users were presented with 27 letters displayed at random.

Evaluation

- **Task 1** focus on evaluating the effectiveness of the device in representing output.

- Specifically the objective of task 1 is three-fold: (1) obtaining the range (minimum and maximum) in terms of intensity for vibration to be recognized correctly; (2) studying the efficacy of our prototype as an output device; and (3) identifying critical areas of the hand in terms of recognition of the stimulation.

- **Task 2,** focus on the input features. Specifically, the objective of the study is two-fold, that is, (1) to evaluate the accuracy in detecting input, and the time spent by users to understand the communication system.

Evaluation

Real-time speech recognition

- For the testing phase of real-time speech recognition twenty English sentences with various levels of difficulty will be tested.

- Three examples of sentences with increasing level of difficulty are:

  ”Be safe”;

  ”What is your address”;

  ”How long have you had these symptoms”.

- After the processing using our prototype the percentage of characters and words recognized correctly by each user are measured.

Evaluation

- The objective of the study will be two-fold, (1) Accuracy of Conversion of Speech to Code, and (2) Operation Time.

- The operation time is broken down to two sections:

  1) Speech Recognition and Conversion Time: This time is measured from the start of the audible speech to the start of the haptic vibrations.

  2) Haptic Vibration Time: It is measured from the start of the haptic vibration to the end of it.

  3) Total Communication Time: It is the sum of the speech recognition and conversion time and the haptic vibration time, from the start of the audible speech until the end of the haptic vibration.

Challenges & Future Works

- Final cost reduction
  - Main Controller unit → 73 $ ❌
- Find the best textile for the glove
- Battery life ⚠️
  - External batteries vs generators
- Partially deaf-blind clients
- Back side of the hand ⇒ client’s defined phrases, tasks
- long-time usability, experience, and functionality study
- Tutorial Mode

Conclusion

- ✓ Intelligent glove for live group conversation for deaf-blind users
- ✓ HCD, MVP
- ✓ Modular
- ✓ Compatible with smart-devices
- ✓ Minimum-level of modification to the existing language

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Any Questions?

Thank You