**Open Refreshable Braille Display (ORBD)**

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**Rationale**

285 million people are estimated to be visually impaired worldwide [1]. Many of these individuals do not have access to blind-assistive technology primarily due to cost and accessibility. One such device, the refreshable braille display, converts digital text to a tactile readout providing a valuable tool in reading and writing applications. However, prices range from $3,500 to $15,000 [2] making it difficult for many low-income visually impaired individuals to buy a device, especially since non-institutionalized persons aged 21-64 years with a visual disability have a median annual household income of $39,700 and about 29% of them live below the poverty line [3]. Since many refreshable braille displays are prohibitively expensive, previous approaches have attempted to lower its cost by restricting the number of characters displayed, but this arose the new problem of higher translation error rates [4]. In order to make refreshable braille displays more effective for a greater number of visually impaired individuals, our open-source device, ORBD, will provide a cheaper alternative to existing braille displays that does not sacrifice on readability, including the number of characters.

**Question**

What changes to the refreshable braille display can allow for more affordability and accessibility?

**Hypothesis**

A new refreshable braille display design will be able to reach more visually impaired individuals without sacrificing its usability.

**Engineering Goals**

* Draft multiple design possibilities to pursue
* Prototype a new approach to a refreshable display at a feasible price
* Can display computer text input in a standard braille alphabet
* Minimizes cost
* Provides an expandable platform to increase the number of characters
* Make device open-source for public accessibility
* If time permits, receive feedback from the Blind Center of Nevada
* Test the readability of the device
* Donate the prototype to allow for further feedback and research

**Expected Outcomes**

A printer-based rail design allows for a stepper motor and gear to turn wheels with tactile braille to appropriate characters. Magnets will assist the wheels to stay at their appropriate characters. Since the wheels rest on a central axle and the motor on the rail theoretically has unlimited extendability, more wheels may be added allowing for more characters to be displayed.

**Procedures**

1. Pre-planning a prototype by making schematics, 3D models, and preliminary plans for development.
2. Assemble the prototype, including using soldering, 3D printers, and other techniques to develop an original design.
3. After each prototype revision, test the following measurements:
   1. Accuracy and readability of characters displayed
      1. Compare output to standard braille alphabet
      2. Compare height of characters and spacing of characters to standards for height and spacing
      3. If time permits, allow individuals to provide feedback on the readability of the display
   2. Attributes of the design
      1. Measure the speed of changing characters, including mean, variance, best case, and worst case
      2. Calculate and log all costs, including electronics and 3D printed components
      3. Measure size of device and power usage
      4. Other attributes as applicable
   3. Attributes of the design
      1. Compare ORBD designs, drafts, and prototypes based on criteria in (a) and (b), as applicable
      2. Compare these attributes with other displays currently on the market, as applicable

**Risk and Safety**

There will be no risks to any participants or other parts involved in data collection. During assembling, 3D printers and soldering pose a potential heat risk, but by following proper precautions, this risk will remain at a minimum. Low-voltage and low-amperage electronics pose minimal to no risk.

**Data Analysis**

The device must first prioritize power efficiency as inefficient actuator design may limit the performance of the microcontroller, so power capabilities will be considered in the draft designs. Next, the speed and accuracy will be measured through inputting characters on a computer, translating them to the display, and recording the time it took and the correctness of the characters based on what was inputted in the computer. Lastly, a cost-benefit analysis for the draft designs and prototype will detail its feasibility as compared to other models.

**Bibliography**

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