

## **DeviceABLE: A Novel Hands-Free Computing App for People with Disabilities** (see attached project photos)

Unfortunately, for millions of people with disabilities, *hands-free computing* is their *only option*, but the current technologies have many drawbacks: very expensive, less functional, bulky /inconvenient gears, less accurate etc. That is why I created DeviceABLE that not only solves all these issues, but also provides many more innovative features. DeviceABLE is a novel app – the only comprehensive app in the market for full computer usage; and is also free, hands-free, and hardware-free. It's also highly accurate, user-friendly, and has many useful customizable features.

For my innovation, I used Python, computer vision, and 15 libraries. My app has three softwares: 1.) I made a *virtual mouse* that follows your head movements, by capturing video using OpenCV, detecting facial landmarks using MediaPipe, and utilizing the PnP algorithm for cursor movement. The mouse *left/right clicks* and *dragging/scrolling* works by closing/opening your eyes/mouth respectively, for 2-seconds (utilizing EAR and MAR algorithm). 2.) I built a customizable *on-screen keyboard* which types when you hover on a key for 2-seconds (utilizing PyAutoGUI). 3.) I also created a *voice-assistant* that has 30 commands to enhance functionality. Finally, I used threading for faster app speeds, then used PyInstaller to convert all my app's scripts to .exe. Then, I created an installer using Inno setup for other computers to run my app.

I tested my app on a diverse group, including two people with disabilities; and found that my app's average accuracy was 91%. By conducting two *statistical t-tests*, I found that my result was highly statistically-significant with 99% confidence. I also tested and compared my app with six other apps and found that DeviceABLE is the best – there is no other app like mine in the market. My app also received 15 excellent feedback from five AT professionals and testers from Technology for Living, Neil Squire, and Spinal Cord Injury BC. 80% of disabled people in developing countries don't have access to assistive technology, so my app will be very helpful.

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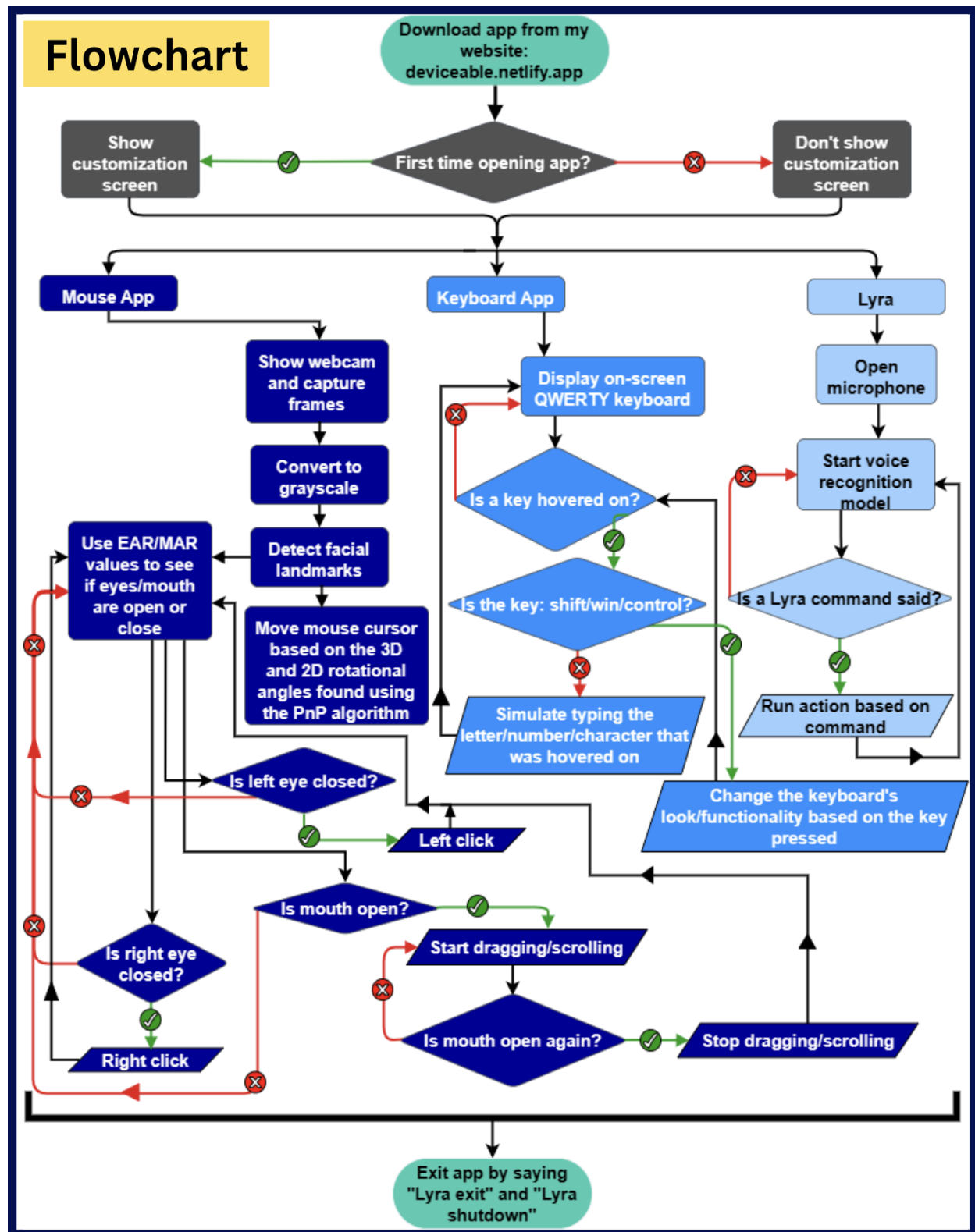
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# PROJECT PHOTOS



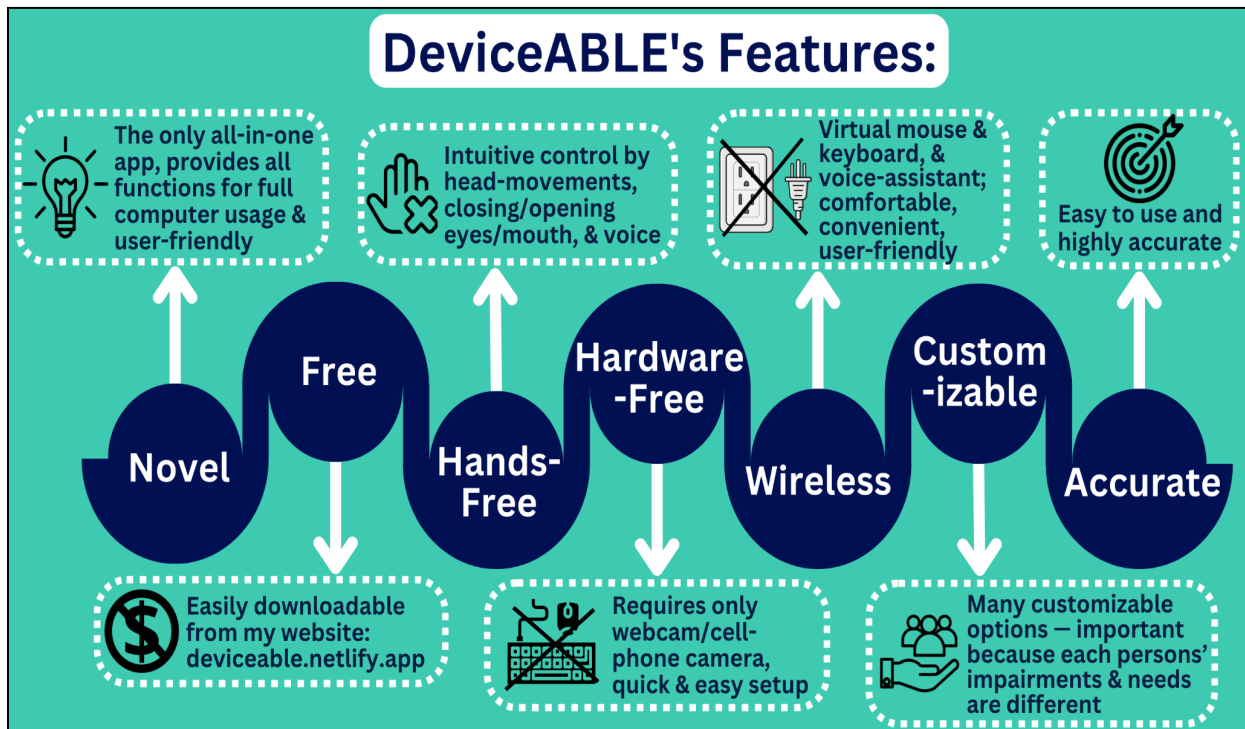


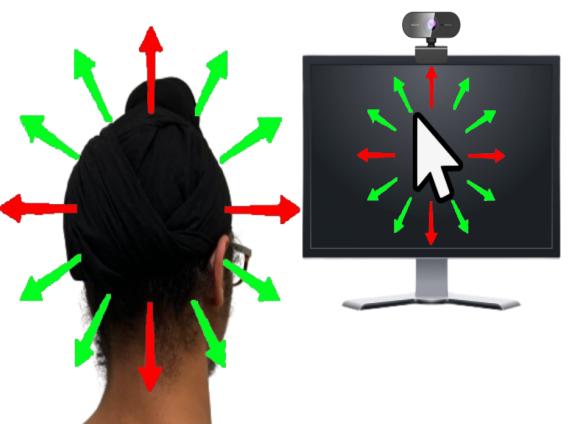
**Other Products**

### Product Gap:

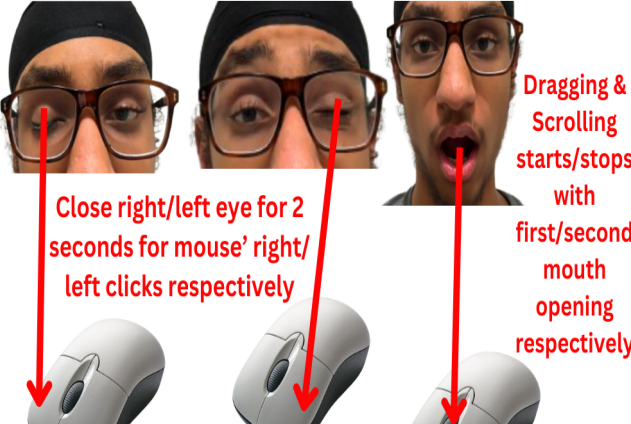
Currently, there are three types of hands-free computing, but they have many drawbacks [3-6]:

- Expensive (some even cost thousands of dollars)
- Less functional (don't provide full computer usage)
- Require bulky/inconvenient gears – difficult to use – so, abandoned by the user
- Less accurate





**Cursor Follows Head Movements**



**Mouse Clicks**

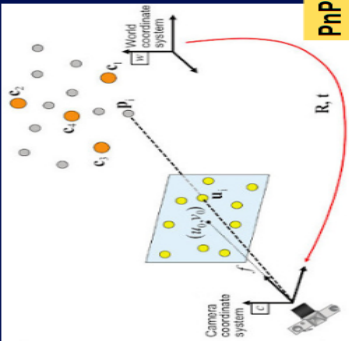
## Working of Cursor & Mouse Clicks

OpenCV captures video frames from webcam/cellphone camera, & converts them to greyscale for efficiency & speed



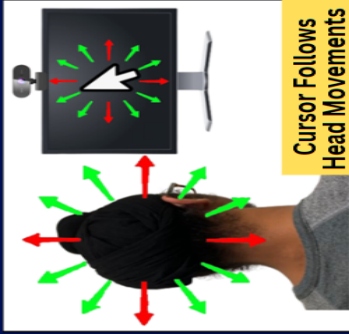
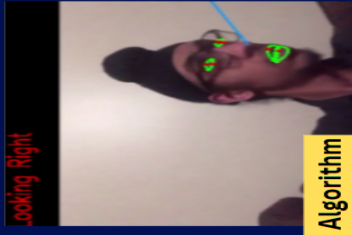
Facial Landmarks

MediaPipe's face-mesh model detects facial landmarks. CHALLENGES: Dlib's face-mesh didn't work when converting to an executable, so used MediaPipe's model.



PnP Algorithm

Cursor follows your head movements based on the 2D and 3D head rotational angles found using the PnP algorithm



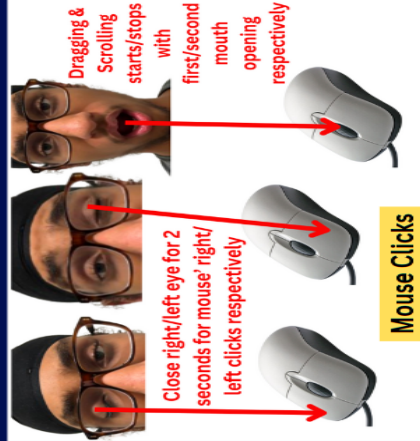
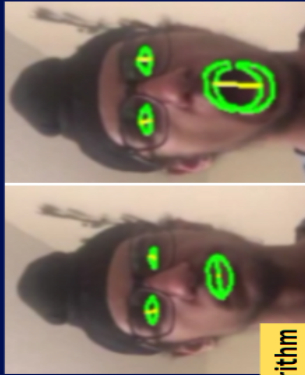
Cursor Follows Head Movements

Utilizing Eye/Mouth Aspect Ratio (EAR/MAR algorithms), left/right clicks and dragging/scrolling are simulated by closing/opening your eyes/mouth, respectively



$$\text{EAR and MAR} = \frac{\|p_2 - p_6\| + \|p_3 - p_5\|}{2\|p_1 - p_4\|}$$

EAR & MAR Algorithm

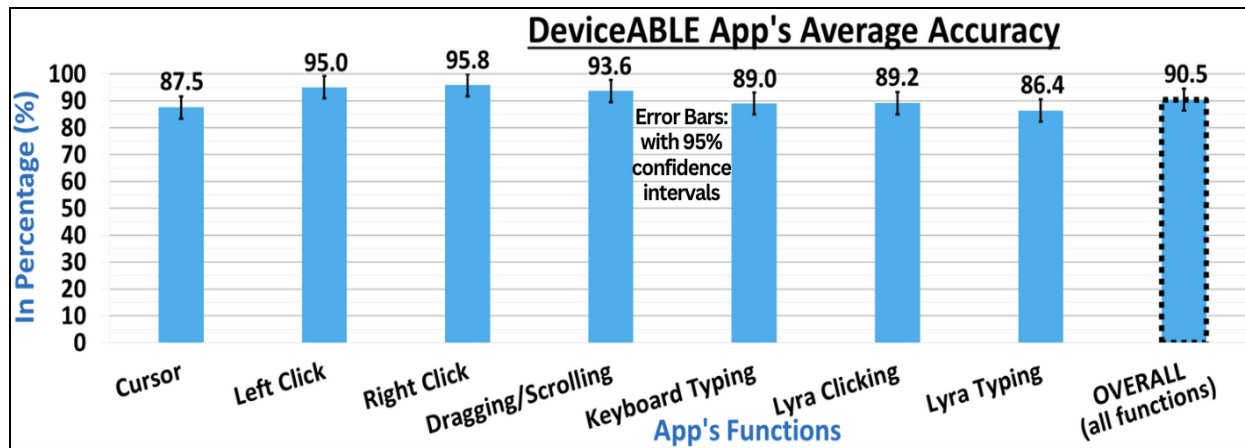


Mouse Clicks

Dragging & Scrolling starts/stops with first/second mouth opening respectively

Close right/left eye for 2 seconds for mouse' right/left clicks respectively





|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |        |                              |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |             |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------------------------------|--|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| t-Test: One-Sample                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |        | <b>2 Statistical t-Tests</b> |  | t-Test: Two-Sample Assuming Unequal Variances                                                                                                                                                                                                                                                                                                                                                                                                                        |             |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |        | Average Accuracy             |  | Group 1 Group 2                                                                                                                                                                                                                                                                                                                                                                                                                                                      |             |
| Mean                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 90.5   |                              |  | Mean                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 92.38 88.53 |
| Variance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 42.2   |                              |  | Variance                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 50.34 33.61 |
| Observations                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 12     |                              |  | Observations                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 6 6         |
| Hypothesized Mean                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 85     |                              |  | Hypothesized Mean Difference                                                                                                                                                                                                                                                                                                                                                                                                                                         | 0           |
| df                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 11     |                              |  | df                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 10          |
| t Stat                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 2.91   |                              |  | t Stat                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 1.029       |
| P(T<=t) one-tail                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0.0071 |                              |  | P(T<=t) one-tail                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 0.164       |
| t Critical one-tail                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 1.80   |                              |  | t Critical one-tail                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 1.812       |
| P(T<=t) two-tail                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0.0142 |                              |  | P(T<=t) two-tail                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 0.328       |
| t Critical two-tail                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 2.2010 |                              |  | t Critical two-tail                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 2.228       |
| $H_0 : \mu \leq 85$<br>$H_1 : \mu > 85$                                                                                                                                                                                                                                                                                                                                                                                                                                                    |        |                              |  | $H_0 : \mu_1 = \mu_2$<br>$H_1 : \mu_1 \neq \mu_2$                                                                                                                                                                                                                                                                                                                                                                                                                    |             |
| <p>Six other apps were tested and compared with DeviceABLE; and it was found that the mean accuracy of those six apps was 81%, so a higher benchmark of 85% was set as hypothesized mean. <math>H_0</math> was 'rejected' because <math>t\ stat = 2.91 &gt; t\ critical = 1.80</math>, and also <math>p\ value = 0.0071 &lt; \alpha = 0.05</math>. Therefore, the result is statistically significant; and DeviceABLE app's average accuracy of 91% is significantly greater than 85%.</p> |        |                              |  | <p>The average accuracy of 12 different participants (unpaired) was randomly divided into two equal groups (6 participants each) for comparison. <math>H_0</math> was 'not rejected' because <math>t\ stat = 1.03 &lt; t\ critical = 2.23</math>, and also <math>p\ value = 0.33 &gt; \alpha = 0.05</math>, which means that both the groups were statistically significantly similar; so DeviceABLE app's average accuracy of 91% is statistically significant.</p> |             |

| DeviceABLE Vs. Other Apps |      |                              |                       |                     |                  |       |             |          |
|---------------------------|------|------------------------------|-----------------------|---------------------|------------------|-------|-------------|----------|
| App's Name                | Free | Functions                    |                       |                     | Operating System |       |             | Accuracy |
|                           |      | Mouse<br>(Cursor, Clicks)    | On-Screen<br>Keyboard | Voice-<br>Assistant | Windows          | Linux | Mac OS      |          |
| DeviceABLE                | ✓    | ✓                            | ✓                     | ✓                   | ✓                | ✓     | In progress | 🔄        |
| Google Gameface           | ✓    | ✓                            | ✗                     | ✗                   | ✓                | ✗     | ✗           | 🔄        |
| Eviacam                   | ✓    | ✓                            | ✗                     | ✗                   | ✓                | ✓     | ✗           | 🔄        |
| Cephable                  | ✓    | 🟡 Experimental Feature       | ✗                     | ✓                   | ✓                | ✗     | ✓           | 🔄        |
| Open Sesame               | ✓    | Error, app didn't launch/run |                       |                     | ✓                | ✗     | ✗           | ..       |
| Smyle Mouse               | ✗    | ✓                            | ✗                     | ✗                   | ✓                | ✗     | ✗           | 🔄        |
| Camera Mouse              | ✓    | ✓                            | ✗                     | ✗                   | ✓                | ✗     | ✗           | 🔄        |

## Professional Feedback for DeviceABLE

- “Good job Jora.”
- “I look forward to using your app in the future.”
- “Keep up the great work.”

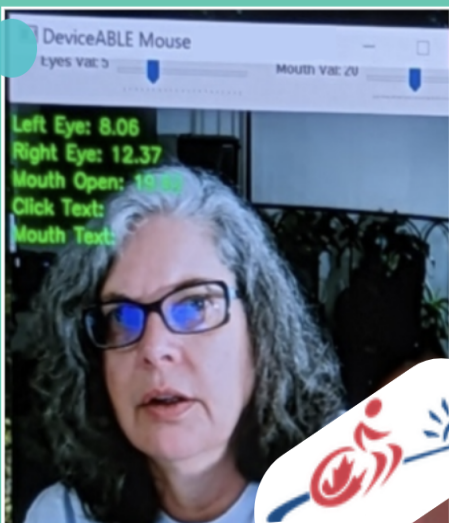
- Gabe



- “DeviceABLE’s creativity combines a virtual mouse, and voice assistant into one comprehensive, customizable application.”
- “The use of intuitive control mechanisms, such as head panning and eye and mouth movements, further highlights its innovation.”

- Ean Price, Innovation Strategist

technology for living



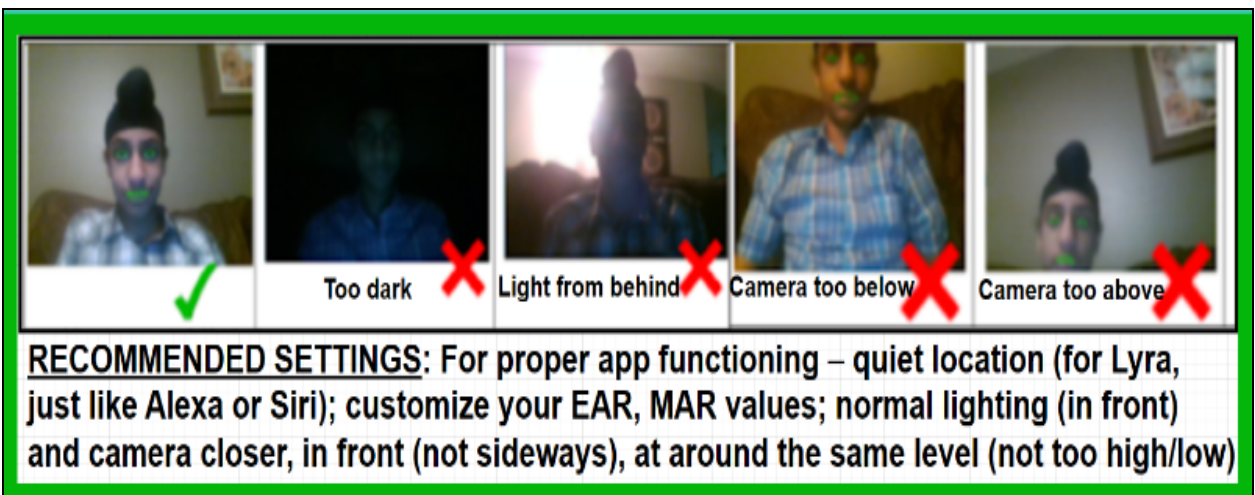
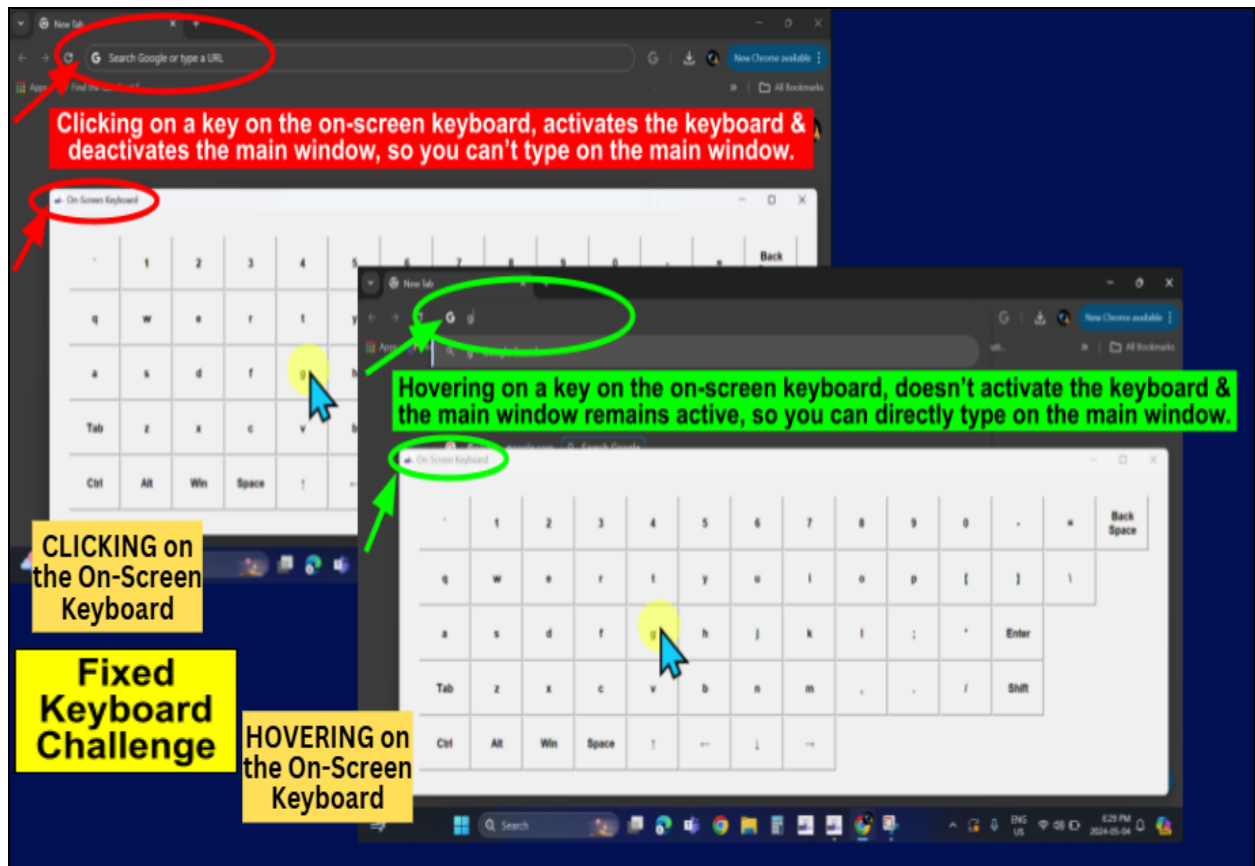
- “Great eye tracking accuracy.”
- “Providing this app for free is great because speech recognition apps can be \$400-\$800 and eye tracking apps can be \$1000+”
- “This app is an impressive early software.”
- “Your app incorporates many useful computer accessibility features across different commercial software, into one software.”
- “The help screen is a great feature for users.”
- “This project is innovative and creative...”
- “It has the potential to meet various accessibility needs for different users.”

- “What you have designed and created is futuristic, usable and noteworthy.”
- “I love playing with your creation.”
- “I am waiting to see how it is integrated into future products for everyone to use seamlessly during their day.”

- Vivian (Spinal Cord Injury BC)

- Eric Chau, Occupational Therapist;  
- Jody Dickerson, Assistive Technology Specialist;  
Neil Squire Society





[Help](#)



- 'Lyra right click' OR shut your right eye for 2-seconds: Right clicks mouse
  - 'Lyra double click': Double clicks mouse
  - 'Lyra drag' OR open your mouth for 2-seconds: Starts dragging
  - 'Lyra stop dragging' OR open your mouth for 2-seconds again: Stops dragging
  - 'Lyra help': Shows this Help window
  - 'Lyra settings': Opens the settings window
  - 'Lyra restart': Restarts the app
  - 'Lyra undo': Performs undo operation
  - 'Lyra redo': Performs redo operation
  - 'Lyra search {query}': Performs a web search
- Mouse and On-Screen Keyboard Usage:
- Mouse cursor follows your head movements. Just pan your head in ANY direction (not just left, right, up, or down) to control the cursor accordingly.
  - Mouse left/right clicks: Close your left/right eye for 2-seconds, respectively. For dragging/scrolling: Open your mouth for 2-seconds to start dragging/scrolling, and then open your mouth again for 2-seconds to stop dragging/scrolling.
  - To use the on-screen keyboard, just hover on any key for 2-seconds, the key will be pressed.
  - To close entire DevieABLE app: First say 'Lyra exit' to close all apps but Lyra, and then say 'Lyra shutdown' to close Lyra too.

**DeviceABLE: A Novel Hands-Free Computing App for People with Disabilities**  
**By: Jora Singh Nahal** **Page # 11 of 11**