Eyes In Motion

Utilizing Eye Tracking for Assistive Technology

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Introduction

Approximately 12.1% of Americans have mobility disabilities, including conditions like Cerebral Palsy, Spinal Cord Injuries, and quadriplegia, which severely impact daily activities and independence. These impairments often require lifelong care due to motor disabilities and muscle control issues. Globally, millions face barriers to accessing adequate care and assistive tech, further limiting their independence.

Research Question

To what extent can eye-tracking technology enable robotic devices to assist individuals with severe disabilities, and can complex motor tasks be simplified into less demanding actions for these devices?

Objective

Develop a prototype software and model robot that demonstrates how user-gaze can direct robotic actions. This serves as a foundation for future advancements in accessibility technology, including wheelchair control, without the need for external limb movement.

Hardware

- **Logitech C920 Webcam:** 1080p HD, 78° field of view, auto light correction.
- **Dell XPS 13 Plus 9320:** Intel i7-1260P, 16 GB RAM, Intel Iris Xe, HD RGB & IR cameras.
- **Nvidia JetBot:** Powered by Jetson Nano with 128-core GPU, 4 GB RAM, wide-angle camera, Ubuntu 18.04, WiFi, Bluetooth 4.0.

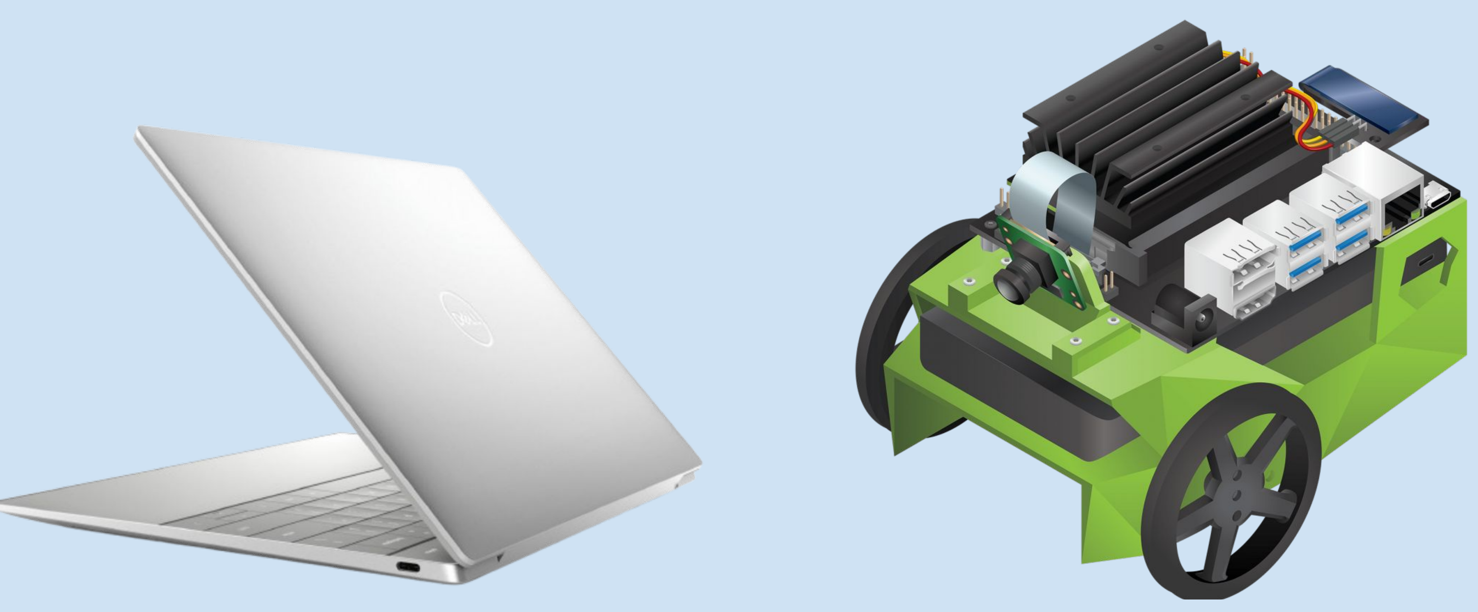

Figure 1: (left) Dell xps. (right) NVIDIA JetBot

Methodology

- Reviewed assistive robots in the medical field, focusing on gaze detection for control
- Chose a laptop webcam for accessibility and widespread use
  - The webcam tracked eye movements to control a cursor, to direct the robot's actions
- Operated via Wi-Fi, with plans to switch to Bluetooth for improved mobility

Acknowledgements

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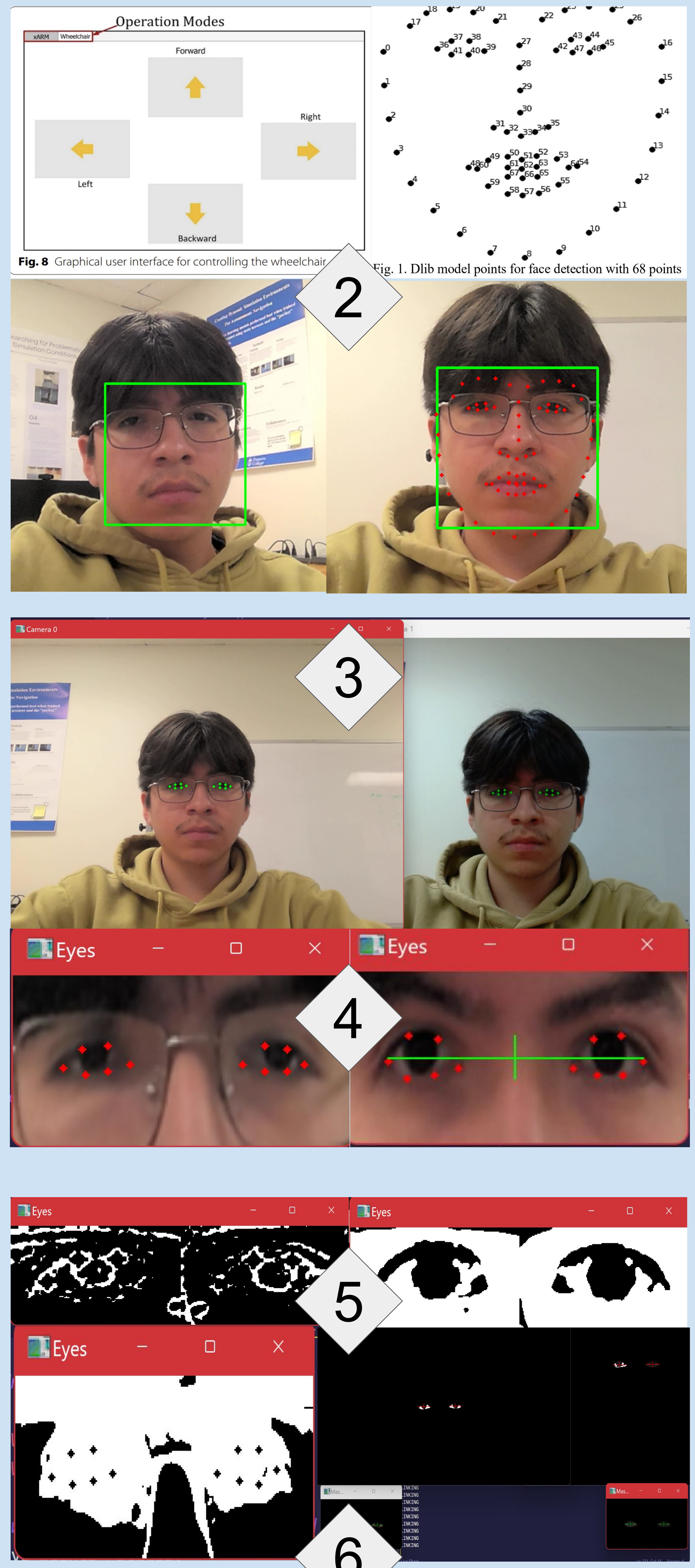
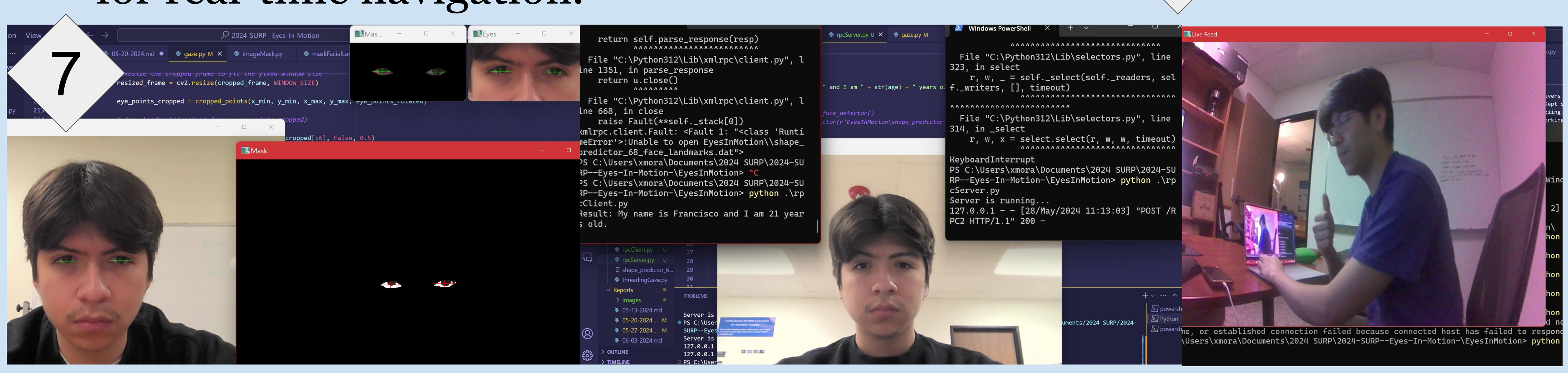
- Thank you to Professor Clark for allowing me to use his lab and materials to construct my robot.

Software Development

1. Researched literature on assistive technology and eye-tracking to build a strong foundation.
2. Implemented face tracking using the dlib library for accurate facial landmark detection, focusing on the eyes.
3. Developed algorithms to precisely identify and track the eye region.
4. Utilized linear algebra and transformations to maintain proper eye orientation for consistent tracking.
5. Applied image masking and segmentation to isolate the eyes for improved detection and analysis.
6. Created a pixel-based system to determine gaze direction and detect blinking.
7. Constructed a Remote Procedure Call (RPC) server and client to communicate between the eye-tracking system and JetBot for real-time navigation.





Next Steps

- Enhance communication between the JetBot and computer for full eye-movement control.
- Implement machine learning to improve pathfinding and simplify navigation.
- Develop a more refined, user-friendly GUI to eliminate the need for coding knowledge.

Results

I developed an eye-tracking script that accurately detects gaze direction and communicates with the JetBot, establishing the foundation for robot control via eye movements. Motor connection issues, traced to incorrect cabling, prevented movement, but the software is fully configured and ready for further development once hardware issues are resolved.