Hands-Free Drawing System

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CONTEXT

Individuals that are quadriplegics or have other upper-limb impairments often face barriers to artistic expression due to their inability to hold or control drawing tools. Our project addresses this challenge by developing a hands free drawing system that enables users to create physical artwork using only their eyes and voice. The system integrates an eye-tracking interface, voice command recognition, and an automated drawing process.
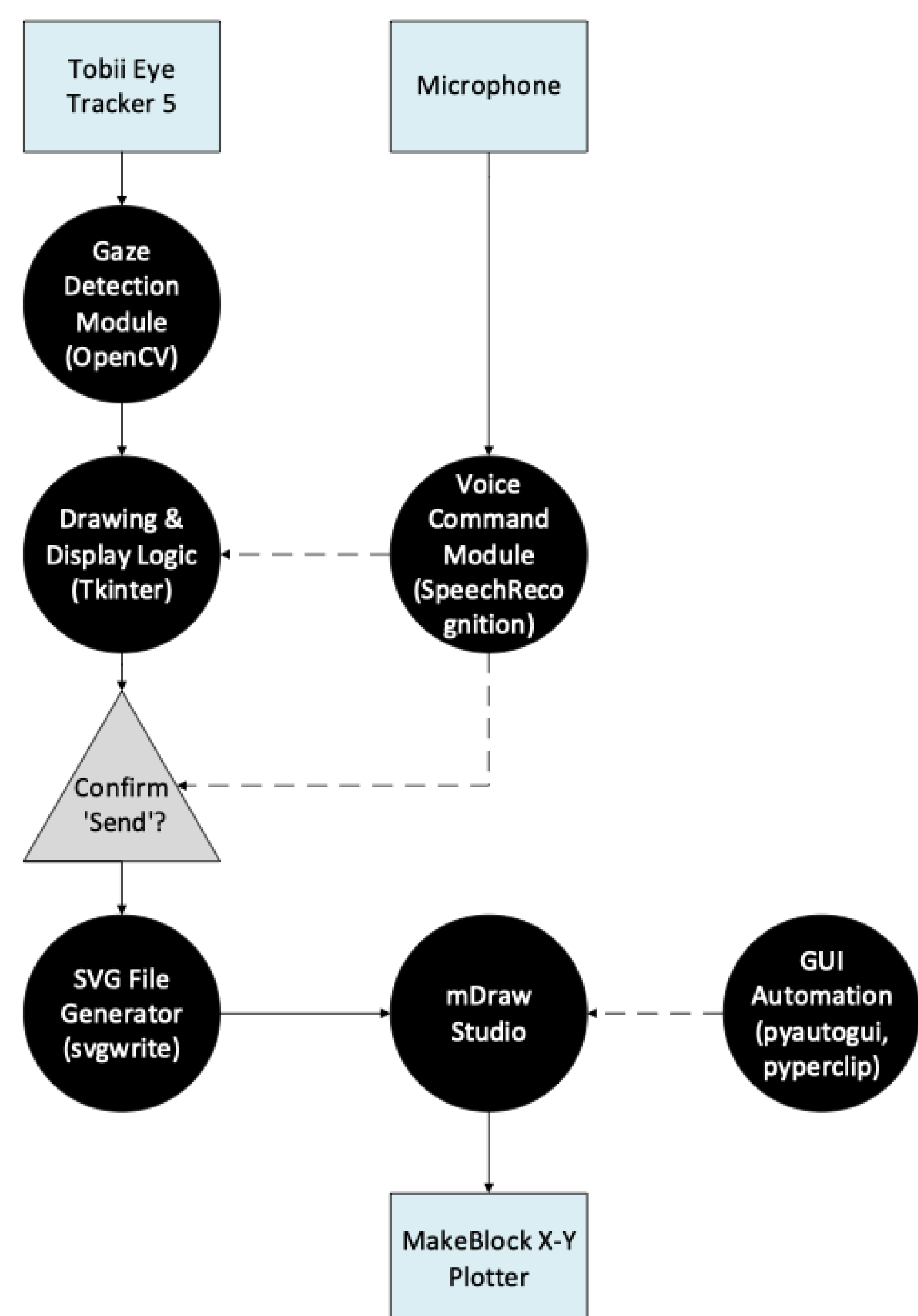
PROBLEM STATEMENT

Individuals with severe upper-limb impairments lose access to traditional creative expression. Tasks like drawing are impossible without fine motor control. Existing tools are either prohibitively expensive, limited to digital-only use, or restrict direct creative freedom. We sought to design a system that lets users draw freely and physically—without using their hands.

BACKGROUND

Artistic expression is known to benefit mental health, yet many assistive technologies fail to offer real-time, hands-on creativity. Past systems (like EyeDraw, Eyegaze Edge, or ARTiculate (Deepgram)) either lacked physical output, used closed hardware, or took creative control away from the user. **Our goal:** restore autonomy and agency through open-source, accessible tech.

TECHNICAL APPROACH

- A hands-free drawing system that is powered by eye tracking and voice commands.
- Components:
  - Eye Tracking
  - Voice Control
  - Drawing Display
  - SVG Output
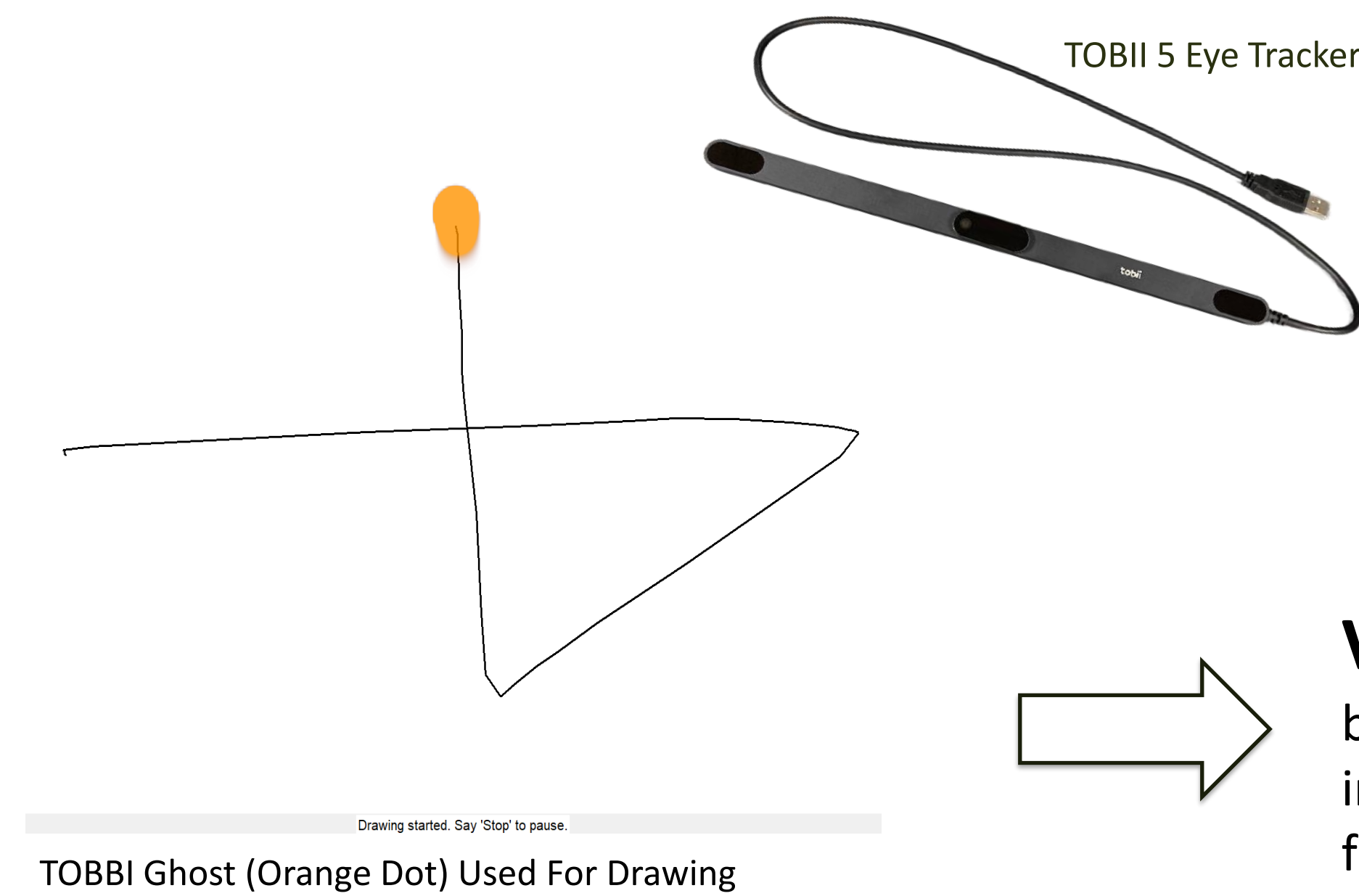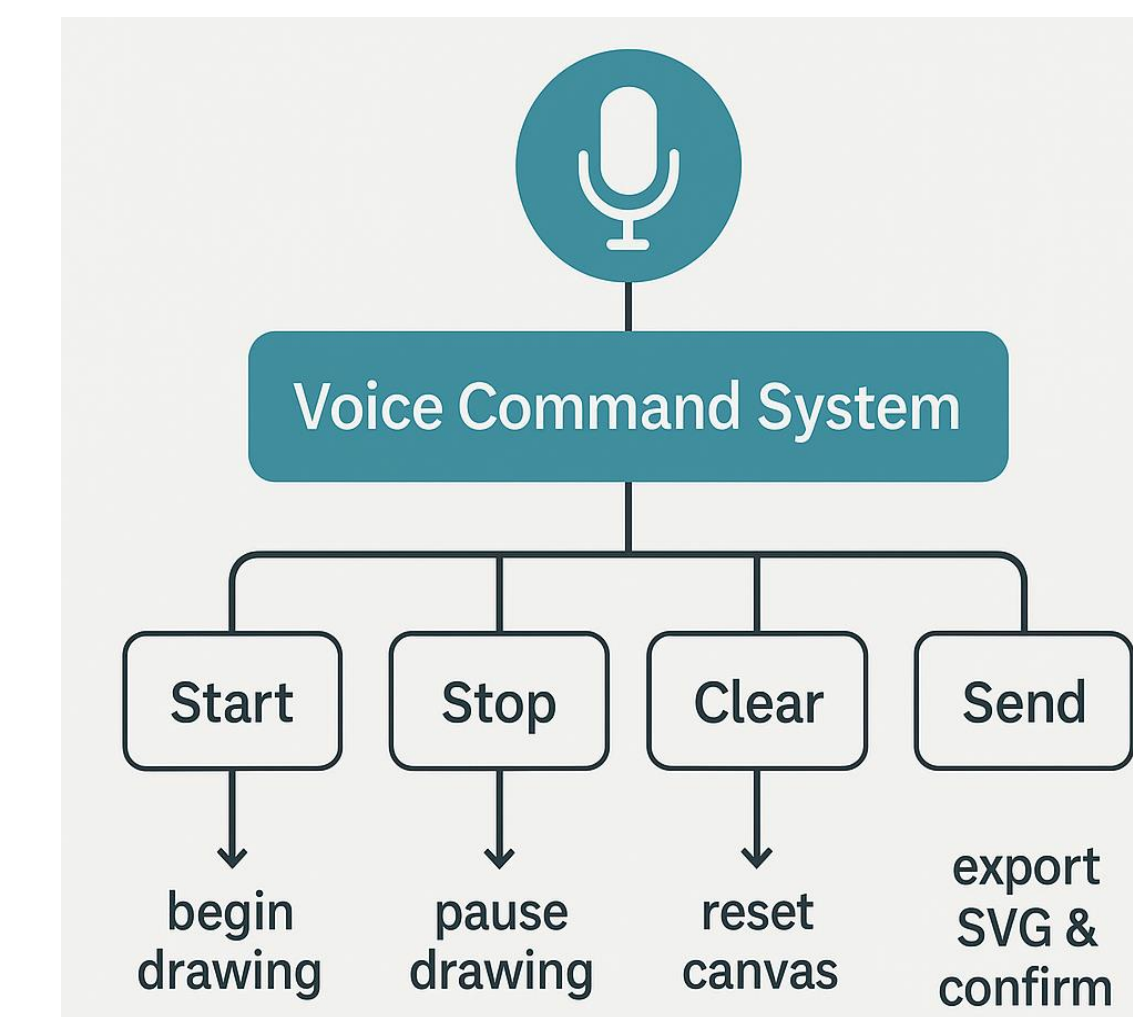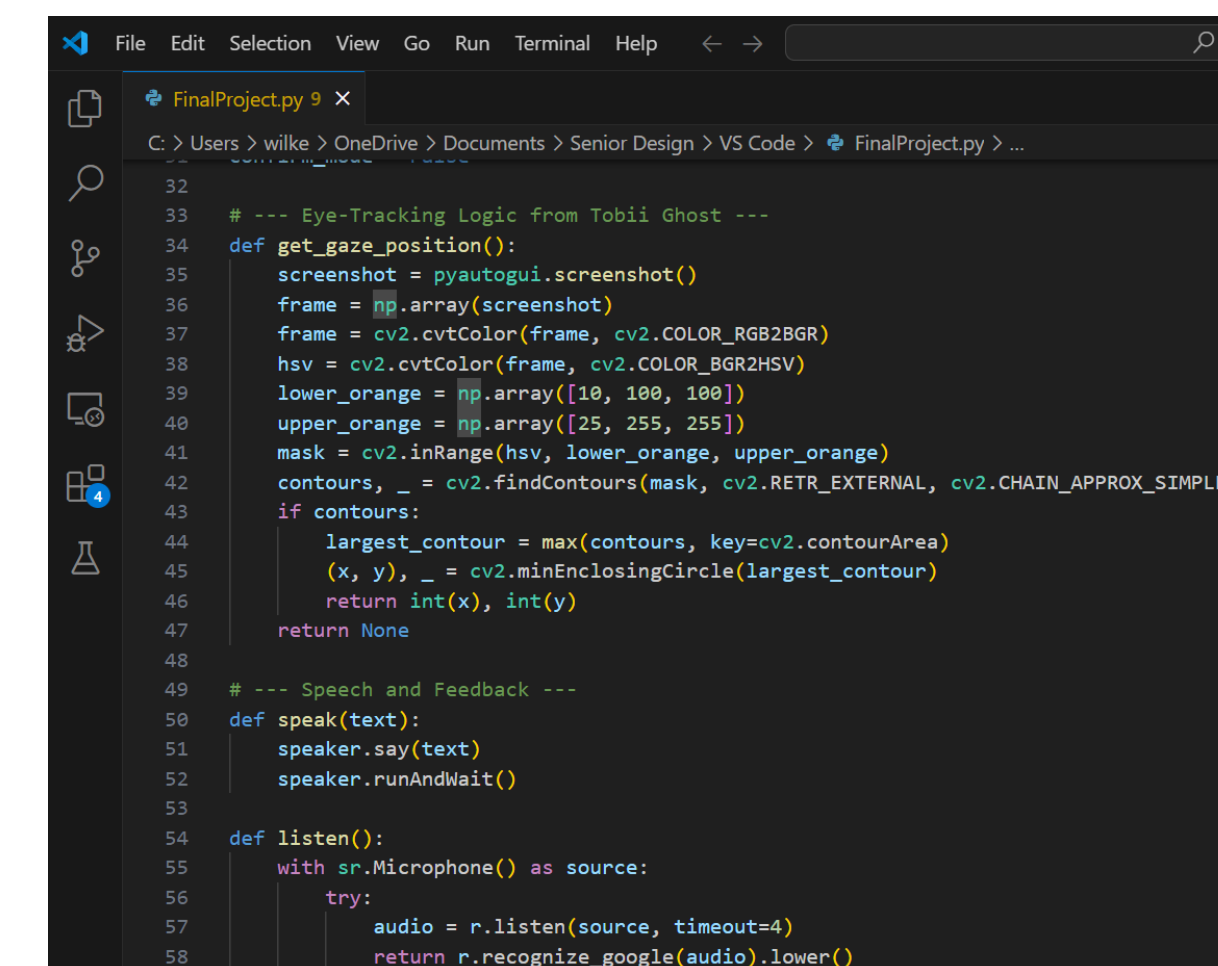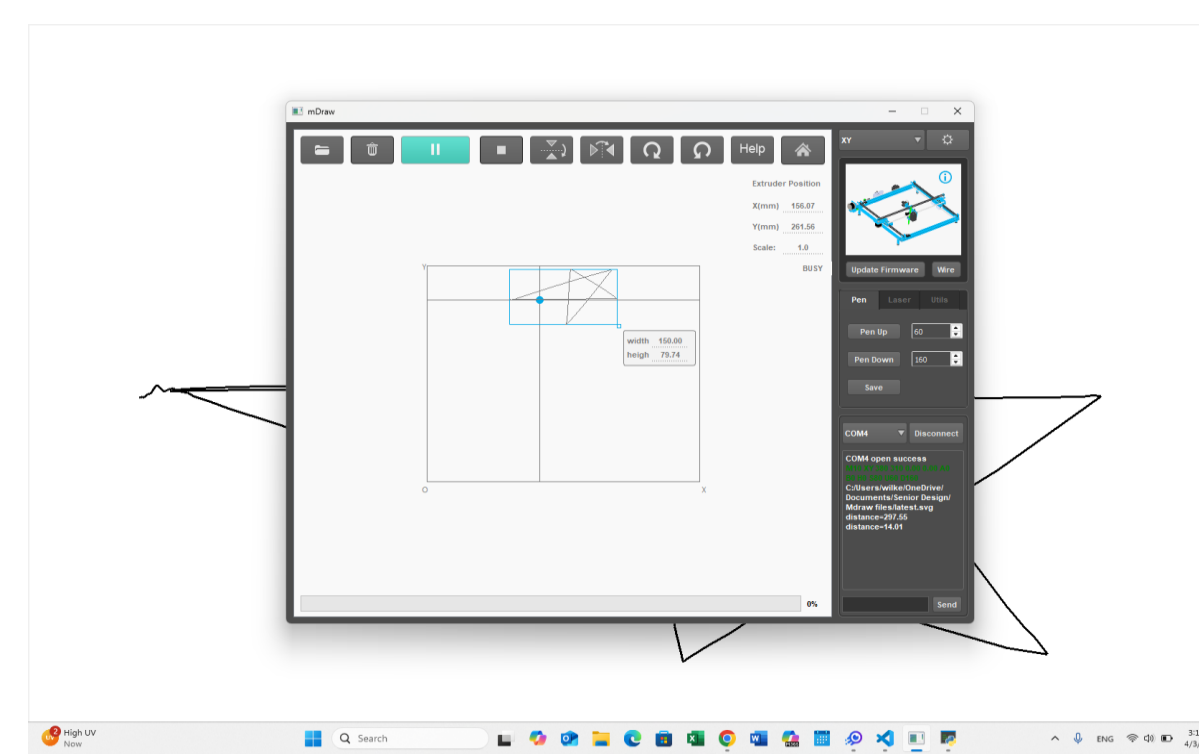 - mDraw Studio
  - Physical Output

SOLUTION

Eye Tracking: Using the TOBII Eye Tracker 5 and TOBII Ghost, we detect the orange dot overlay and translate the user's gaze into (x, y) coordinates for live tracking and freehand drawing on the digital canvas.

TOBII 5 Eye Tracker

TOBBI Ghost (Orange Dot) Used For Drawing

How eye tracking works

1 An eye tracker consists of cameras, projectors and algorithms.

2 The projectors create a pattern of near-infrared light on the eyes.

3 The cameras take high-resolution images of the user's eyes and the pattern.

4 Machine learning, image processing and mathematical algorithms are used to determine the eyes' position and gaze point.

Gaze point

Voice Interface: A Python based speech recognition system interprets voice commands allowing full hands-free control over the drawing process.

Voice Command System

| Start | Stop | Clear | Send |
| begin drawing | pause drawing | reset canvas | export SVG & confirm |

Coding and mDraw: A custom Python script automates the drawing process: it captures the eye-drawn image, scales it for 8.5" x 11" paper, saves it as an SVG, and uses GUI automation tools (PyAutoGUI, pygetwindow) to open mDraw Studio and paste the file path.

mDraw Studio Interface

Drawing: The system then automates execution using mDraw Studio to control a MakeBlock X-Y Plotter. It opens the SVG, pastes the file path, and starts the drawing process—completing the task with no manual input required.
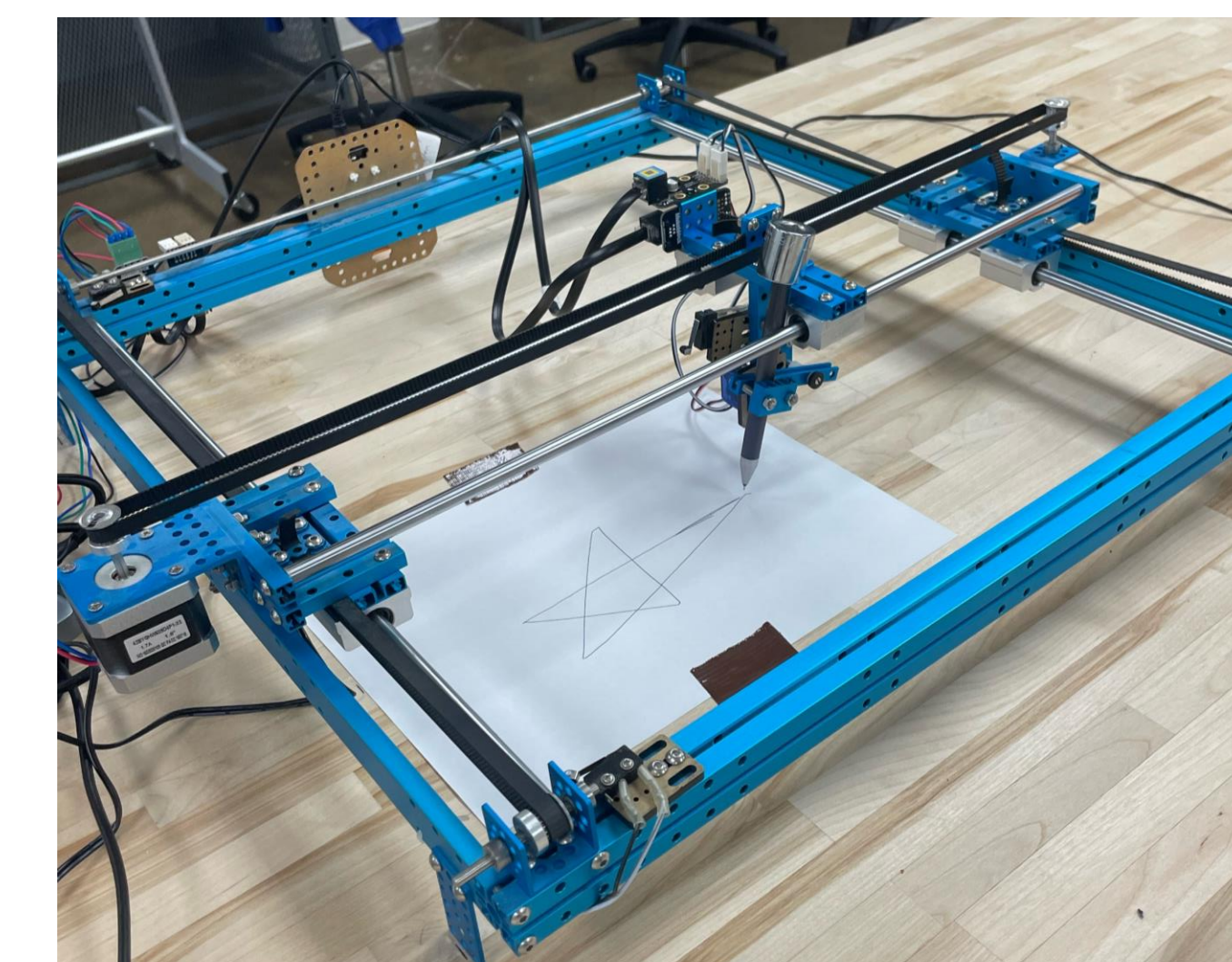
MakeBlcok X-Y Plotter Drawing

A user draws on the screen using a gaze based input from the TOBII Eye Tracker (located on the bottom of the monitor). Once the drawing is complete, the SVG output is automatically sent to the MakeBlock X-Y Plotter (located on the users left), which renders the image onto paper using the Orion Arduino's motor control system.

TOBII Eye Tracker 5

Arduino Orion

- Central control unit for the MakeBlock X-Y Plotter
- Features built-in motor driver ports for direct control of stepper motors
- Executes motion control logic, converting drawing data into coordinated motor signals
- Powers the X and Y axis movement and the pen lift mechanism in the plotter
- Executes G-code to direct the pen's path on the drawing surface
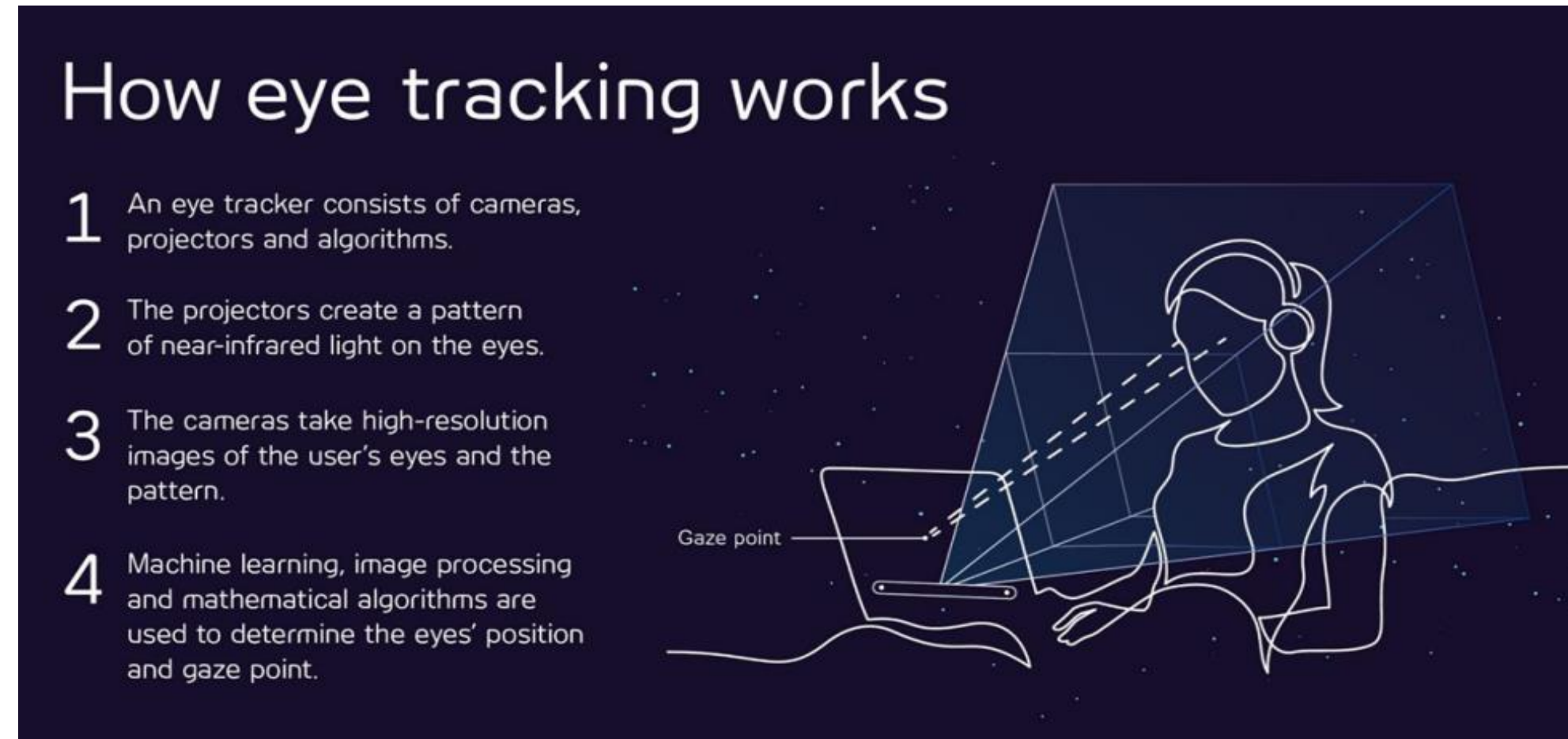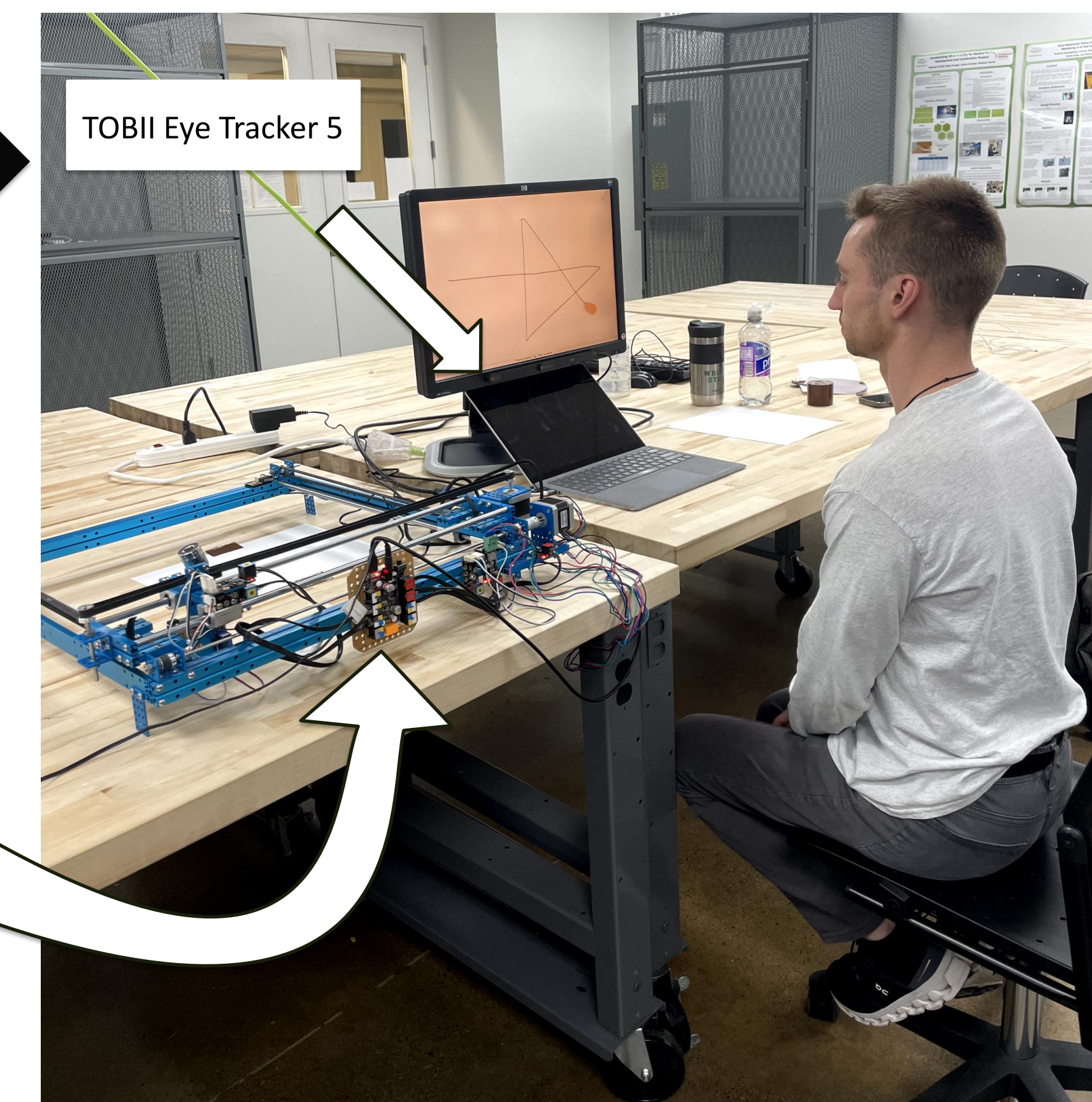
DISCUSSION

Key Features

- Fully hands-free operation (no mouse/keyboard)
- Voice-confirmed export to avoid accidental plotting
- Open-source and reproducible
- Supports real paper drawing in standard 8.5" x 11" size

Open-Source Licensing

The system is licensed under the GNU General Public License v3.0 (GPLv3), ensuring future adaptations remain free and open-source. This is critical for accessibility, affordability, and ongoing innovation in the assistive tech community. Developers can build upon, modify, and redistribute the system for non-commercial use while maintaining user freedom.
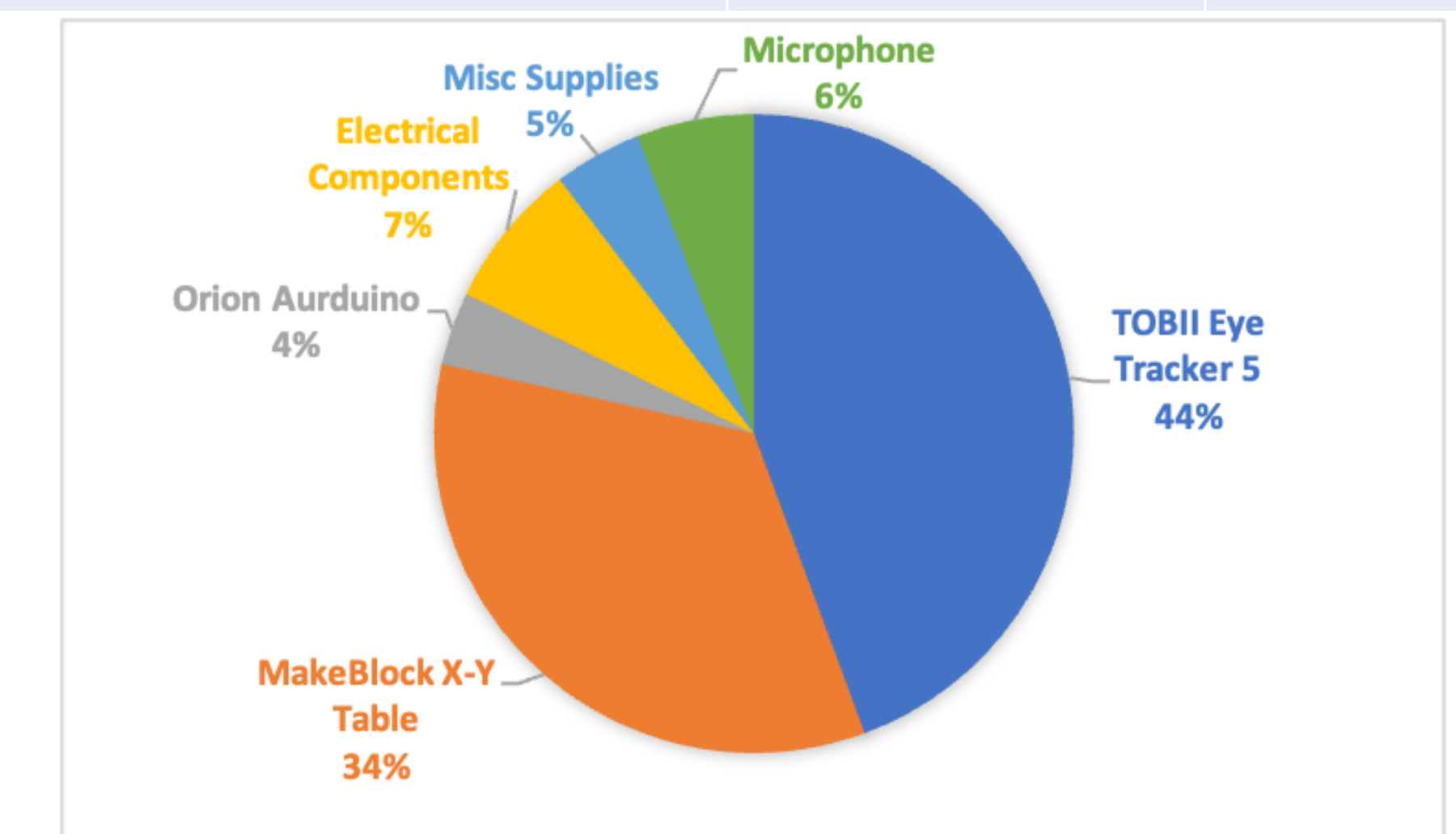
CONCLUSION

We successfully developed a hands-free system that enables individuals with severe upper-limb impairments to create physical artwork using only their eyes and voice. By combining head and eye tracking, voice recognition, and automation, our project demonstrates that assistive technologies can enhance creative expression and independence.

FUTURE WORK

- Use TOBBI SDK for more precise and direct gaze tracking
- Add mid-draw pause, undo, or cancel commands for better error recovery
- Enable dynamic brush size, color, or shape selection via additional voice commands
- Explore portability or wireless options for greater flexibility
- Conduct usability testing with actual users who have upper-limb impairments to better evaluate and improve the system

BUDGET

Item	Source	Cost ($)
TOBII Eye Tracker 5	WSU	299.00
MakeBlock X-Y Plotter	Client	229.99
Orion Arduino	Client	25.00
Microphone	External	39.99
Electrical Components	WSU	50.00
Miscellaneous Supplies	WSU	30.00
Total		673.98

ACKNOWLEDGMENTS