Smart Cap

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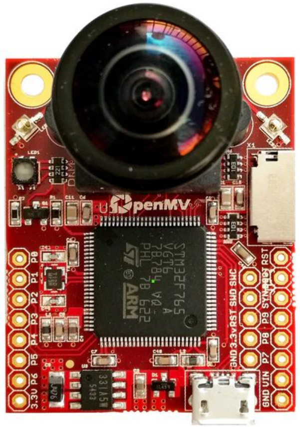
[Link to Repository]

Description

Smart Cap: Navigating Crowds with Innovation

- Introducing the Smart Cap: a game-changing wearable device designed to revolutionize how individuals with visual impairments navigate crowded environments.
- Using an OpenMV camera, this cap detects nearby people and provides intuitive feedback through NeoPixels.
- Born from the bustling streets of New York City, the Smart Cap isn't just a piece of technology; it's a new lens for enhanced spatial awareness, offering safety, confidence, and a new level of independence for its wearers.

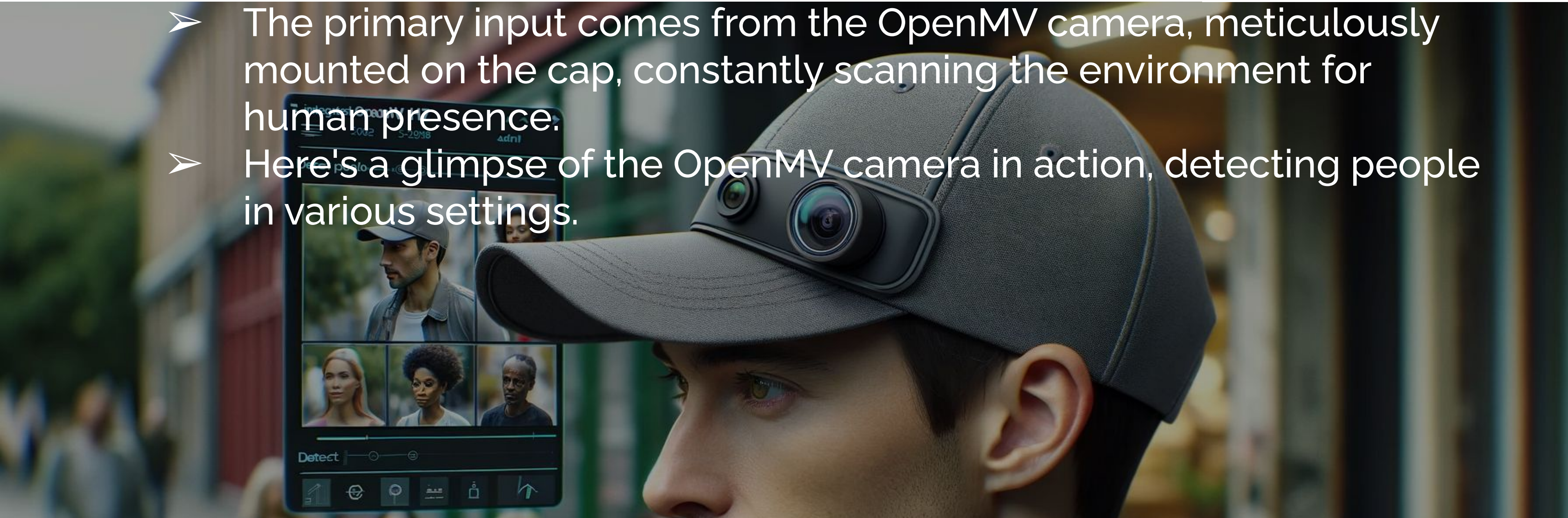
How does it work?



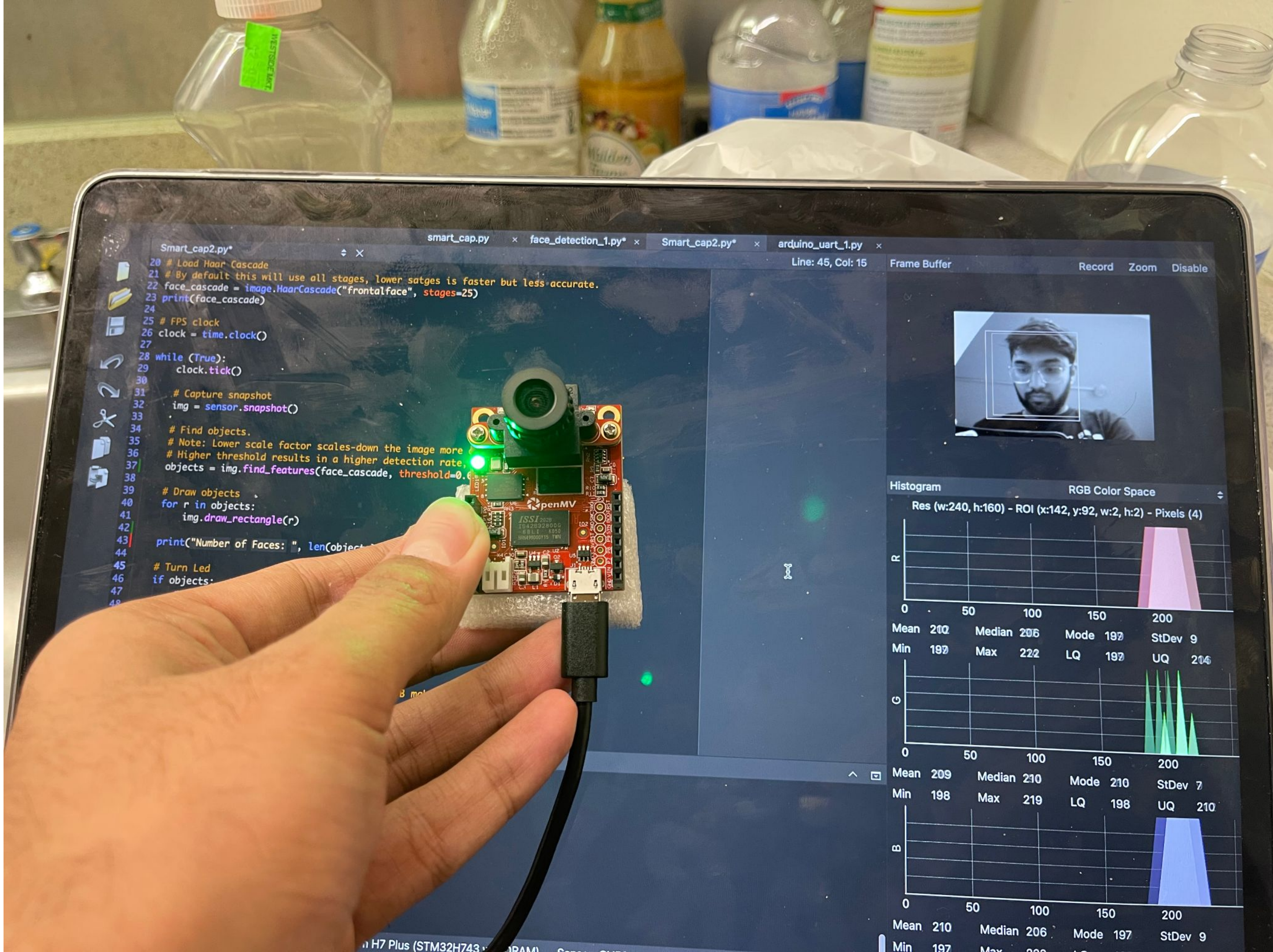
Inside the Smart Cap: Inputs, Processing, Outputs

❖ Inputs:

- ➢ The primary input comes from the OpenMV camera, meticulously mounted on the cap, constantly scanning the environment for human presence.
- ➢ Here's a glimpse of the OpenMV camera in action, detecting people in various settings.



Please Ignore The Abundance Of Bottles In The Back



- **Processing:**
  - The heart of Smart Cap, the OpenMV H7 Camera Microprocessor, processes the camera data. It runs algorithms to interpret the presence and proximity of people around the wearer.
  - This diagram shows the data flow from the OpenMV camera to the NeoPixels, highlighting the processing stages.

OpenMV Camera Module:

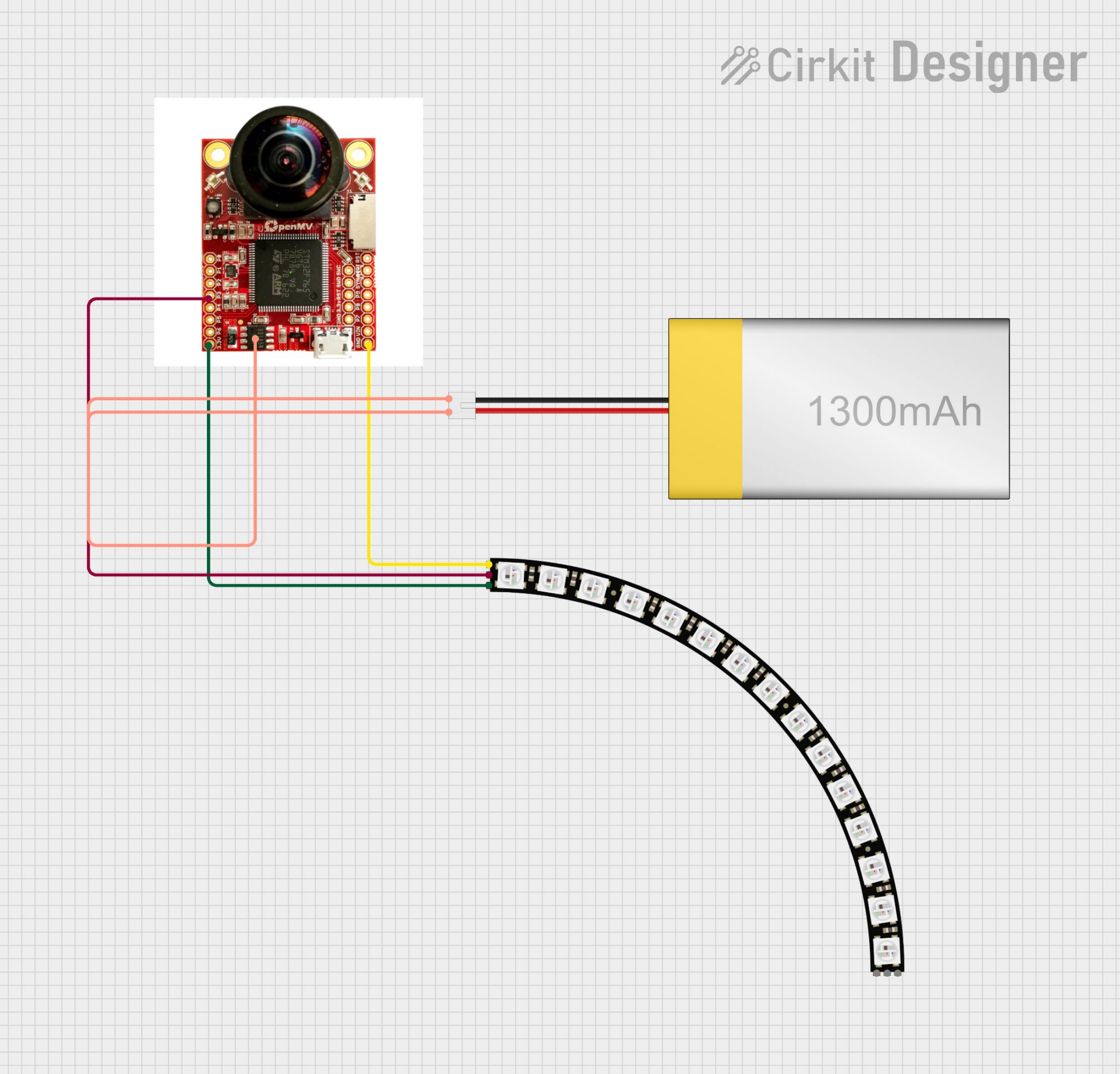
- This is the central component in the schematic, used for capturing images and running computer vision algorithms.

NeoPixel LED Strip:

- The strip is connected with three wires indicating power (PW), ground (GND), and data input (DI).
- The power (PW) and ground (GND) wires are connected to the corresponding power and ground outputs from the battery, ensuring the LEDs receive the necessary power.
- The data input wire is connected to one of the output pins on the OpenMV camera, which allows the camera module to control the lighting patterns and colors of the NeoPixels.

Battery Pack:

- Labeled as "1300mAh," which suggests it's a rechargeable battery capable of providing power to the circuit.



- **Outputs:**
  - ➢ On detection, the cap uses two main output methods:
    1. **NeoPixels**: Colorful and dynamic, these LEDs change patterns and intensity based on the number of people detected.
    2. **Mobile Notifications**: *[Yet To Be Implemented]* For a more personalized alert, the cap sends notifications to the wearer's smartphone.
  - ➢ Here's how the NeoPixels light up in response to people detected:

- **Demonstration of Individual Components**:
  - While the complete circuit integration is in progress, let's look at the individual components at work.
    - **OpenMV Camera Demo**: Notice how the camera differentiates between an empty space and a space with people.
    - **NeoPixels in Action**: Observe the variation in light patterns with different detections.
    - **Arduino Processing**: A sneak peek into the Arduino IDE showing the code that makes it all happen.
  - These visuals represent the crucial steps in the Smart Cap's operation, paving the way to our final integrated system.

Inspiration

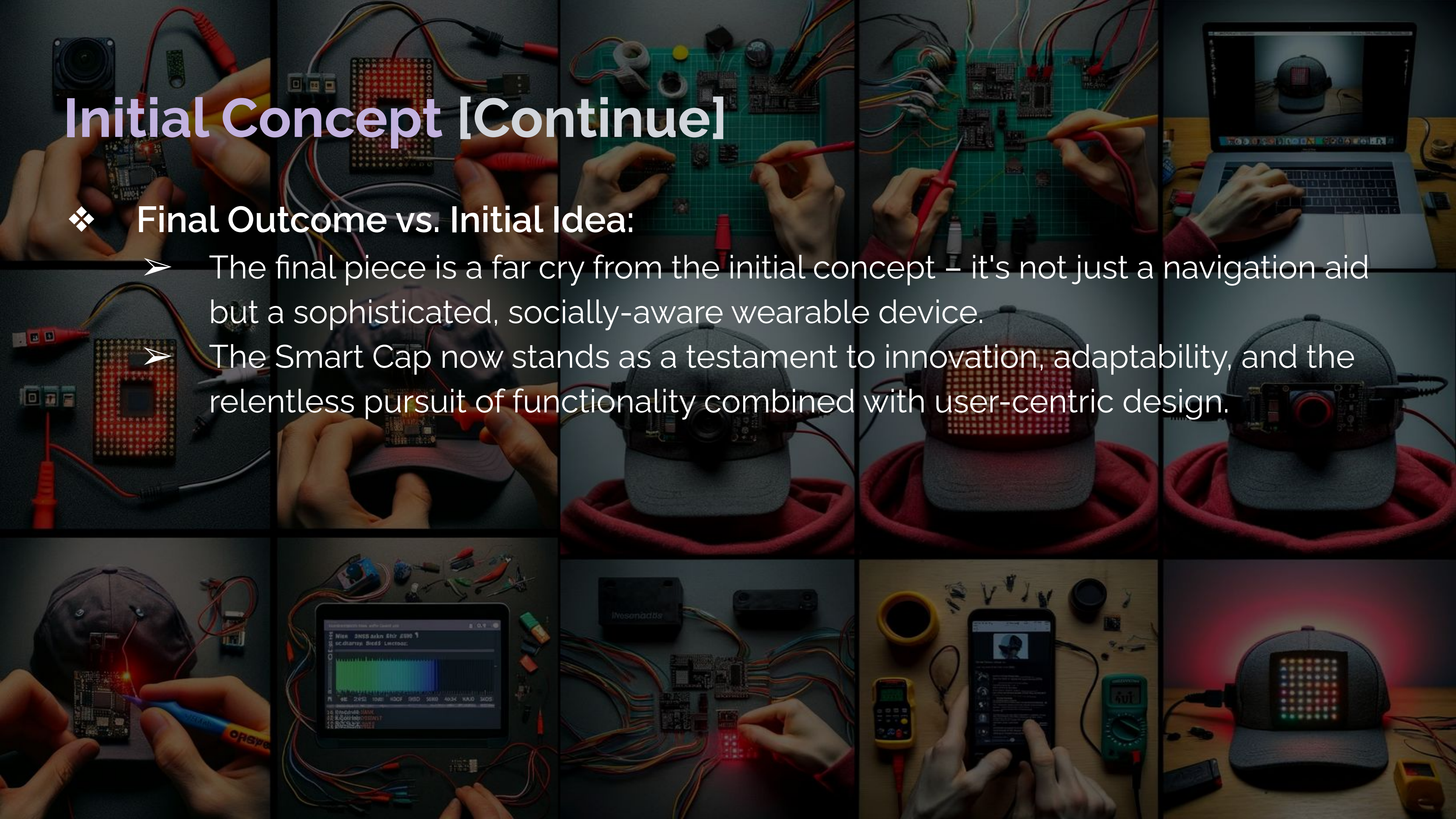
- **Urban Challenges and Visual Impairments:**
  - The bustling streets of New York City, crowded and constantly moving, presented a daily navigation challenge, particularly for those with visual impairments.
- **Personal Observations:**
  - Observing the struggles of visually impaired individuals in these environments sparked the initial idea. The need for a tool to enhance spatial awareness became apparent.
- **Technological Integration in Daily Life:**
  - The integration of technology into everyday accessories inspired the concept of a 'smart' cap – a familiar item but with extraordinary capabilities.
- **Evolution During Development:**
  - As the project progressed, inspiration also came from the world of fashion and wearables – aiming for a design that was not only functional but also stylish and socially acceptable.
  - The dynamic feedback from testing the prototype, especially the interaction of the NeoPixels and their visual appeal, further fueled the project's evolution.
- **Community and Accessibility:**
  - A deeper understanding of the importance of inclusivity in design emerged. The goal shifted from mere functionality to creating a device that empowers and includes.

Initial Concept

- **The Birth of an Idea:**
  - The initial concept was a simple navigation aid for visually impaired individuals – a cap equipped with basic sensors to detect obstacles and provide audio alerts.
- **Shift from Basic to Advanced Sensing:**
  - The project took a significant turn from using simple proximity sensors to the OpenMV camera for sophisticated person detection.
  - This shift was driven by the need for more precise and contextual awareness in crowded settings.

Initial Concept [Continue]

- **Experimentation with Feedback Mechanisms:**
  - Originally, the feedback was to be purely auditory. However, through experimentation, it evolved to include visually appealing NeoPixels and discreet mobile notifications.
  - Trials with different LEDs and sound modules helped refine the choice of NeoPixels for their versatility and user-friendly nature.
- **Integrating Advanced Technologies:**
  - The integration of advanced technology like TensorFlow for person detection was initially planned but faced hardware limitations.
  - This challenge led to exploring Haar Cascade as an effective alternative, demonstrating the adaptive nature of the project.



Initial Concept [Continue]

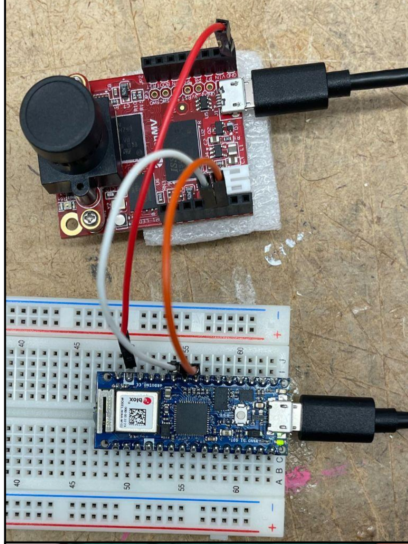
- ❖ **Final Outcome vs. Initial Idea:**
  - ➢ The final piece is a far cry from the initial concept – it's not just a navigation aid but a sophisticated, socially-aware wearable device.
  - ➢ The Smart Cap now stands as a testament to innovation, adaptability, and the relentless pursuit of functionality combined with user-centric design.

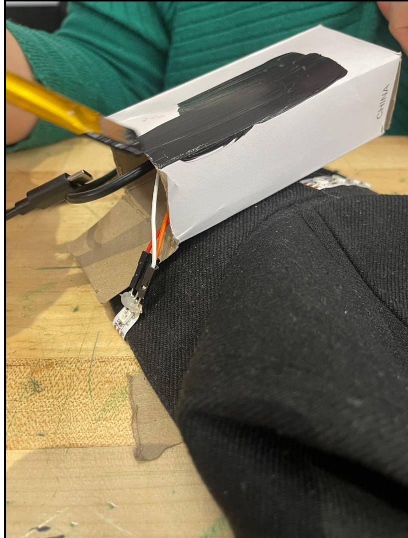
Process

- **Project Inception:**
  - The process began with a clear goal: to create a wearable aid for spatial awareness in crowded environments. The initial steps involved conceptualizing, sketching, and planning the basic components.
- **Technological Exploration:**
  - A significant part of the journey was exploring and understanding the capabilities of the OpenMV camera and Arduino Nano 33 IoT. This exploration was crucial in shaping the project's direction.
- **Surprising Discoveries:**
  - One of the first surprises was the limitation of the OpenMV camera in running advanced TensorFlow models, leading to a pivot towards Haar Cascade for person detection.
  - The realization that audio alerts and blinking LEDs could be anxiety-inducing in crowded settings shifted our focus to visual feedback through NeoPixels.

Process [Continue]

- **Overcoming Communication Challenges:**
  - Establishing effective communication between the OpenMV camera and Arduino Nano presented significant challenges.
  - The transition from UART to I2C communication was a key learning moment, offering stability and efficiency.
- **Iterative Design and Testing:**
  - The project evolved through continuous testing and redesigning. Each iteration brought new insights, from optimizing the placement of components to refining the user interface.
- **Lessons Learned:**
  - This journey taught me the importance of flexibility in design and the need to adapt to both technological constraints and user feedback.
  - I learned that simplicity in design often leads to better functionality and user experience.
  - Surprisingly, integrating aesthetics with technology was both challenging and rewarding, emphasizing the need for wearables to be as appealing as they are functional.





Next Steps / Version 2, 3, 4, ...

- **Enhanced Sensing Capabilities:**
  - For the next iteration, I aim to incorporate more advanced sensing technologies, possibly integrating LiDAR or radar sensors for improved spatial awareness and accuracy in dense environments.
- **Advanced AI Integration:**
  - Leveraging deeper machine learning algorithms to not only detect people but also interpret social contexts – like distinguishing between a crowded street and a queue.
- **Improved Power Management:**
  - A key focus will be on optimizing battery life and possibly incorporating solar cells for sustainable power, making the cap more practical for extended use.

Next Steps / Version 2, 3, 4, … [Continue]

- **Social Interaction Features:**
  - Exploring features that allow multiple Smart Caps to interact with each other, enabling a new level of social awareness and connectivity among wearers.
- **Design and Comfort Enhancements:**
  - Aesthetics and comfort will get a major upgrade – experimenting with lightweight materials and sleeker, more fashionable designs.
  - Incorporating adjustable and customizable features to cater to a wider range of users and preferences.
- **User Interface and Accessibility:**
  - Improving the user interface with more intuitive controls and feedback systems, ensuring the cap is easily operable by all, including those with limited tech experience.
  - Enhancing the app integration for more personalized settings and notifications.

Next Steps / Version 2, 3, 4, ... [Continue]

- **Research and Collaboration:**
  - Continuing research into the needs and challenges of visually impaired individuals and collaborating with organizations in this field for real-world testing and feedback.
- **Market Research and Commercialization:**
  - Conducting extensive market research to understand the commercial viability and exploring pathways to bring Smart Cap to a broader audience.
- **Developing Custom Machine Learning Models:**
  - Moving beyond the constraints of the OpenMV H7 camera, the next version of Smart Cap will focus on developing proprietary machine learning models tailored specifically to our use-case.
  - This shift allows for a more nuanced understanding of complex social environments, surpassing the capabilities of pre-built models.
- **Training with Diverse Data Sets:**
  - Key to this development is the collection and utilization of diverse, real-world data to train these models, ensuring they are robust and effective in varied scenarios.

Thank you!

[Link to Sample Bill]