Mission

• As technology advances, so does society’s ability to provide tools for people with physical disabilities.

• TiresiaScope’s objective is to help the blind by creating a headset that uses sounds to assist in navigating their surroundings.
Motivation

- The initial intent was to improve upon the primary tool already available to people who are blind—the cane.
- We decided on a device which could inform the user of nearby objects before coming into close contact with them.
- We wanted the device to be extendable to provide feedback as to the *identity* of these objects as well.
What is the TiresiaScope?

• Tiresias, the blind prophet
• Detects nearby objects with ranging sensors
• Identifies faces with a camera
• Relays information to user through sound: musical tones indicate object distance while surround sound shows direction, and a beep indicates a visible face
Block Diagram
PYNQ

- Dual-Cortex ARM Cortex A9 processor supports coding in Python
- Individual Microblaze processors on FPGA control I/O for Arduino and PMOD headers
- Why did we choose PYNQ?
  - Processing power for computer vision
Camera: OpenMV M7

- On-board STM32F765VI ARM Cortex M7 processor
- 640x480 8-bit grayscale at 30 FPS
  - 320x240 16-bit RGB565 also available
- Programmable in python
  - Face detection library
Ultrasonic Sensor:
Ultrasonic Range Finder - LV-MaxSonar-EZ1

- Detection range: 160mm to 6.45m
  - Our long-range sensor
- Reliable range data at long distance
- Multiple interface options
  - TiresiaScope makes use of UART
Optical Sensor:
Simblee™ IoT 3D ToF Sensor Module

- Detection range: 100 mm to 2 meters
  - Our backup sensor
- More precise but shorter range
- I²C interface
Audio Codec: WM8731

- Stereo audio output
- SPI data interface, I²C control interface
- Why do we need an audio codec?
  - PYNQ only has mono output
  - Surround sound is essential to indicate object direction
PCB Layout
Software

Python is used for the frontend processing

Sensors

• Sensor value inputs are converted into the frequency of a certain tone depending on object distance

Camera

• Images are captured and face detection is run on-board
System Flow

• Periodically poll the array of sensors for range data, poll camera for face detection
• Calculate range bins for detected objects
• Form a sound sample from calculated ranges
• Pass the sample to the audio codec to play for the user
Wearable Apparatus

- Prototype: skateboard helmet, sturdy enough to mount sensors and camera

Mounting:

- PYNQ set on top of the helmet
- Camera front and center
- Sensors distributed around the forward hemisphere
Demo

https://www.youtube.com/channel/UCelcv9P1Y4hdrRZrNyjMQpw/
Conclusion

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Questions?