BU Department of Electrical & Computer Engineering

Boston University
Electrical & Computer Engineering
EC464 Capstone Senior Design Project

Final Project Testing Plan

OPTICLE

by

Team 3
Opticle

Team Members

Annamalai Ganesh (amg1998@bu.edu)
Luca Guidi(lucag@bu.edu)
Jami Huang (jamih@bu.edu)
Stefan Wong (spwong@bu.edu)
Nancy Zheng (nancyzhe@bu.edu)

Client: Eshed Ohn-bar (eohnbar@bu.edu)

April 12, 2022

I. Required Materials

A. Hardware:
- Raspberry Pi 4 Model B (with 16 GB MicroCenter SD card)
- Raspberry Pi Zero
- Pi Sugar Power Source
- Charmast Portable Power Bank
- OpenCV AI Kit: OAK-D Camera
- Linear Resonant Actuator
- Switch
- Bone-conducting headphones
- Desktop monitor
- Keyboard
- Mouse

B. Software:
- Python 3 Scripts:
  - Point Cloud Detection (Mode 1) + Obstacle Detection (Mode 2) + Audio Mode
- Motor Control:
  - Raspberry Pi GPIO

C. Other:
- Platinum Extreme Accessory Kit (Chest Mount)
- 3-D Printed Wrist Mount

II. Set-Up

Our set-up includes both software and hardware components: an object detection Python script that is run on a Raspberry Pi 4, which is connected to an OAK-D camera and wired to a linear resonant actuator. The hardware is attached to a chest mount where the camera is mounted to a screw in the middle and the pi and portable battery is attached to the body of the user. Both the Pi 4 and OAK-D are connected to the portable battery to receive power. The actuator is attached to a Raspberry Pi Zero which is housed on a 3-D printed wrist mount. This wrist mount will be meant to be worn like a watch where the actuator is touching the user's skin. There is also a switch attached to the right strap of the chest mount, near the user's right side of their collarbone. Both Pis are connected to a keyboard, mouse, and monitor display via HDMI so that the Raspberry Pi Desktop can be used to run the script. Once the scripts are running, both Pis will be unplugged so the user can use the device portably. The python script utilizes the OAK-D camera where it uses point cloud data to determine whether an immediate obstacle is in front of the user. Point cloud data is generated by combining both RGB and depth data. By drawing a cuboid of space in front of the user and looking at the density of data points in that cuboid, the system is able to alert the user of nearby obstacles. When an object is detected, the script will send a detection value via TCP/IP to the Raspberry Pi Zero, which will then send a PWM signal to the appropriate GPIO pin on the Pi Zero. The LRA is wired to this GPIO pin which will allow the LRA to receive the pwm signal and vibrate to alert the user whenever an object is detected. The user will also wear bone-conducting headphones that will output audio from the Pi and will also receive speech input from the user that will be received by the Pi.

III. Pre-Testing Setup Procedure

1. The user should put on the chest mount and ensure a snug fit.
2. Mount the Raspberry Pi, portable battery, and OAK-D camera onto the mount and ensure that they are tightly secured on the back of the belt and in the center respectively.
3. Connect the HDMI, micro usb, and OAK-D to the Raspberry Pi.
4. Connect the ground wire of the PCB to GND on the Pi, and the other wire to GPIO Pin 8.
5. Connect both the Raspberry Pi and the OAK-D to the portable battery.
6. Have the user hold the wrist mount in one of their hands.
7. Power on the Raspberry Pi and go into the directory where the required files are stored by running the following: "*cd BUSeniorDesign-Opticle-21-22/examples/test"*
8. The user should put on the bone conducting headphones.
9. Connect the Pi Zero to a monitor, keyboard, and mouse.
10. Power on the Pi Zero and go into the directory where the required files are stored by running the following: "*cd BUSeniorDesign-Opticle-21-22/point-cloud-projection*"
11. Unplug both Pis from monitors and enter the hallway for testing.

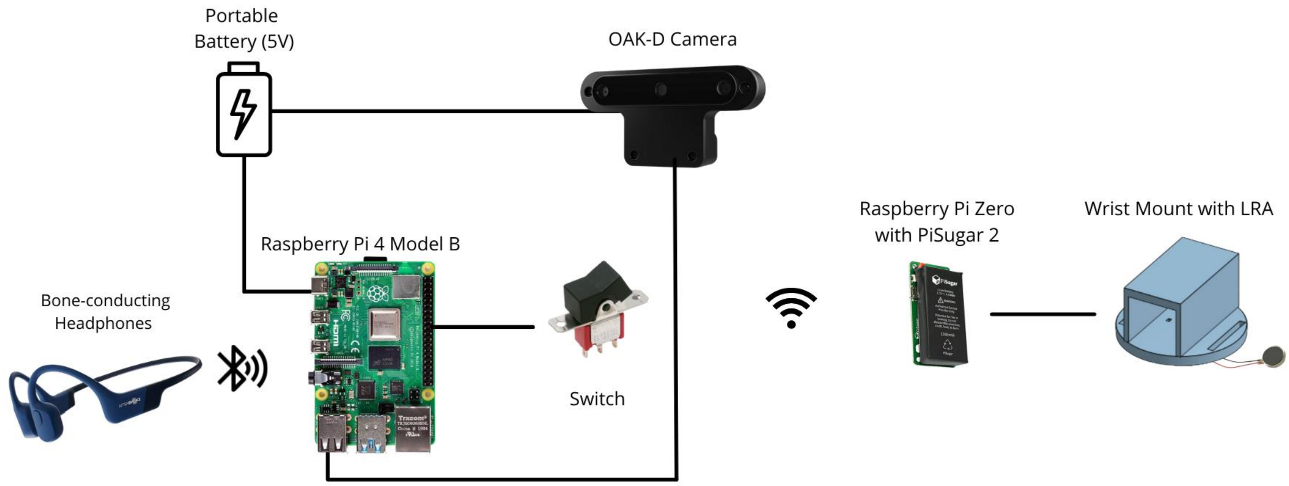

Figure 1: Illustration of Setup

IV. Testing Procedure

Showing Mode 1

1. Run “*spatial_tiny_yolo.py*” on the Pi 4
2. Run “*piserver.py*” on the Pi Zero
3. One person will stand near the user within walking distance.
4. The user will then move forward until the person is in front of the user. See if the system detects the person.
5. The user will then attempt to walk around the person. See how the system responds when there is no longer an obstacle or if the obstacle is out of the range of detection.
6. A chair will be placed near the user.
7. The person will then move around until the chair is in their walking path. See if the system detects the chair.
8. The user will then attempt to walk around the chair. See how system responds when there is no longer an obstacle

Showing Mode 2

1. Flip switch to mode 2.
2. Place a backpack nearby the user and have the user walk around until it finds it.
3. Have the user listen for a matching object and its distance from the user.

V. Measurable Criteria

The criteria for successful running and output is as follows:

1. The Raspberry Pi 4 should successfully power on the OAK-D camera and begin object detection.
2. The Raspberry Pi Zero should successfully power on and be connected to the LRA. When the OAK-D camera detects an object in front of the user, the LRA should vibrate.
3. The LRA should only vibrate when the camera detects an obstacle between 0.7 and 1.7 m in front of the user.
4. When no objects are in front of the user, the LRA should not vibrate.
5. When in mode 2, the system should ask the user for an object to scan for.
6. The system should only output found objects that match the label the user asked for and tell the user the object’s distance.
7. If the system cannot recognize the user’s input, it should prompt the user to try again.

Hardware Pinout

Pin	Usage/Description
Gnd	Ground
GPIO-8	PWM output for LRA

Score Sheet

Mode 1

Object	Distance	Motor Vibration Correct?
Person	+1.7m	
Person	0.5-1.7m	
No Person	N/A	
Chair	0.5-1.7m	
No Chair	N/A	
Result		/5

Mode 2

Object	Distance	Motor Vibration Correct?	Audio Output Correct?
Person	+1.7m		
Person	0.5-1.7m		
No Person	N/A		
Backpack	0.5-1.7m		
No Backpack	N/A		
Result		/5	