OPERATIONS MANUAL

Overview

The Operations Manual provides computer control personnel and computer operators with a detailed operational description of the information system and its associated environments, such as machine room operations and procedures.

1 PROJECT OVERVIEW

1.1 Introduction and Purpose

We are **Sway Aid (Searching Wisely for Adolescents and Youth)**. Our senior design project gives us the opportunity to make a societal impact and potentially save a life. The objective of this project is to save a human from being trafficked. The trafficking industry is one of the fastest growing industries, estimated to be worth 150 billion dollars. Tallahassee, Florida is a very significant location for traffickers. In Tallahassee, victims of trafficking are often sold into the industry by their parents. Across Florida, there is a ring for the transportation of trafficking victims. Victims are transported from Tallahassee, to Jacksonville, to Orlando, to Miami, to Tampa, and back to Tallahassee. **Something must be done to rescue these victims from a lifetime of slavery.** By incorporating our collection of mechanical, electrical, industrial, and computer engineering knowledge, we plan to create a device that will be used to give the person an opportunity to alert authorities of their situation and whereabouts.

This device will allow the person in need to easily receive help immediately and remain confident that even if they leave the device, they can still receive help. We have had the opportunity to work with the Tallahassee Police Department, as well as several nonprofit organizations, to gather information on trafficking instances in Tallahassee in order to best identify and address needs that our device will meet to be successful. The device will be designed to incorporate discretely into public area hotspots of trafficking and be accessible to adolescents. This operation manual will thoroughly explain our technology and its subsystems.

1.2 System Timeline

We will locate our product in women's restrooms in high trafficking areas such as rest stops and gas stations along interstate highways. After the victim enters a stall of a women's restroom, they will see a sign instructing how to use our device, if needed. Once the victim exits the stall, she may interact with our dispenser by using our fingerprint scanner to receive a GPS tracker disguised as a feminine pad or tampon. When the victim exits the bathroom, our facial recognition device will be activated via Bluetooth. Once the victim comes in range of the camera, a picture will be taken and compared to our database of missing persons to identify the victim. All in all, this information – fingerprint, GPS location, and an image of the victim – will be sent to the local police department to aid in the rescue of the victim.

1.3 Glossary

Human Trafficking: the action or practice of illegally transporting people from one country or area to another, typically for the purposes of forced labor or sexual exploitation.

Pimp: The traffickers in street based commercial sex tracking are often individual trafficker, more commonly known as "pimps". These traffickers may vary in their relationship to the victim but are similar in the tactics they employ to recruit, control and sexually exploit their victims.

Subsystems: a self-contained system within a larger system.

Fingerprint scanner: a type of electronic security system that uses fingerprints for biometric authentication.

GPS tracker: a navigation device normally carried by a moving vehicle or person or animal that uses the Global Positioning System to track the device's movements and determine its location

Facial Recognition: a technology capable of identifying or verifying a person from a digital image or a video frame from a video source.

Artificial Intelligence: sometimes called machine intelligence, is intelligence demonstrated by machines, in contrast to the natural intelligence displayed by humans and animals; a computer's self-learning capabilities

Fingerprint sensor R307: a fingerprint sensor with TTL UART interface. The user can store the fingerprint data in the module and can configure it in 1:1 or 1: N mode for identifying the person

Raspberry Pi: is a series of small single-board computers developed in the United Kingdom by the Raspberry Pi Foundation to promote teaching of basic computer science in schools and in developing countries; used to support the fingerprint scanner and facial recognition subsystems

CanaKit: a kit with the Raspberry Pi that has the rated power supply, case, breadboard circuit board for experiments, and connecting ribbon between the breadboard and the Pi that supplies the GPIO signals, LEDs, and resistor packs, breadboarding wires

HDMI: a standard for connecting high-definition video devices

PSEUDOCODE: an informal high-level description of the operating principle of a software program or other algorithm. It uses the structural conventions of a normal programming language, but is designed for human reading other than machine reading

ETHERNET CABLE: are networking hardware used to connect one network device to other network devices or to connect two or more computers to other electronic devices

2 SYSTEM OVERVIEW

2.1 System Application

OVERVIEW

The functions of our design were determined based on what technology is most helpful in the fight against Human Trafficking. Across Florida, there is a circuit where victims are taken without notice throughout major cities like Tallahassee,

Jacksonville, Orlando, Miami, and Tampa. TPD has been identifying the steps they are currently taking to combat human trafficking. Our technology will allow the person in need to receive immediate help and remain confident that even if they leave the technology, they can still get help. Our technology will attract victims of human trafficking in hot spot trafficking areas. Upon instruction, the victim will provide consent of use by using the fingerprint scanner. This action will send an immediate alert to law enforcement and a disguised GPS tracker will be dispensed. Our technology will provide law enforcement with a location and a visual lead (via facial recognition) on each victim.

2.2 System Organization

Our overall prototype is supported by 6 subsystems: 3 that are hardware-based, and 3 that are both hardware and software based. In sections 2.3 and 2.4 such systems are going to be explained in detailed.

2.3 Hardware Subsystems

The subsystems that only have hardware are a poster, which the victims read in order to activate the technology. We used a female hygiene product vending machine to disguise most of our technology as well as dispense the GPS tracker.

2.3.1 Poster

The poster is very significant because it is the first step that is taken to be able to rescue a victim. It is located in a bathroom stall on the back of the door. It contains triggering words to capture the attention of the victims and encourage them to use our device if needed (Figure 1). It also has all the information on how to activate the vending machine and what the vending machine will do to help them. The poster also notifies the victim that upon using the fingerprint scanner, they are giving consent to call authorities, to be tracked and recorded.

Figure 1: Poster

2.3.2 Vending Machine

The vending machine (Figure 2) is the component of the system that holds a fingerprint scanner, two Raspberry Pi's, a camera, and a GPS tracker, all shown in Figure 3 as an exploded view. NOTE: This design includes the camera within the vending machine for simplicity sake for engineering design day. In an idealized scenario, the camera will be incorporated into the display screen (2.3.3) to avoid legality issues in installing a camera within a bathroom.

The body of the vending machine is made of 20-gauge aluminum sheet that is machined and bent into its final form. The door of the vending machine is composed of the same material and is attached to the vending machine with a 4-inch stainless steel door hinge (https://www.mcmaster.com/1795a2). 20-gauge aluminum sheet is used to provide a rigid and strong casing for the interior components stated above. This provides a deterrent from tampering with the device. The vending machine is mounted to walls with four aluminum L-brackets (https://8020.net/25-4149.html) and eight wall anchors that are rated at 50 lbs each. Six 10-32 fasteners, along with their appropriate bolts, are used to connect the vending machine, hinge, and door together.

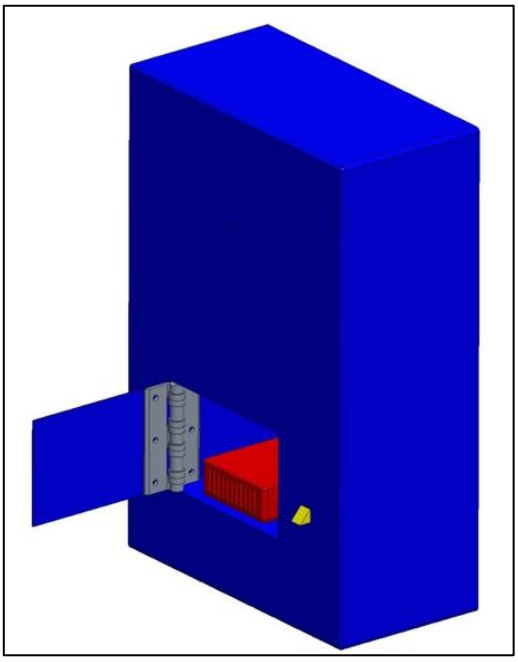

Figure 2: Vending Machine

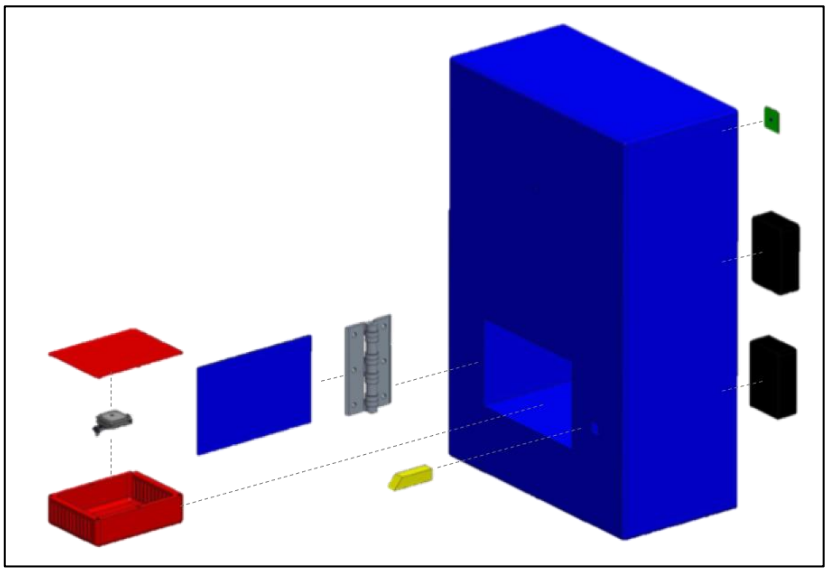

Figure 3: Vending Machine - Exploded View

Figure 4 below shows the drawing of the vending machine before final shaping. The 20-gauge aluminum sheet is cut with a water jet and is bent 90 degrees along the dotted lines into the page. There are two cavities that are created when bending the aluminum sheet metal. These cavities are used to hold the GPS tracker and the fingerprint scanner.

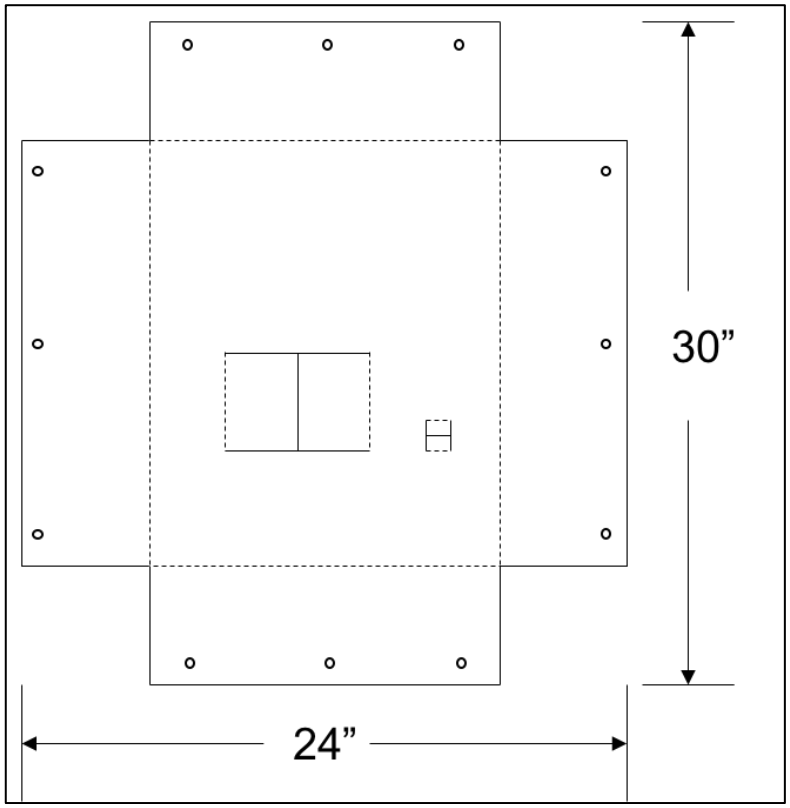

Figure 4: Vending Machine Drawing

2.3.3 Display Screen

The display screen shown in Figure 5 below is a screen with a camera that displays everyday advertisements to the everyday person. Once the vending machine is activated, the display screen notifies instruction and captures the image of the victim. The display screen can show the image, fingerprint information, and location of the victim. This is shown (Figure 6) and would function as so for engineering design day. NOTE: In a realistic setting, the display screen would not show directions to the user. Rather, it would serve as a disguise for the camera, to get the users attention and capture an image to be used in the facial recognition process.

Figure 5: Display Screen – Before Activation

Figure 6: Display Screen – After Activation

2.3.4 Entire system

Figure 7 shows how the entire system works together. The vending machine is located in a female restroom where a male trafficker will not be able to enter. The vending machine is then activated by the victim with their fingerprint where a

disguised GPS tracker is dispensed to the user. As the victim leaves the restroom, the display screen notifies the victim to get close to the screen so that the screen can take the image of the victim. The location, image, and fingerprint information are then sent to the authorities where they can determine the best action for the situation.

Figure 7: System

2.4 Technological Subsystems

This project has three essential technological subsystems that contain software as well as hardware. The three technologies are a Fingerprint Scanner, a GPS tracker and Facial Recognition.

2.4.1 Fingerprint Scanner

The fingerprint scanner is composed of hardware and software. For the hardware, a fingerprint sensor R307 is used which can store 1000 prints, it has a 3.3V operation, it can be operated via USB and it detects the fingerprint as the output. Also, a USB-TTL UART Module is used to connect the fingerprint scanner to the Raspberry Pi 4. For the software part, a raspberry Pi 4 is used. In order to get the Raspberry Pi 4 working, different software had to be downloaded on a desktop first, which were Noobs and Raspbian. Once these were downloaded on a desktop, then they are installed into the Raspberry Pi 4. From there, the Raspberry Pi 4 is used and the code for the fingerprint scanner is written. The following code says that once a finger is detected on the scanner, it will display a picture of the fingerprint as well as saving it onto the computer. Once the code runs, you can place a finger on the fingerprint scanner and on the monitor a picture of the fingerprint will show, and it will also be saved on the Raspberry Pi. Below is the step by step installation process for the fingerprint scanner with the Raspberry Pi 4. NOTE: This code also stores the print and allows a recognition process to occur to identify the user belonging to said print. In the event that this device were implemented in a realistic setting, authorities would be able to identify whether the victim using the scanner were registered as a missing persons or a victim who has already used the system.

1. Wiring and Connections
    - Insert the Raspberry Pi into the CanaKit (the Raspberry Pi case that has cooling functionalities)

- Connect the Fingerprint module to the raspberry pi using male/female wires (Figure 8)
  - Black Wire to GND
  - White Wire to TXD (Blue in figure)
  - Green Wire to RXD
  - Red Wire to VCC
- Take the Raspberry Pi and connect an HDMI cord to one of it ports and connect the other end to a monitor
- Connect a keyboard and Mouse to the Raspberry Pi
- Connect the ethernet cable to the Raspberry Pi for reliable fast internets connection. If there is internet set up, you can type in the password in the raspberry Pi system, however, the ethernet cable with give the best results.
- Connect the Raspberry Pi's power cable to the power port on the Raspberry Pi and connect the other end to an outlet. (it is IMPORTANT that this is the last step in the wiring process)

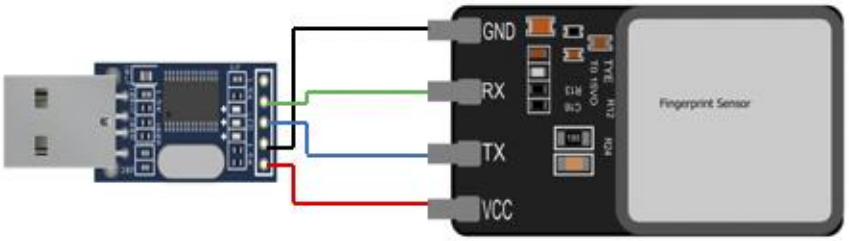

Figure 8: Fingerprint Wiring diagram

2. Raspberry Pi set up
   - Once the power cable is connected to the Raspberry Pi should now be activated
   - The Raspberry Pi's home screen will now be on the monitor
   - Open the terminal to input the commands
   - Execute the commands needed to run the fingerprint scanner
   - Fingerprint, name of user, and fingerprint image will be stored

   Step by step tutorial/code link:
   https://drive.google.com/file/d/1x48WYqWR28XqSCUJfozmxpqamcaB2qdP/view

   The fingerprint scanner module is a prerequisite for the GPS Tracker and Facial Recognition module. Once it is activated, using Bluetooth, a signal will be sent to the other modules and they will be activated and ready for use

2.4.2 GPS Tracker

The GPS tracker is composed of hardware and software. For the hardware, it includes the GPS itself, the Adafruit Ultimate GPS Breakout. This GPS module has a built-in antenna that is capable of tracking up to 22 satellites on 66 channels for extreme accuracy

(Position Accuracy 1.8 meters). It can do up to 10 location updates a second for high speed, high sensitivity logging or tracking. The GPS contains a 3.3 V regulator that will enable the GPS to be powered with 3.3-5V DC. An important element to observe is the Fix LED light on the module. Once the GPS is turned on, it will immediately search for a fix or when it connects with satellites and is able to return a position. The LED will blink at a rate of 1Hz when the GPS is searching for satellites to connect with. It will need to connect to at least four satellites for it to work. Once the GPS is connected to the satellites it needs, the LED will blink once about every 15 seconds. The GPS breakout can connect to any type of microcontroller that can receive a TTL serial at 9600 baud. In this case an Arduino Nano was used. In order to give the GPS commands, the module is connected to the Nano. Arduino IDE (Arduino Software) needs to be downloaded on a desktop or laptop, it is used to write and upload programs to Arduino compatible boards. The following code will display the speed, latitude and longitude, date, time, and the number of satellites that are connected, to the user. The code also consists of a format to make the transfer of the data to Google Earth the easiest possible. Below is a step-by-step installation process for the GPS tracker with the Arduino Nano.

1. Wiring and Connections
    - Connect the Arduino Nano to the Ultimate GPS breakout using male/male jumper wires (Figure 9)
        - VIN to 5V
        - GND to Ground
        - TX (transmit) to digital pin 8
        - RX (receive) to digital pin 7
    - Connect Arduino Nano to desktop or laptop with a **Mini-B USB** connection

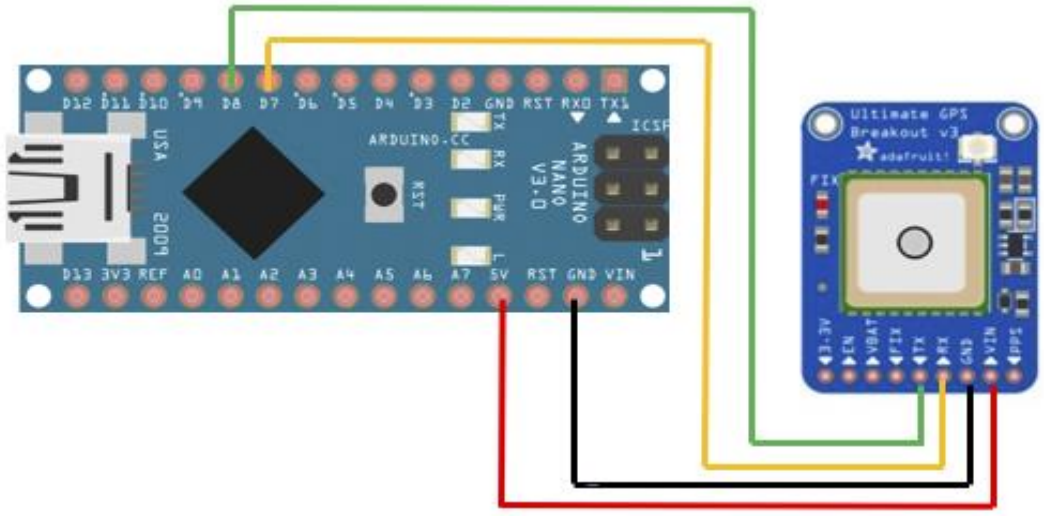

Figure 9: GPS Tracker Wiring diagram

2. GPS Tracker set up
    - Download Arduino IDE
        - https://www.arduino.cc/en/main/software
    - Download Adafruit GPS library
        - https://github.com/adafruit/Adafruit_GPS
    - Save and compile code
        - 
GpsTrackerCode.docx
    - Upload code to Arduino Nano
    - Wait until GPS finds Fix (blinks once every 15 seconds)
    - Open serial-monitor to observe data (Set baud rate to 115200)

2.4.3 Facial Recognition/Artificial Intelligence

The facial recognition is the final step of the technology interaction. It is also composed of hardware and software. The hardware needed for this subsystem is a Raspberry Pi 4, a Raspberry Pi camera, CanaKit (the Raspberry Pi case), HDMI cable, Keyboard, Mouse, ethernet cable, Raspberry Pi power cord, a monitor.

For the software part, a raspberry Pi 4 is used. In order to get the Raspberry Pi 4 working, different software had to be downloaded on a desktop first, which were Noobs and Raspbian. To capture an image using the raspberry pi, you will need to connect the Raspberry Pi Camera v2 is to the raspberry pi. The Raspberry Pi Camera v2 is a high quality 8-megapixel camera.

To run the AI (Facial Recognition Module) you will need OpenCV. Using the Raspberry Pi, an image of the victim will be captured and saved to a file on the Raspberry Pi. Using OpenCV, the captured image of the victim will be analyzed using AI with a database of images (ie. Missing Persons), to see if it can recognize and find a match of their face with an image in the database. Below is the step by step installation process for the fingerprint scanner with the Raspberry Pi 4.

1. Wiring and Connections
    - Insert the Raspberry Pi into the CanaKit (the Raspberry Pi case that has cooling functionalities)
    - Take the Raspberry Pi and connect an HDMI cord to one of it ports and connect the other end to a monitor
    - Connect the Raspberry Pi camera to the Raspberry Pi using the camera port

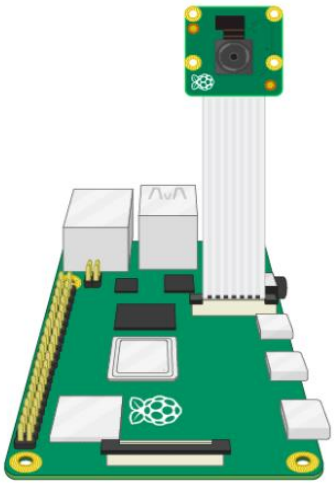

Figure 10: Raspberry Pi Camera

- Connect the keyboard and Mouse to the
- Connect the ethernet cable to the Raspberry Pi for reliable fast internets connection. If there is internet set up, you can type in the password when in the raspberry Pi system, however, the ethernet cable with give the best results.
- Connect the Raspberry Pi's power cable to the power port on the Raspberry Pi and connect the other end to an outlet. (it is IMPORTANT that this is the last step in the wiring process)

2. Raspberry Pi set up and commands to run the module
    - Once the power cable is connected to the Raspberry Pi should now be activated
    - The Raspberry Pi's home screen will now be on the monitor
    - Go to the main menu and open the Raspberry Pi Configuration tool

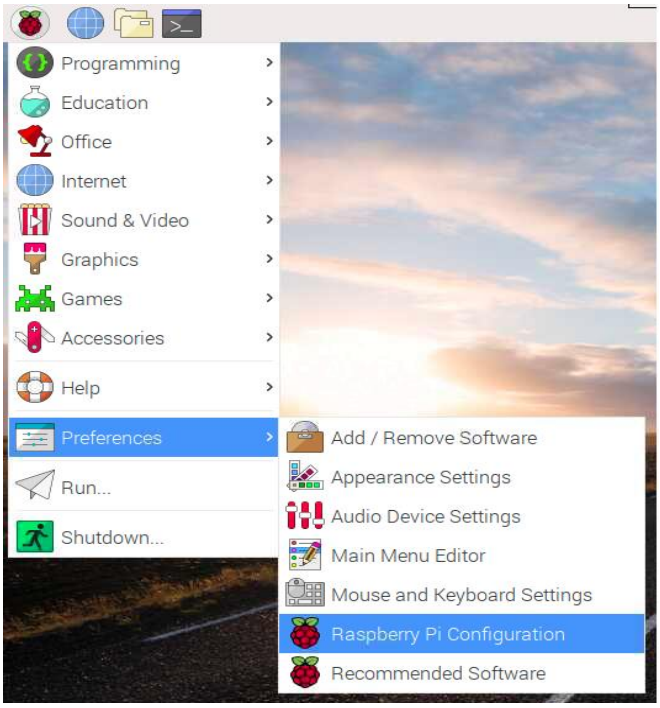

Figure 11: Raspberry Pi Configuration

- Select the Interfaces tab and ensure that the camera is enabled:

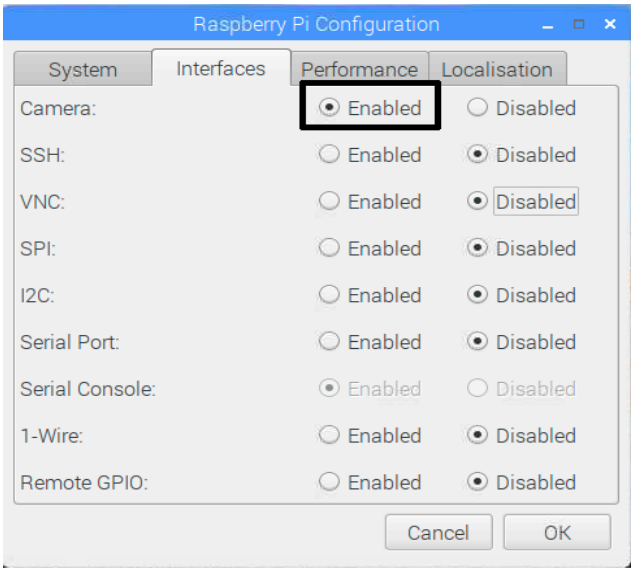

Figure 12 Initializing Raspberry Pi Camera

- open up the terminal and type in the following commands
  - `sudo apt update`
  - `sudo apt full-upgrade`
- once all the upgrades are made, the next command will be
  - `sudo raspi-config`
- Using the keyboard, navigate to and select *Interfacing Options*, and the navigate to and select the *Camera* and follow the prompts to enable the camera

- In the terminal type in the following command to capture in image using the raspberry pi
  - `raspistill -v -o Desktop/test.jpg`
- An image will be captured and saved as “test.jpg” in a folder a folder called “raspberry-pi”
- To capture a video
  - `raspivid -o Desktop/testvideo.h264 -t 10000`
- A video will be taken and saved as “testvideo.h264” in a folder a folder called “raspberry-pi”
- Open up OpenCV and type in the code needed to make to comparisons (the code is in the link below)
  - https://www.pyimagesearch.com/2017/06/19/image-difference-with-opencv-and-python/

2.5 Processing Overview

Provide information that is applicable to the processing of the system. Include system restrictions, waivers of operational standards, and interfaces with other systems.

When the first system is activated (the fingerprint scanner), the other subsystems will be activated using a blue tooth signal. Once the fingerprint scanner has been activated the authorities will be notified by getting a phone call. Then the vending machine will release the GPS tracker using a solenoid (not factored into the design as of yet due to school closure), connected to the Raspberry Pi hosting the fingerprint scanner. A Bluetooth signal will be sent out and activate the raspberry Pi hosting the camera. This will initiate the code to take images of the user and run the code to compare the gathered images to a database of missing persons using facial recognition software.
Restrictions on the fingerprint systems may be its inability it read a damaged or sweaty fingerprint.
Limitations of the facial recognition module is that it may not be able to process blurry or sideview pictures, or pictures where the person’s profile is obstructed (ie, they’re wearing sunglasses or a facial scarf).

2.6 System Integration

The assembly of the system begins with the vending machine. The fingerprint scanner is then attached and secured into the smaller of the two cavities on the front shown in Figure 4. The two Raspberry Pi’s are then mounted from the back of the vending machine into their respective locations. One Raspberry Pi is connected to the fingerprint scanner and the other is connected to the camera. The GPS trackers are then loaded into the vending machine. The exploded view shown in Figure 3 can be used to determine the positioning of the components. The entire assembly is then secured to the wall. Lastly, the display screen is mounted to the wall outside of the restroom area.

3 OPERATION

3.1 Safe and Effective Use of the Product

The only features the user needs to physically interact with is the fingerprint scanner and the GPS tracker. The user's whole fingerprint should be placed on the fingerprint scanner to avoid scanning partial fingerprints. This allows for the best fingerprint to be recorded. The GPS tracker should be stored in a dry location on the user to provide the most accurate location to the authorities. Avoid placing the GPS tracker in wet areas so that there are no electronic failures. When interacting with the display screen, the front view of the user's face should be displayed to the camera. This allows for the facial recognition system to get the highest quality image.

3.2 GPS Care

The GPS trackers are loaded and unloaded into the vending machine by removing the vending machine from the L-brackets that are secured to the wall. GPS trackers should be inspected and tested annually and should be replaced if they fail inspections. The parameters that need to be checked during inspections are battery voltage, the GPS signal strength, and cleanliness.

3.3 System Reset

For resetting the systems for the fingerprint scanner, you will have to restart the Raspberry Pi and once logged back in, open the scrip and run it. Executing the f.clearDatabase() command on the terminal will clear the entire database of the Raspberry Pi and most important delete any fingerprints or profiles that were stored previously.

3.4 Troubleshooting

Hardware Issues:

Fingerprint scanner:

i. If the fingerprint scanner fails to detect a victim’s fingerprint: Ensure that the surface of the fingerprint scanner is dry. Make sure that the technology is powered on and the software is up to date to prevent any connection failures between the technology and the missing victim database.
ii. If reregistering a new print: It often takes two fingerprint images to successfully register the fingerprint.
iii. If the second activation still does not allow the door to be opened: User should try and stay within the bathroom until authorities arrive.

GPS Device:

i. If the user has difficulty opening the door to receive the GPS device: User should try activating their print again, using the same finger.

Facial Recognition:

i. If the user isn't still able to receive the GPS device, the user should exit the bathroom to get their picture taken by the camera outside of the bathroom. This will ensure that the police have an image on the user.

Software Issues:

Fingerprint:

i. Upon activation, if the fingerprint scanner fails to search for a match in the missing victim database this will send an alert to our system notifying that our technology is failing to connect to the database and this error will be resolved remotely.

GPS:

i. In the case that the GPS fails and doesn't work, or the victim happens to lose contact with the tracker; the authorities will at least have the date, time and location of when the device was used and a potential lead on the victim.

Facial Recognition:

i. If the Facial Recognition falsely matches the human trafficking victim to another missing victim in our missing victim database: Our facial recognition feature will also provide a snapshot image of the victim that can be used to confirm if this a correct match. Additionally, if there's a match through our technology fingerprint scanner, we can use this to see if both the facial recognition as well as the fingerprint scanner matches to the same missing victim. This will provide the software expert to resolve the error within the code.

Google Earth:

i. If our original GPS tracker file isn't supported by Google Earth: we will import the GPS data as a .gpx, .loc file, serial or USB cable. If the import takes a long time, we will decrease the sampling rate when collecting the GPS data. If our technology gets a connection error, we will restart the GPS device and return to step 1 "import the GPS data as a .gpx, .loc file, serial or USB cable."