



OpenSpot

Final Presentation

Presented by Company 7

Presentation Outline



Team Members and Introduction



Technical Case



Business Case



Risk Analysis and Standards



Demonstrations



Reflection and Conclusion

OpenSpot Team



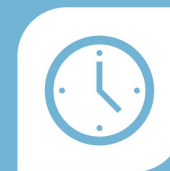
The Problem



Busy parking lots



Parking Disputes



Wasted Time

Our Solution



Camera locates
open spots



Mobile-friendly website
to browse parking areas
with open spaces



LED indicator lights
to show parking
density in the area



OpenSpot

Technical Case

System Design - High Level Overview

Hardware

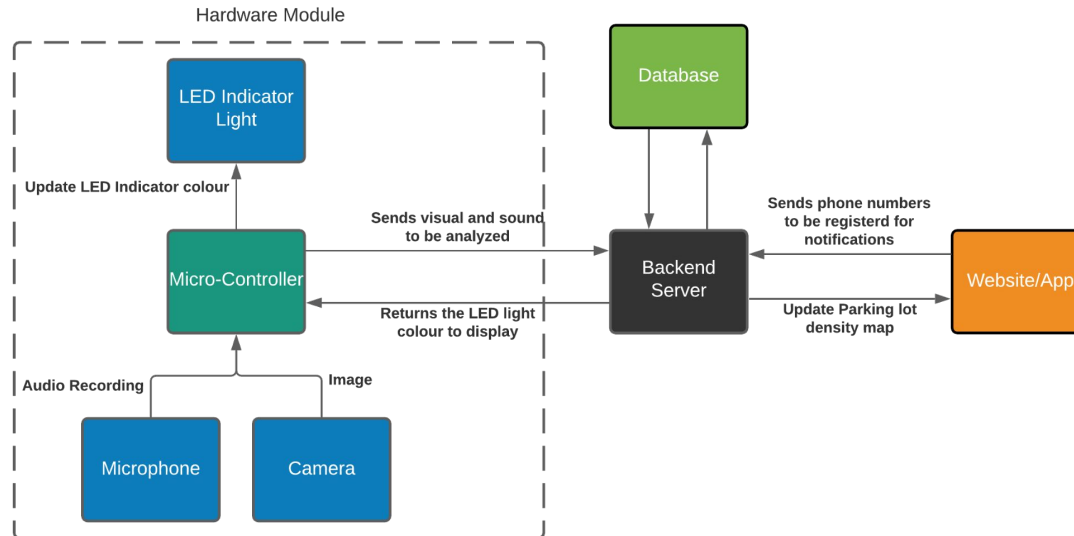
- Microcontroller
- Camera
- Indicator Light
- Microphone

Backend Servers

- Django and NodeJS
- MongoDB Database
- Google Cloud Platform

Computation

- Mask R CNN Model with Pre-Trained Weights
- Trained on MS COCO Dataset
- Fingerprinting audio detection



Current State of Hardware Module

Updates Incorporated

- Upgraded RGB DMX Light
- Aluminum Module Housing
- Aluminum J-Mount
- Metal mounting bracket
- Components housed in junction box
- Powered by battery pack



Module

Module Details

All Peripherals

Cables wired through J-Mount

Weatherproof housing



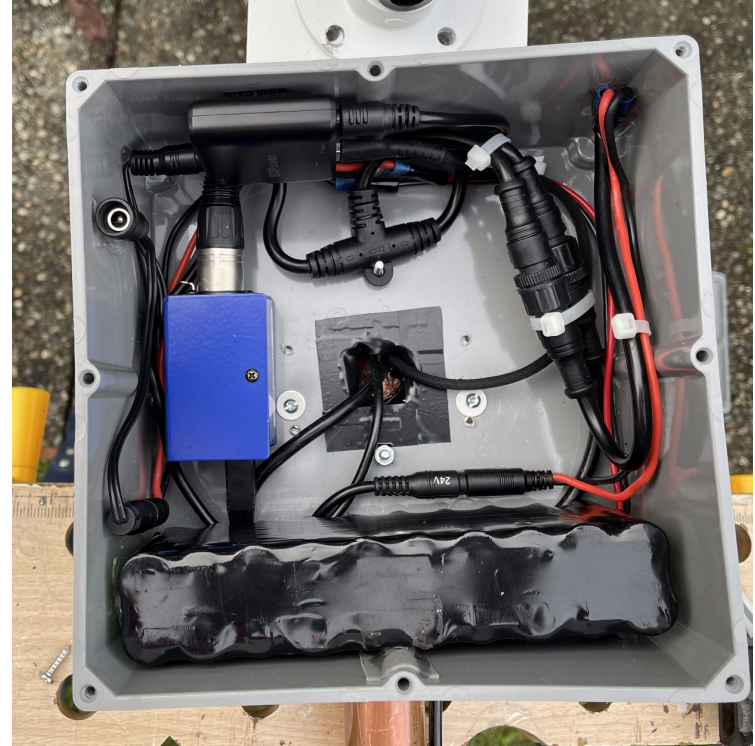
Junction Box

Junction Box Details

Holds battery, connectors, and adapters

Cables wired through pole

Weatherproof PVC Thermoplastic



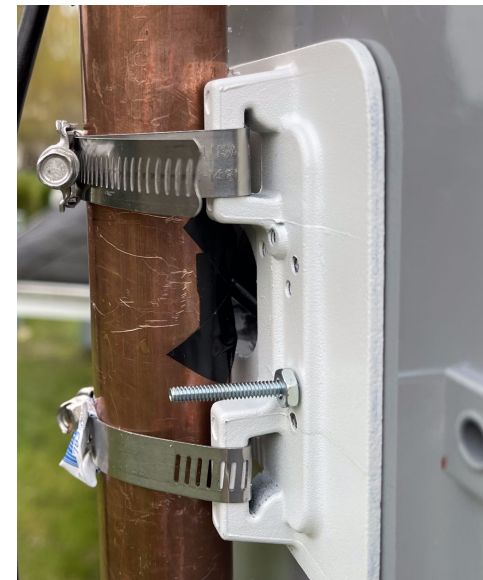
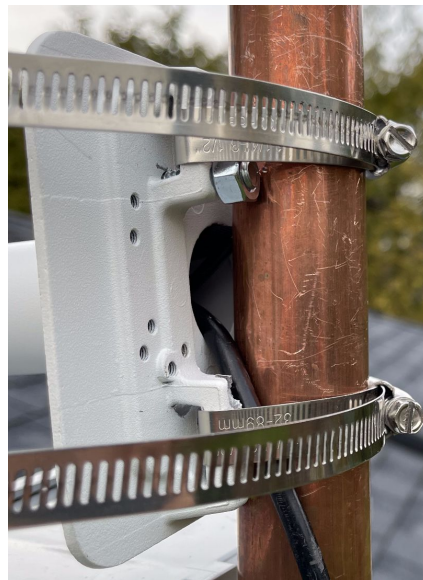
Mounting System

Mounting Details

Module J-mount connected to metal bracket

Junction box mounted to metal plate

Hose clamps used for both



Pole Used For Testing

Pole Details

Total of 12 ft tall, 1.25 inches thick copper pole

Modular design using sharkbite fittings

Used a 12x12 inch workbench as the base



Hardware Materials and Sustainability

- Housing is made out of aluminum
- Junction box is made out of thermoplastic

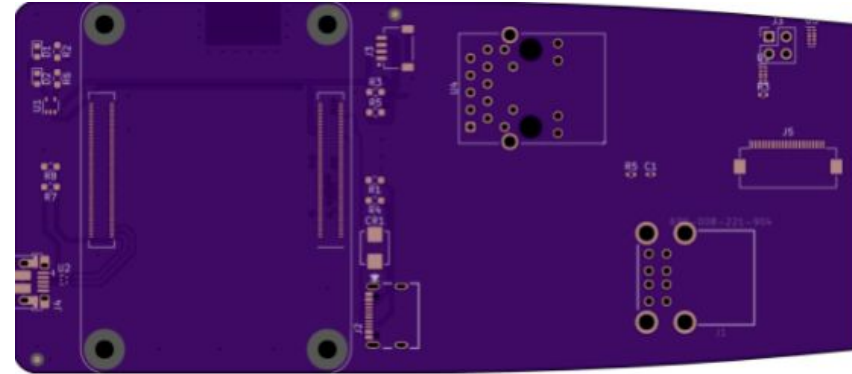
All electronics used are reusable

- Electronics can be recycled by ERA
- Pi can recycled/reused using a free service called PICYCLE
- Camera, microphone, and LED need to be broken down to recycle
- NiMH battery



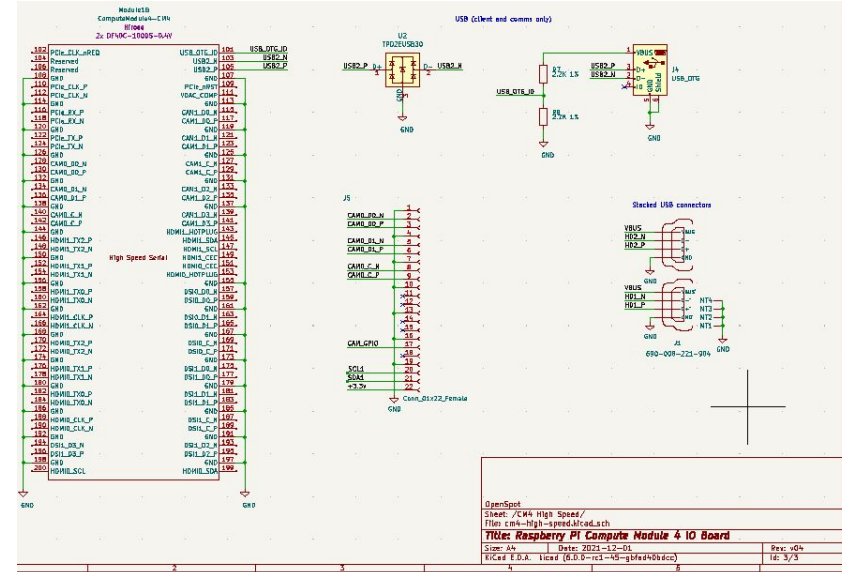
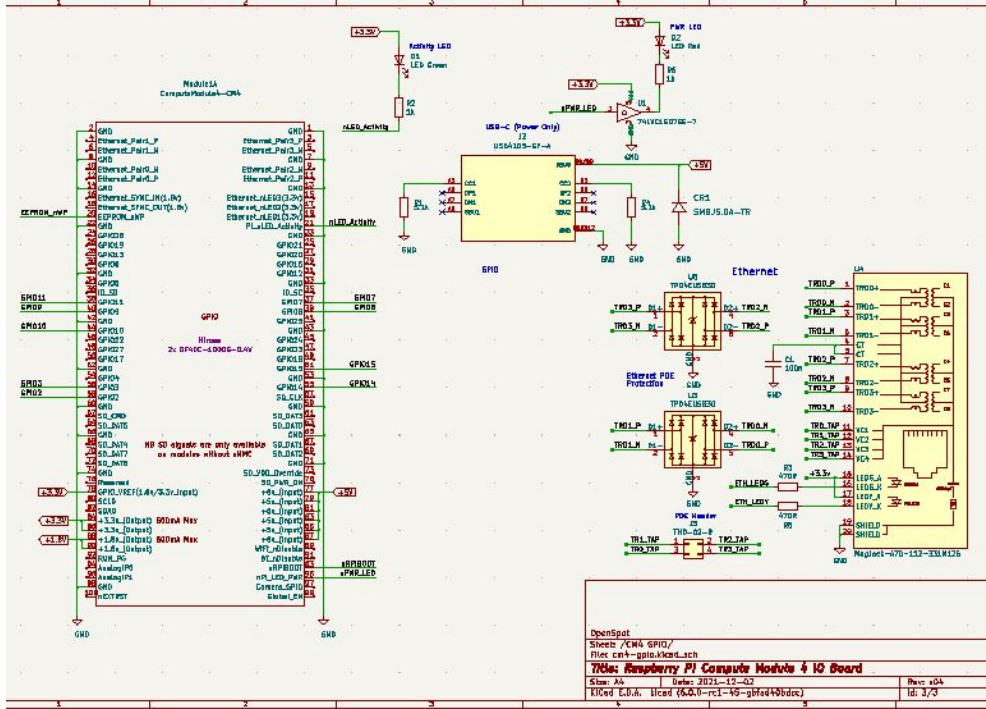
Current State of PCB

Part Name	Digi-Key Part Value
Over Current Diode	SMBJ5.0A-TR
USB-C Port	USB4105-GF-A
Ethernet port	MagJack-A70-112-331N126
Stacked USB	Molex_USB_67298-4090
Raspberry Pi Module	Compute Module 4-CM4



Item	Cost
CM4 Module	\$44
PCB x 3	\$53.20

Schematic of PCB



Current State of Computer Vision



Utilizing a Mask R CNN Model with Pre-Trained Weights



New and Improved Bounding Box Drawing and Overlap Computation



Room for Optimization

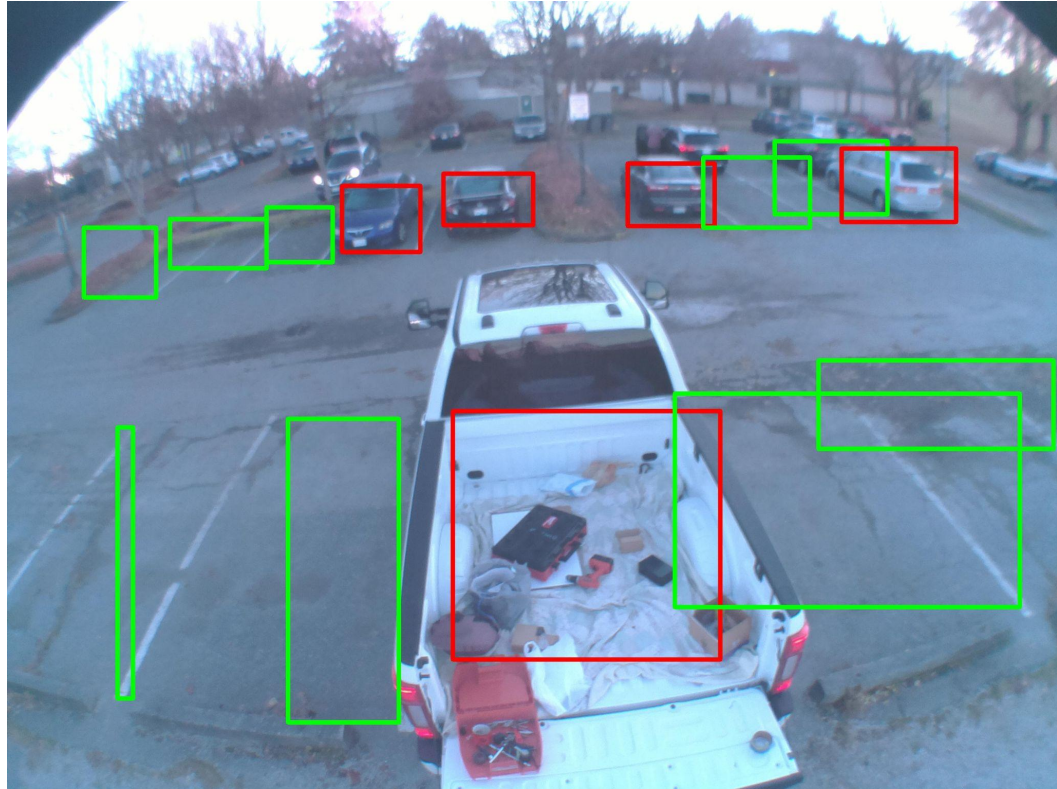
CV Updated Overlap Computation (Previously)

Previously

References were Boxes

Only utilized 2 corner points

Incorrect Overlap Computation



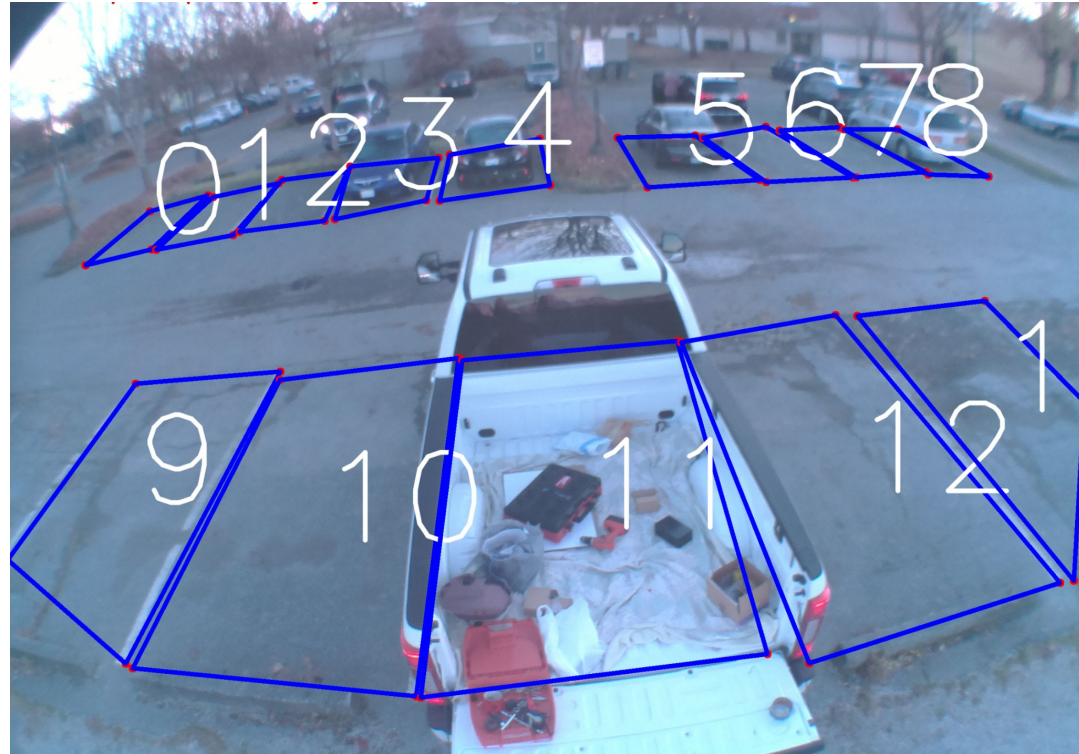
CV Updated Overlap Computation (Current)

Currently

References as Polygons

CV Detection uses Boxes

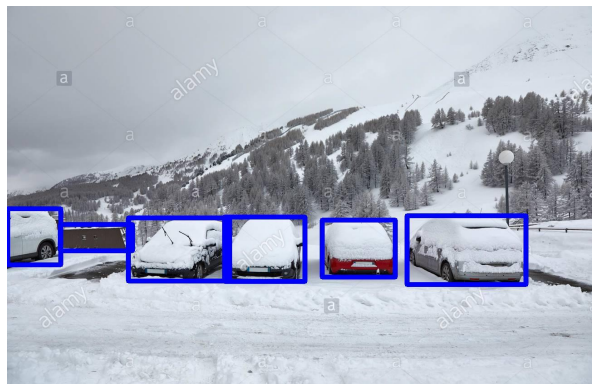
Fixed Overlap Computation



CV Environment Conditions

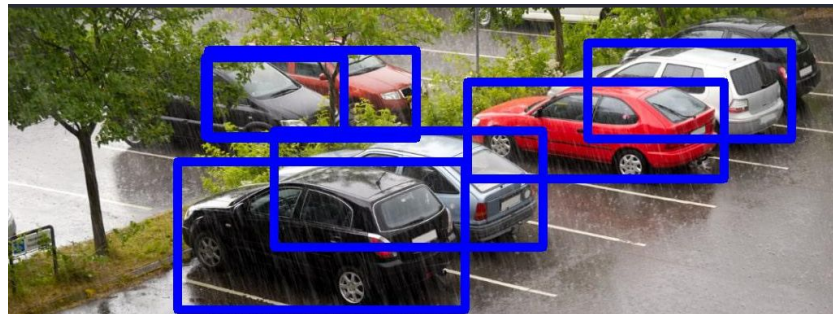
Snowy

- CV worked on snow covered cars in 4 out of 5 stock photos

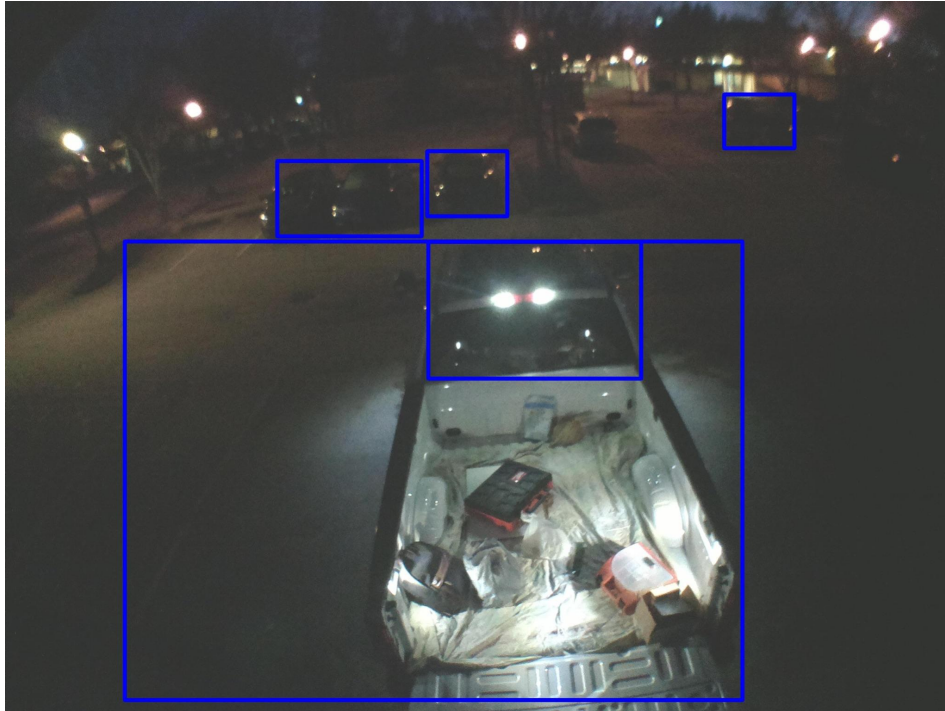


Rainy

- CV worked in rain condition photos in 5 out of 5 stock photos
- Functioned during our testing



CV Environment Limitations



Limitation due to lighting



Accuracy of detection dropped



Can upgrade hardware

Current State of Audio Recognition



Utilizing an Audio Fingerprinting Technique



Current Database of 40 Car Alarms Registered



Room for Improvement

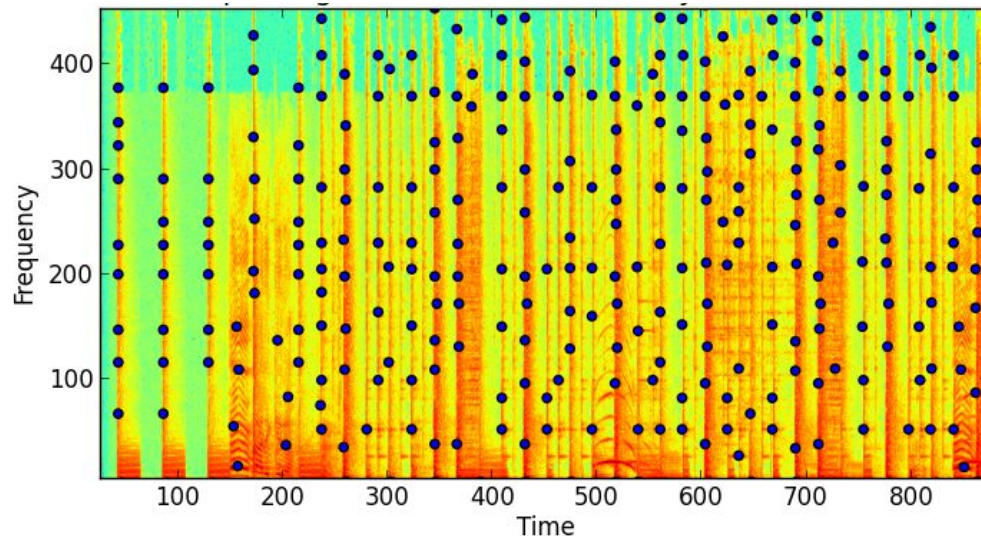
Audio Recognition Fingerprinting

Fingerprinting Algorithm

Build spectrogram using FFT

Find peaks using HP filter

Hash generated using peaks
and time delta



Current State of Website



Map presented with real-time availability



Able to switch between different parking lots

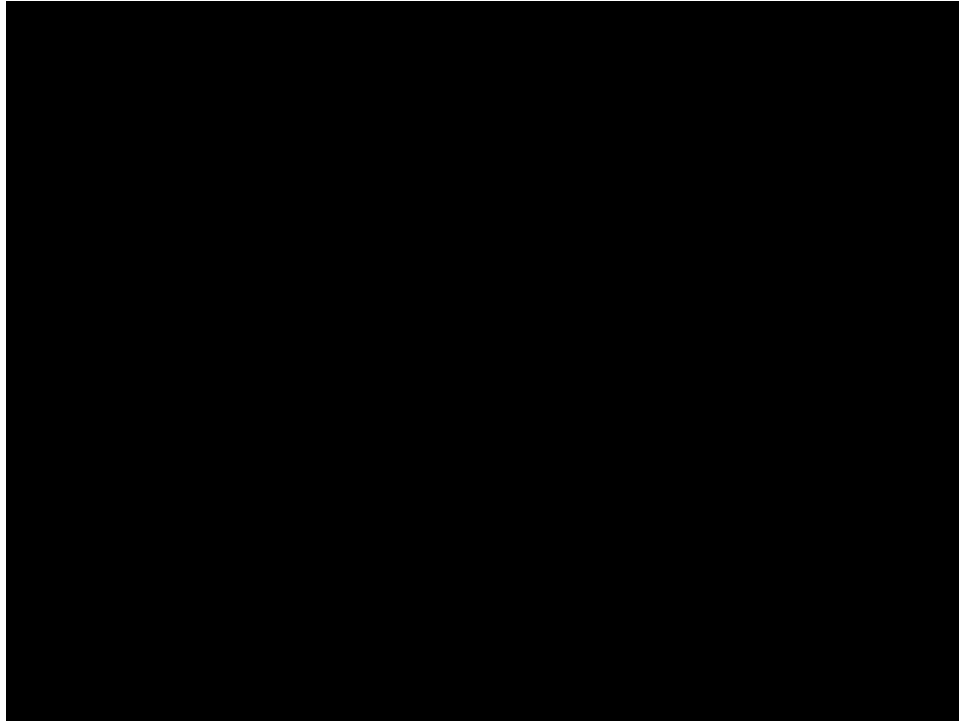


Subscribe or unsubscribe to text notifications service



Mobile responsive view

Mobile Responsive View



Current State of Text Notifications



Notifications every 15 minutes



Subscribe/Unsubscribe on Website



Notifications sent for 50%, 75%, and 100% full

To: +1 (845) 757-6276

Text Message
Today 3:33 PM

Sent from your Twilio trial account -
The Parking Lot: Kensington, is 100%
full, please try another parking lot.

Sent from your Twilio trial account -
The Parking Lot: SFU is 75% full.

Sent from your Twilio trial account -
The Parking Lot: test is 50% full.

Utility Scripts Developed (Planning)

Google My Maps

OpenSpot Script

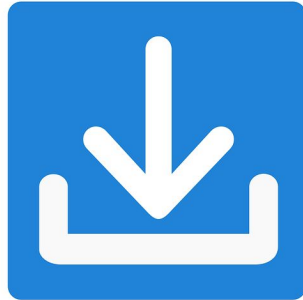
Database



Utility Scripts Developed (Previewing)

Receive Photo From Module

OpenSpot Software



Installation Software

● Performed by technician

● Setup Backend References

● Draw Bounding Boxes



Parking Lot:

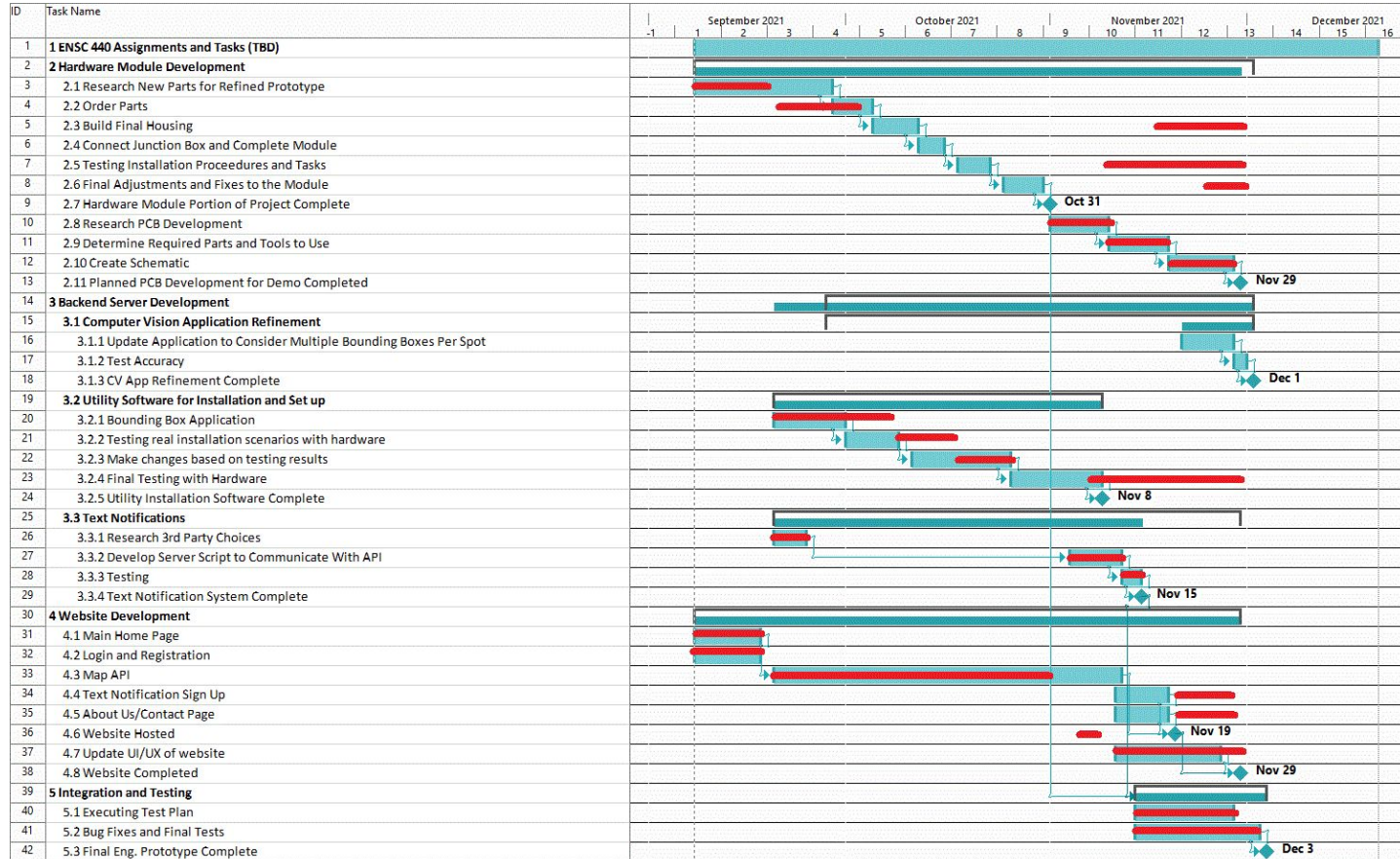
Module #:

Picture File:

Click Browse to select the reference image

Bounding Boxes:

Development Schedule (Actual vs Planned)



- actual
- planned



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Business Case

Market Size

Smart Parking Market Categories

1. Hardware

2. Software

3. Services

2021 Market Size

\$6.6B

Projection

**16.74B
in 2021**

Competition

Cleverciti

<https://www.cleverciti.com/>



Price and Business Model



Cash Flow



Strategy

OpenSpot Module

OpenSpot units will be sold for \$1,400

Planning, Setup and Installation

Mapping ideal spots, installation of OpenSpot Module. Between \$847 to \$877 for a 2 hour duration.

Website Service

Monthly fee of \$70

Maintenance

Between \$150 to \$225 for a 2 hour duration


Budget

Monthly Fixed Cost (FC)	Amount	Variable Cost (VC)	Amount
Salary	\$22,985.00	Shipping	\$68.67
Rent	\$1,500.00	Duties	\$34.60
Utilities	\$1,000.00	PCB 2 Layer	\$24.00
Equipment	\$1,500.00	Computer Module	\$35.20
Marketing	\$500.00	SIRSE DMX LED	\$54.12
Additional Development	\$500.00	SIRSE T Cable	\$9.02
Total:	\$27,985.00	Open DMX USB Interface	\$56.00
		USB Microphone	\$42.00
		Fish-Eye Camera	\$16.79
		SIRSE Power Cable	\$4.01
		Newark Aluminum Housing	\$31.28
		Mounting Bracket x 2	\$44.77
		J Mount	\$25.19
		BiX Power Supplies	\$78.56
		NiMH Battery Pack	\$134.40
		NiMH Battery Charger	\$15.87
		Junction Box	\$16.00
		Pole Clamps	\$11.15
		Total:	\$699.40

$$\text{Units} = \frac{\text{Fixed Cost (FC)}}{\text{Price per unit} - \text{Variable Cost (VC)}}$$

$$\text{Units} = \frac{27,985.00}{(1400.00 - 699.40)}$$

Break Even Units = 40




Monthly Budget:
\$33,580.20

$$\text{Units} = \frac{\text{Fixed Cost (FC)}}{\text{Price per unit} - \text{Variable Cost (VC)}}$$

$$\text{Units} = \frac{27,985.00}{(1400.00 - 699.40)}$$

Break Even Units = 40



Total Operating Cost for 1 Year:
\$400,494.40

Financing



Current Costs Distributed Evenly For Prototype



Received Funding from ESSEF



Angel Investors When Entering Market

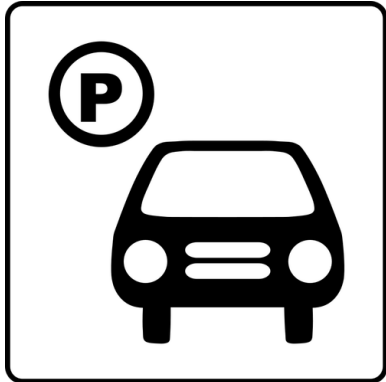


VANTEC Angel Network

Ideal Customer

Clients

- Parking lot owners
- Parking lot companies
- Malls, schools, etc.



Users

- Drivers at the parking lot
- Visitors planning their visit





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Risk Analysis and Management

Risk and Safety: Mounting and Electrical Installation



Risks

Mounting failing and
module falling

Technician injured during
installation



Mitigation

- High quality IP-rated materials
- Use two clamps for redundancy
- Electrical installation performed by electrician
- Provide proper tools to reach high heights



Alternatives

Mount the module and
junction box directly to the
pole

None. Ensure professionals
are trained and familiar with
the tools

Risk and Safety: Battery



Risks

Degraded battery performance



Mitigation

Insulate battery pack and protect from the elements within the junction box



Alternatives

- Use a constant life wire connection
- Lithium-ion battery

Business Risks: Customers



Risks

Clients not possessing adequate budget

Older drivers unwilling to adopt system



Mitigation

- Reach out and provide estimates for potential clients
- Website designed with simplicity and ease of use in mind



Alternatives

Provide limited number of modules to these clients.

None. Do not want to limit users to a specific demographic.

Commercialization Plan B

1

Government business for light pole replacements

2

License Plate Recognition (LPR)

3

Pay parking service





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Standards

Hardware Standards



IEEE C57.12.31-2020: Enclose Integrity for Coastal Environments

Junction box & module mounted 12ft high

Mounting brackets and clamps made of stainless steel

IEC 60529:1989: Degrees of Protection Provided by Enclosures



IP68

Junction box rated NEMA 6P

Camera module housing made of aluminum

Graphical User Interface Standards

ISO 9241-220:2019: Ergonomics of Human-System Interaction

Map is the main focus point

Information is presented immediately

Simple to switch between parking lots





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Final Demonstration

Technician User Manual Demo - Planning Phase



1 Prerequisite Knowledge

This user manual is for OpenSpot technicians who meet the required qualifications to install OpenSpot modules. The qualifications include being a certified electrician, certified to operate a boom lift, and ability to run scripts using terminal.

2 Planning

The following steps will describe how to use Google's My Maps tool to plan a new parking lot from start to finish.

2.1 Starting a New Map

1. Go to <https://www.google.com/maps/>
2. Using the button in the top left-hand corner, click the red button "+ CREATE A NEW MAP" to start a new plan
3. With the new map open, click on the title "Untitled Map" to rename it to the parking lot you are working on. Click save to return to the map.

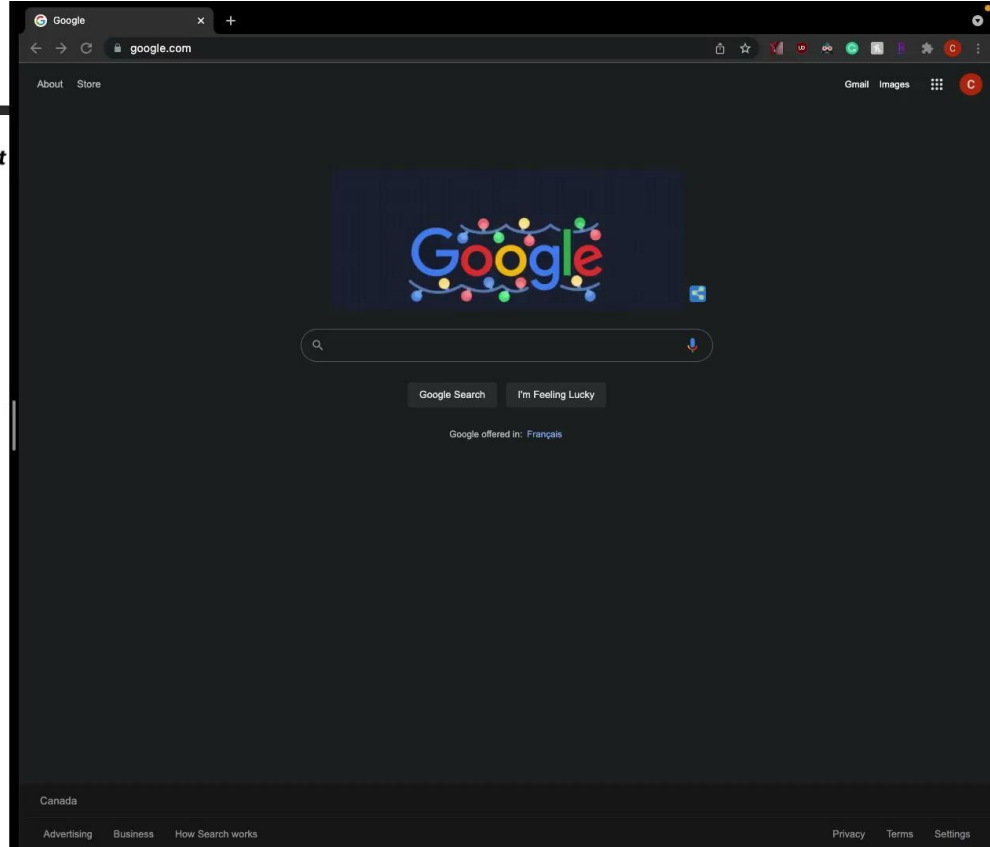


Edit map title and description

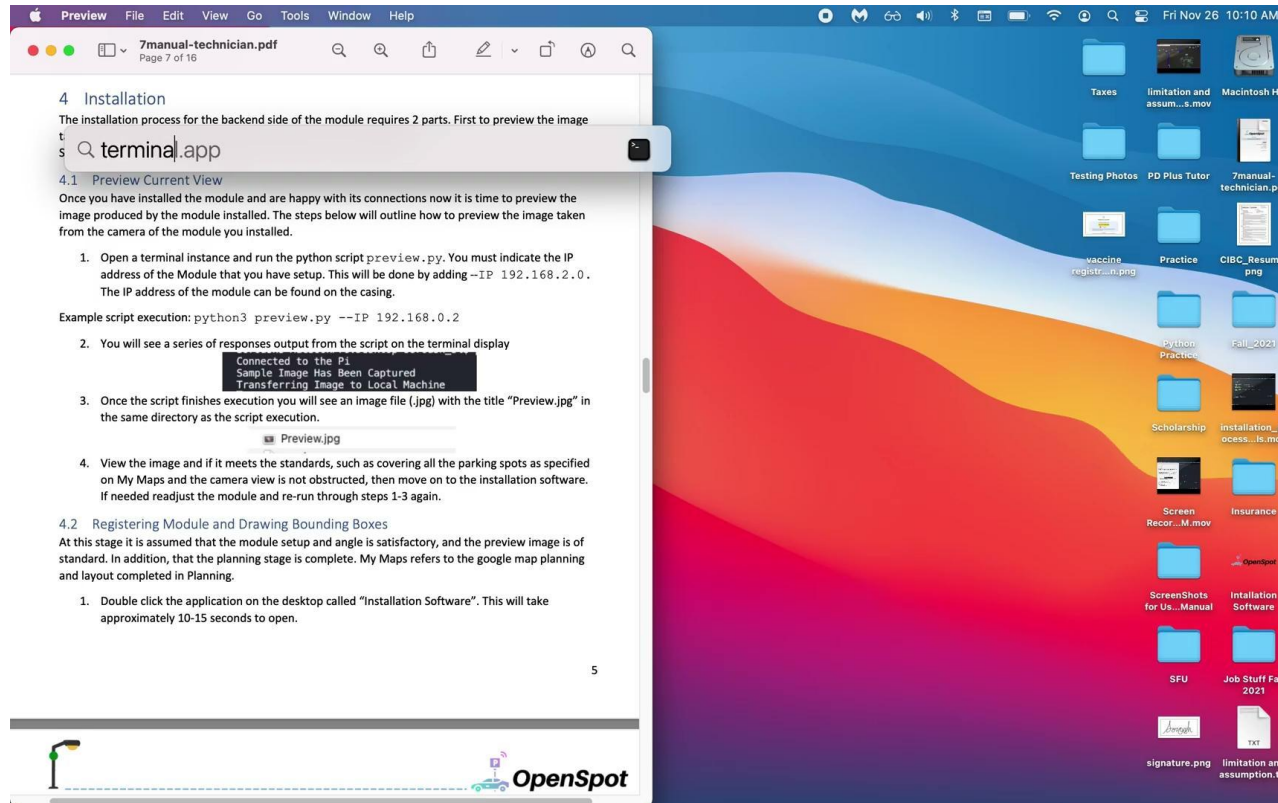
Map title

Description

4. Using the search bar at the top, enter the parking lot or place you are planning.
5. Change the Base Map to Satellite by clicking the Base Map tab and choosing Satellite



Technician User Manual Demo - Previewing Module



The screenshot shows a Mac desktop with a PDF viewer window titled "7manual-technician.pdf" and a terminal window. The PDF viewer displays the "Installation" section of a manual, specifically the "Preview Current View" subsection. The terminal window shows the execution of a Python script named "preview.py" with the command `python3 preview.py --IP 192.168.0.2`. The terminal output indicates a successful connection to the Pi, image capture, and transfer to the local machine. A small thumbnail of a "Preview.jpg" file is visible in the terminal output. The desktop background is a colorful abstract pattern, and various files and folders are visible on the right side of the screen.

4 Installation

The installation process for the backend side of the module requires 2 parts. First to preview the image

terminal.app

4.1 Preview Current View

Once you have installed the module and are happy with its connections now it is time to preview the image produced by the module installed. The steps below will outline how to preview the image taken from the camera of the module you installed.

1. Open a terminal instance and run the python script `preview.py`. You must indicate the IP address of the Module that you have setup. This will be done by adding `--IP 192.168.2.0`. The IP address of the module can be found on the casing.

Example script execution: `python3 preview.py --IP 192.168.0.2`

2. You will see a series of responses output from the script on the terminal display

```
Connected to the Pi
Sample Image Has Been Captured
Transferring Image to Local Machine
```

3. Once the script finishes execution you will see an image file (.jpg) with the title "Preview.jpg" in the same directory as the script execution.

Preview.jpg



4. View the image and if it meets the standards, such as covering all the parking spots as specified on My Maps and the camera view is not obstructed, then move on to the installation software. If needed readjust the module and re-run through steps 1-3 again.

4.2 Registering Module and Drawing Bounding Boxes

At this stage it is assumed that the module setup and angle is satisfactory, and the preview image is of standard. In addition, that the planning stage is complete. My Maps refers to the google map planning and layout completed in Planning.

1. Double click the application on the desktop called "Installation Software". This will take approximately 10-15 seconds to open.

5


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Technician User Manual Demo - Installation Software

Preview File Edit View Go Tools Window Help


7manual-technician.pdf Page 12 of 16

spots specified, in range from 0-14. The ordering in which I draw my bounding boxes must follow the planning stages parking stall ID.



9. Once you have identified the order in which you must draw the bounding boxes you can get started. In order to draw a bounding box for a parking stall, you must select the corners of the box in the specified order, **top left**, **top right**, **bottom right**, and finally **bottom left**. This sequence of drawing the bounding box will be shown in the images below.


- a. Please refer to section Bounding Box Drawing Tips and Advice for additional guidance.



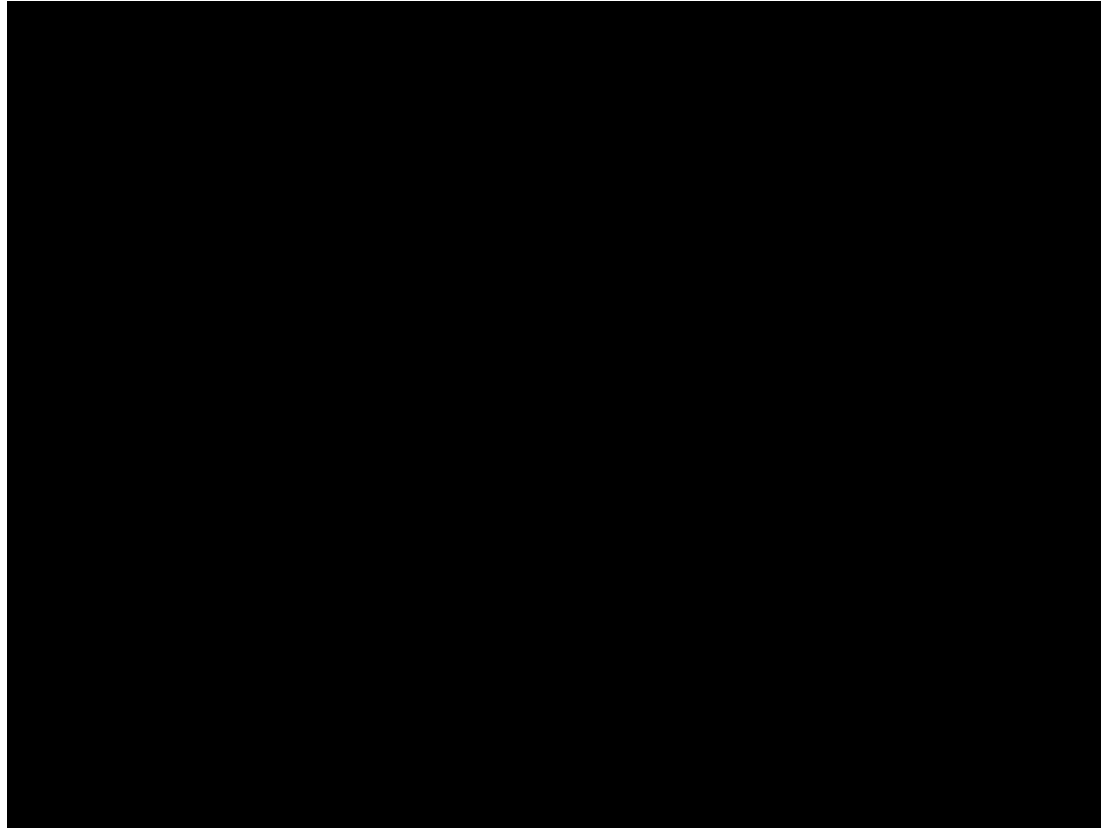
Preview File Edit View Go Tools Window Help

2024-11-26 15:49 PM

you've drawn the boxes



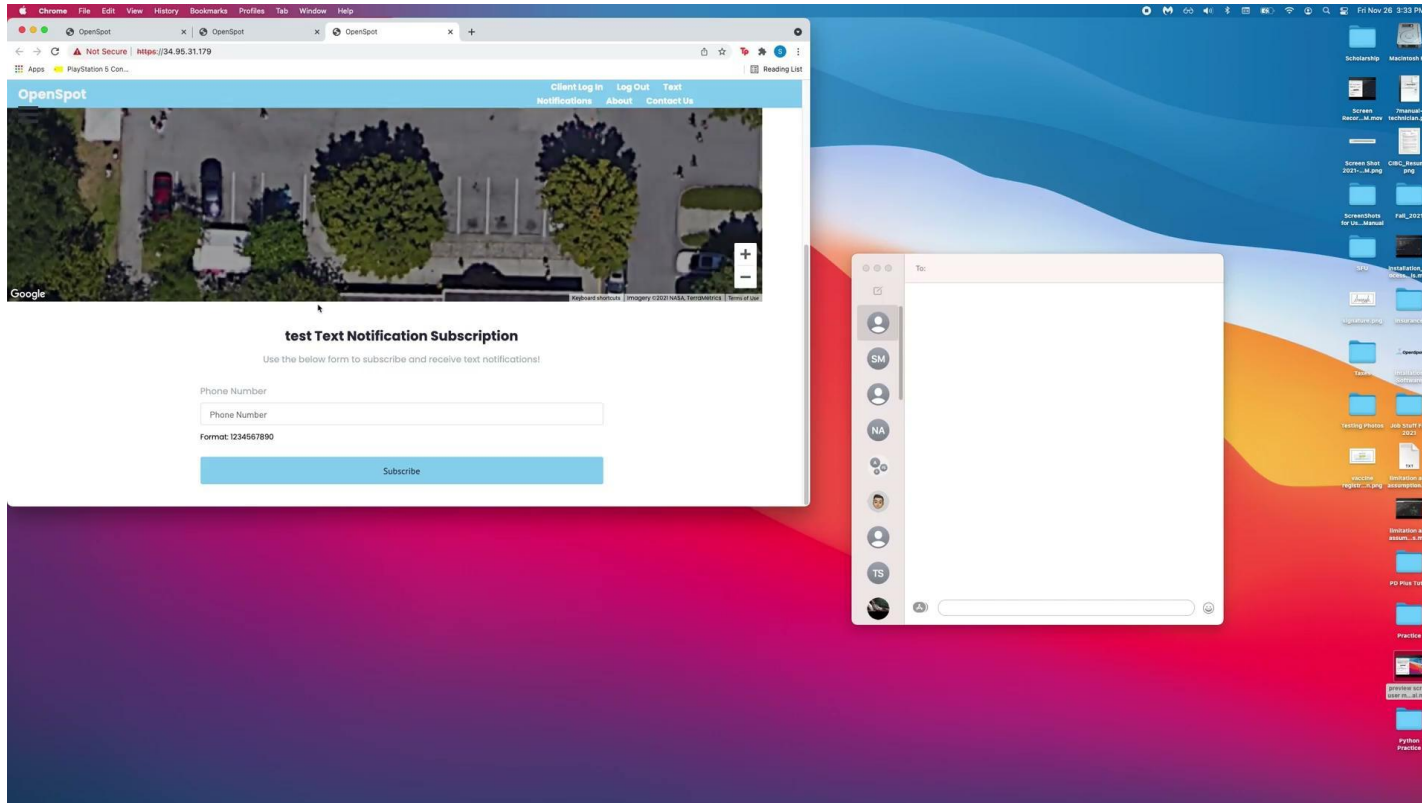
Technician User Manual Demo - Module Connections



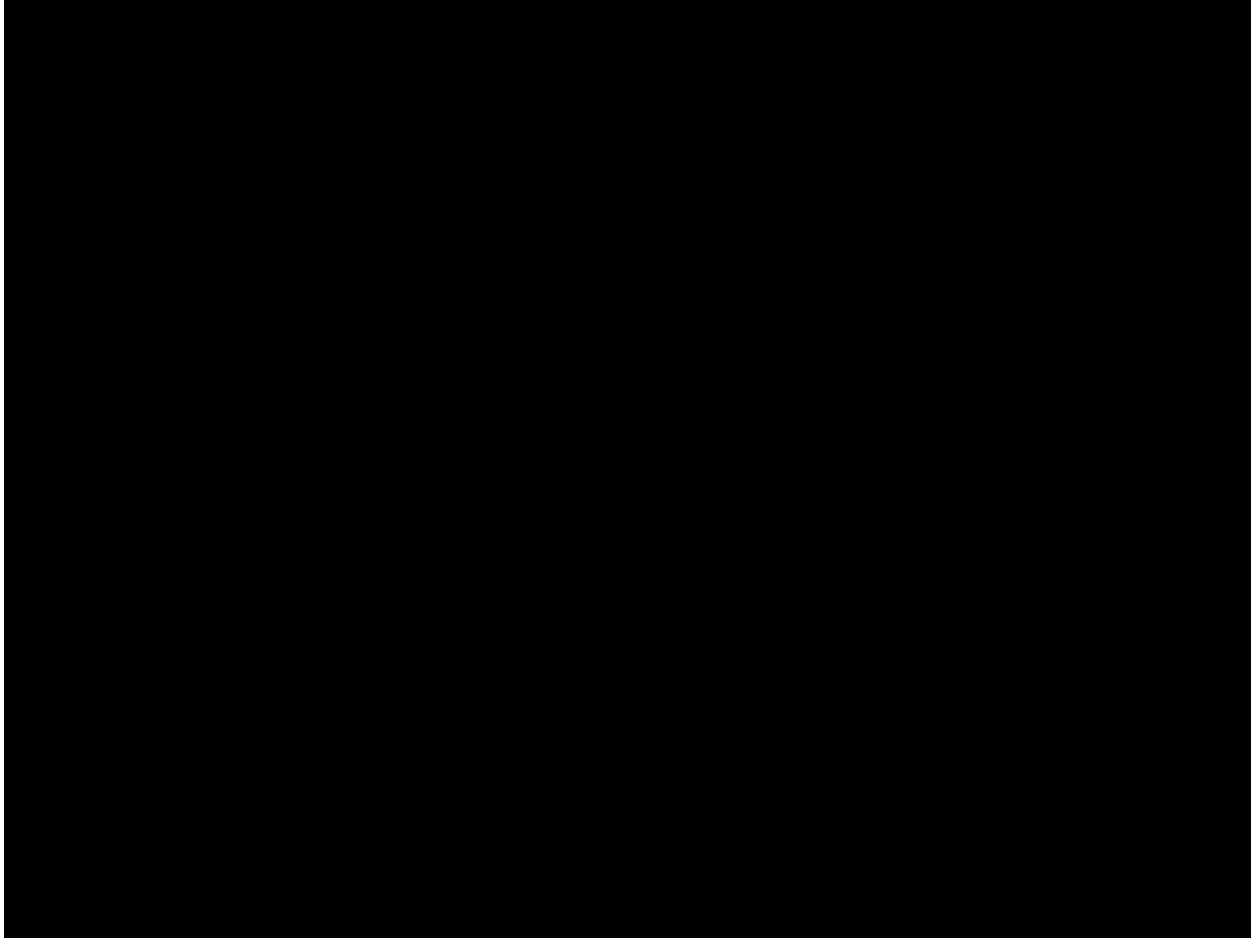
Technician User Manual Demo - Module Adjustment



Text Notification Demo

The image is a composite screenshot. On the left, a Chrome browser window displays the OpenSpot website. The page has a blue header with navigation links: 'Client Log In', 'Log Out', 'Text Notifications', 'About', and 'Contact Us'. Below the header is a Google Street View image of a parking lot. Underneath the image is a form titled 'test Text Notification Subscription' with the instruction 'Use the below form to subscribe and receive text notification!'. The form includes a 'Phone Number' label, an input field containing 'Phone Number', a 'Format: 1234567890' label, and a blue 'Subscribe' button. On the right, a Windows desktop is visible with a blue and red background. A messaging application window is open in the foreground, showing a 'To:' field and a list of contacts with initials: SM, NA, TS, and others. The desktop background is filled with various icons for folders and files, including 'Scholarship', 'Macintosh HD', 'Screen Shot 2021-11-26.png', 'Fall_2021', 'Testing Photos', and 'FD Pink Timer'.

Full System Demo





OpenSpot

Summary, Reflection and Closing Remarks

Feedback Incorporated

1

LTE Module instead of WAP

2

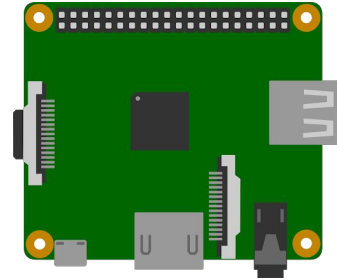
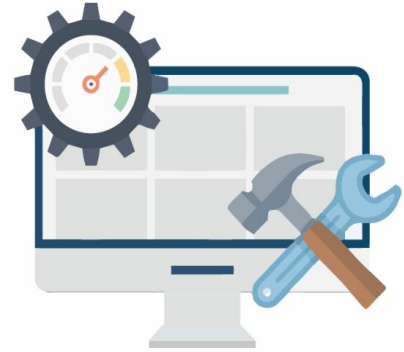
Installation and set up process

3

Drawing CV reference boxes

4

PCB development



Summary of Project

Main Features

- Website and text notifications
- Computer vision and audio detection
- Hardware module and pole
- Installation and setup process/software

Integrated System

- Fully integrated and functioning system

Optimization and Improvements

- Website
- Computer vision
- Audio detection
- Hardware



Team Learnings and Reflection

What would we do differently?

1. Worry less about cost of parts
2. Have more in-person meetings

What did we learn?

1. Internal deadlines before hard deadlines
2. Meeting minutes are extremely valuable
3. Increase amount of time for system-integration testing

Individual Learnings

Curtis

Project management and estimating timelines, Python (CV and Audio Recognition), GUI design, and overall general application development

Soroush

Python (CV and Audio Recognition), frameworks (Django, NodeJS), and database management (MongoDB)

Justin

Python (Raspberry Pi), hardware design (PCB, module design, mounting methods), and electronics (Wiring)

Gurmesh

Hardware design (PCB, module, mounting system), Python (Raspberry Pi), and electronics (battery system and wiring)

Darius

Web development process (React and NodeJS), Python (Raspberry Pi), and server management

Future Plans for OpenSpot

OpenSpot's Future

4/5 members have no interest

Soroush to pursue with someone in his network

New requirements for potential investor



Acknowledgements

Eric Lui for information on light pole construction and electrician advice

Sikander Kang for hardware supplies and building advice

David Agosti for insight into SFU's parking lot situations and general advice

Roman Rodomansky for a wonderful reference and slides for audio recognition

Teaching staff for ENSC 405W and 440



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Question Period

Company 7