The Modern Pulse of Innovation

Tech Clinic Report 19-20

Lafayette College Technology Clinic 2020: Year-End Project Progress Report

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Preface

At the beginning of the year, our goal was to consider the implementation of RFID in camera systems for ski resorts (Ski Net).

This report serves to explain how we attacked those goals and shifted our goals due to the ongoing COVID-19 pandemic.

We will present our progress, and developed plans for Ski Net, as well as a new project started in response to the pandemic (the Pulse Purifier).

Through our work we will pass on useful and scalable ideas that Pulse can implement following Tech Clinic's contribution.

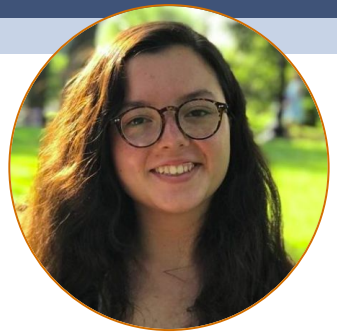
Through this project, our group has gained valuable exposure to developing ideas in a business climate and consulting for a client.

We want to thank you for providing us this opportunity.

Meet the Team

George Crittenden ‘21

Junior Economics and Finance major. Mathematics minor. Fellow at the Dyer Center for Innovation and Entrepreneurship. Member of the finance and flowchart subgroups, as well as working on special projects assignments.



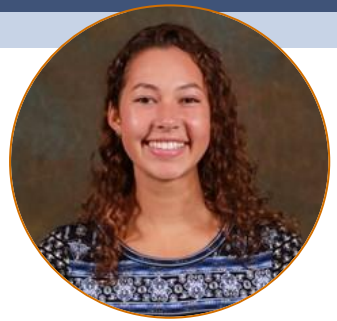
Rabia Demirelli ‘21

Junior Engineering Studies and Economics double major. Specialization in macroeconomy and business. German minor. Born and raised in Istanbul. Passionate about traveling and discovering new cultures. Member of flowchart subgroup.

Nicholas McBride ‘22

Sophomore Civil and Environmental Engineering major. Specialization in Geotechnical Engineering. Minor in Geology. Enjoys writing and inspecting video game design in free time. Member of the tech and camera subgroups.

Meet the Team continued



Sophia Sharpless ‘21

Junior Mechanical Engineering major. Special interest in biomechanical engineering and footwear design. Minor in Spanish. Enjoys baking and doing sudoku puzzles in free time. Member of the Track and Field team. Member of the flowchart subgroup.

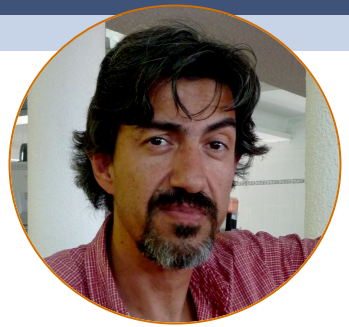
Sidharth Vijay ‘21

Junior Chemical Engineering and Mathematics & Economics dual degree. Special interest in strategy and management consulting. Born in India and raised across eight different countries. Acting as Team Liaison.

Meet the Advisors

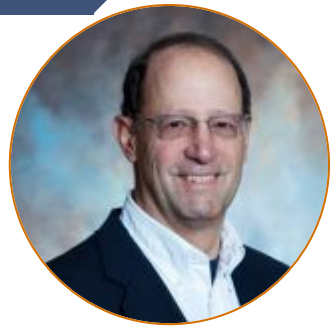
Dan Bauer

Since founding the Tech Clinic in 1986, Dan has worked with teams of Lafayette students solving real-world problems. His background is in mechanical engineering, photojournalism and anthropology. Has studied in three continents.



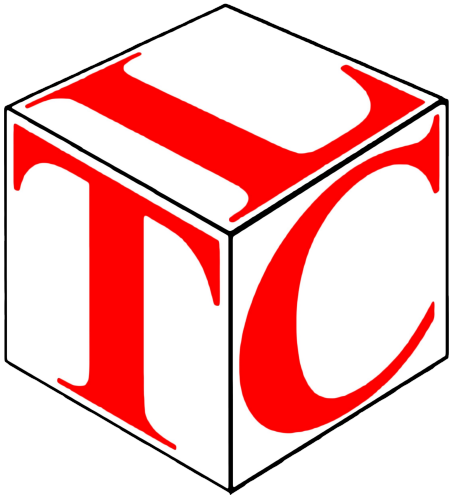
Luis Schettino

Associate professor of Psychology and Neuroscience. His main focus of research is motor control in humans. His interests include computational approaches for human-machine interaction.



Larry Malinconico

Director of Technology Clinic and Associate Professor of Geology/Geophysics at Lafayette College.



"Technology Clinic is a two-semester program in which teams of students from each academic division work together on imaginative solutions to real-world problems for clients."

- Students are nominated by professors and former Tech Clinic students
- Project teams are purposely multidisciplinary
- No requirements for prior experience to encourage "out-of-the-box" thinking

Pulse Innovations

- Pulse Innovations works with RFID technology to create integrated solutions for asset tracking
- Pulse works closely with RFRain
  - RFRain is a company that invented a smart reader system and associated software
  - Pulse achieves item level reporting utilizing RFRain's technology
- Pulse presents ready-to-go systems that utilize RFID to streamline user experiences for businesses
- At a broader level, Pulse provides user friendly solutions for the everyday consumer through various technology integrations

Ski Net

Visual development in the realm of Snowsports. Continuation from the work done during the first semester, focusing on camera system development, tag system integration, and testing.

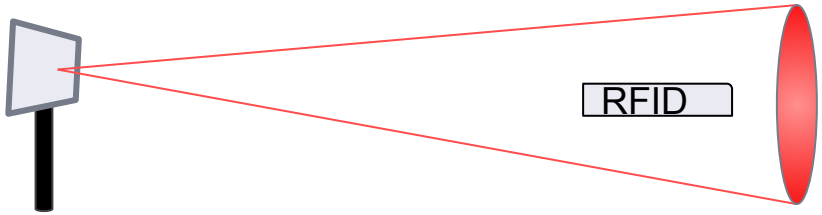
What is Ski Net?

SkiNet refers to software and hardware coupled to bring the best possible “action shots” of users in snow sports, specifically on ski and snowboard slopes. It combines RFID and camera technology to capture the best images of the customers. The idea is for customers to purchase these action shots as souvenirs.

Semester 1 Overview

- The technology consisted of the antennas supplied by RFRain, the RFRain RFID reader, RFRain RFID tags, a raspberry pi, and the raspberry pi camera v2.
- The antenna's limitations were found during testing, which can be seen in the figure to the right.
- Overall, the semester was about learning how the tech worked and what the limitations were. From this information, we could move forward in the coming semester.

Event/ Direction	0 degrees (straight on)	45 degrees
Tag was lost	60 ft (18.3 m)	51.5 ft (15.7 m)
Tag was found	15 ft (4.5 m)	8 ft (2.45 m)



Semester 2 Overview

- The second half of this project consisted of testing of new technology. Following the determination of the shortcomings of the technology testing of Semester 1, other technology such as a new antenna, new RFID tags, and new cameras were tested.
- Different triggering methods for the camera were also investigated.
- Various softwares for camera controls were tested.
  - These included UIs created using Python for the raspberry pi and software available online for USB cameras, such as *IC Capture 2.4*.

Technology

- **Yagi Antenna** — The yagi antenna is an antenna meant for range that is largely directional. This means increased range, but the detection cone is much smaller than other antennas.
- **RFRain Reader** — The reader is able to read the RFID tags when attached to an antenna and logs the data.
- **Dog Bone Tags** — A Dog Bone Tag is a type of RFID tag found to have more range than other tag designs.
- **USB Camera** — A USB camera connects to the USB port of a computer, which can be controlled from online softwares.
- **Raspberry Pi and Camera** — A raspberry pi and camera module can be combined and coded to provide custom-made camera control and UI.

Yagi Antenna

Raspberry Pi

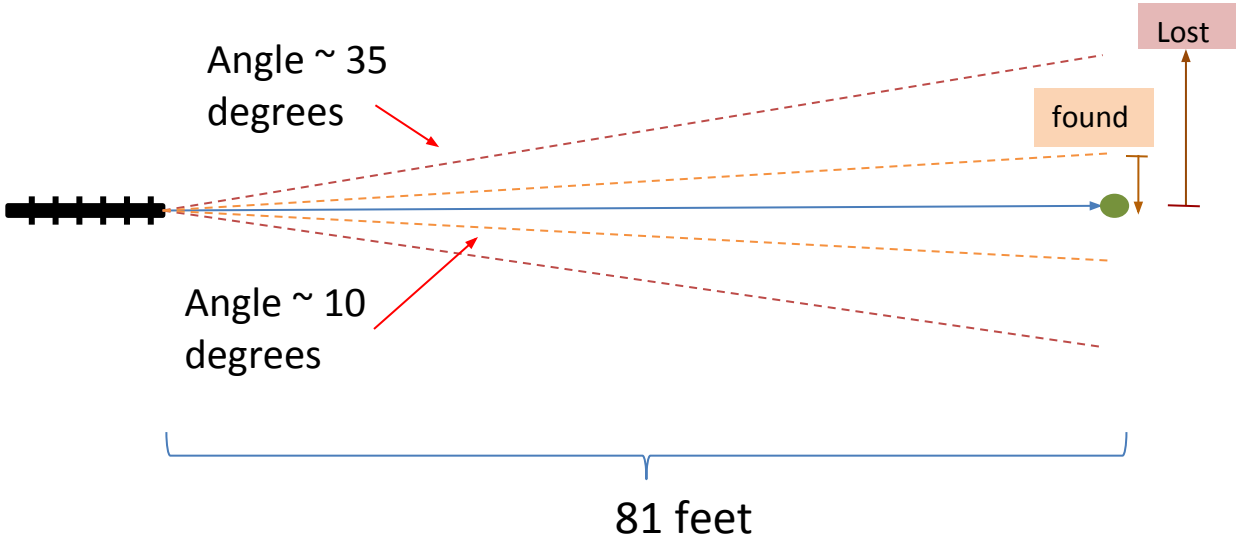
- To control the reader and cameras, a raspberry pi was used. A raspberry pi is a motherboard fit with HDMI ports, USB ports, ethernet ports, pin connections, camera connections, and an SD Card. The pi acts as a small computer and runs off its own operating system (OS), Raspbian.
- The reader was controlled through a Raspberry Pi v3 by connecting to the reader's specific IP address
- A camera was controlled using Python and a Raspberry Pi v4, a programming language with an Integrated Development Environment (IDE) pre-downloaded onto the pi.
- A specific IP was used to control the pi camera software. For other purposes, a computer monitor was used.

S2 Testing: Yagi Antenna

- Firstly, the Yagi antenna was tested to find its range and cone. The antenna was set up on the Lafayette College quad and the Dog Bone Tag was used. An individual walked across the quad with the tag, and it was noted when they left and entered the cone's range. Doing this, it was found that the tags were lost at ninety feet, found again at eighty feet, and the cone in which they were consistently read was ten degrees. The cone at which the tags were lost was approximately 35 degrees.
- Testing was also conducted when attaching a Dog Bone Tag to a ball with a strip of tape. The ball was thrown towards the antenna while loosely taped to simulate flapping of the tag in the wind. The ranges of reading were similar. It was found out that there is a vertical range of approximately nine feet. The tag was read between 65 and 70 feet from the antenna when thrown from 80 feet away.
- Through testing, issues with tag detection were also noted. At speeds faster than jogging perpendicular to the antenna, tags were not easily detected. Additionally, tags could not be read when shielded by the human body.

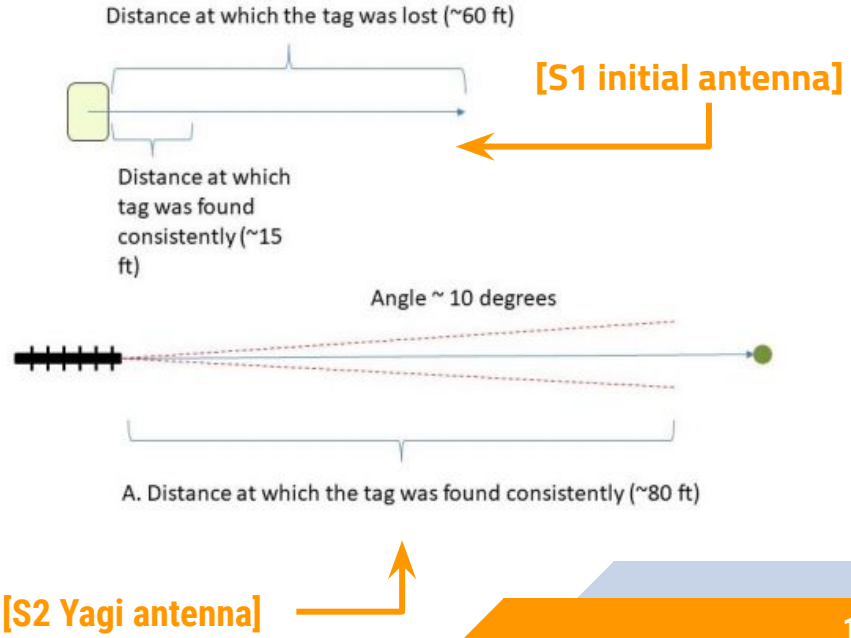
S2 Testing:
“Lost and Found” Cones with Dog Bone Tags

- The red lines represents the angle at which the tag was lost, found to be 35 degrees (17.5 degrees on each side).
- The orange lines represents the cone in which the tag was found, found to be ten degrees (five degrees on each side).
- The distance from the antenna at which the tag consistently read was 81 feet.



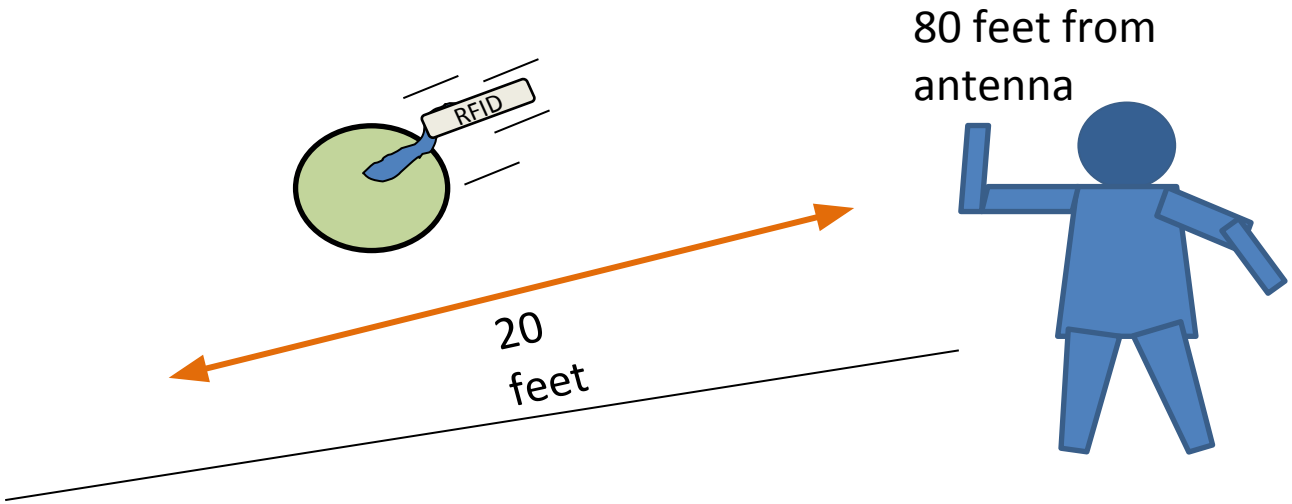
S2 Testing: Antenna Comparison

- The detection distance of the Yagi antenna is longer.
- The Yagi antenna had a smaller cone of around 10 degrees, compared to RFRain antenna, which had approximately 45 degrees.
- We concluded that the directional low-angle of the Yagi antenna is more useful in a ski slope environment, as it would be helpful in detecting a single user



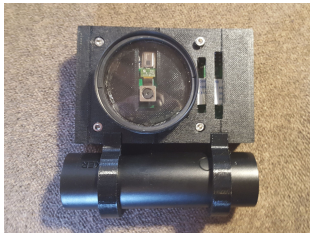
S2 Testing: Hanging Tag

Below is a visual representation of the hanging tag testing. The RFID was loosely attached to a tag to simulate the blowing of the wind. It was thrown from 80 feet away from the antenna, and was read in mid-air at approximately 65-70 feet from the antenna.



Tested Cameras

- Nikon D500 SLR
- Dome WebCam 3 meg
- IMAGESOURCE DMK
- ELP HD DIGITAL USB Webcam
- Raspberry Pi Modules
  - Raspicam v.2.1 - 8 meg
  - Arducam telephoto 2 meg
  - Arducam autofocus 8 meg



Camera Criteria

- The most important criteria for the cameras are as follows:
  - **Image Quality** — The pictures must be crisp enough and clear enough for consumers to want to buy them. In other words, the best picture possible.
  - **Ease of Operation** — The system must be easy enough to use so a non-professional can utilize it. This includes a friendly user-interface.
  - **Ease of Installation and Maintenance** — The system must be installed and implemented fairly easily and be able to be maintained without inconveniencing the ski resort.
  - **Cost** — Given that multiple cameras will be required, the cost should not be too high. However, there is a trade-off between cost and quality.
- The most important criteria for the camera software are as follows:
  - **Power** — The cameras should be able to be controlled remotely such that physical installation and maintenance are easier.
  - **Access** — The files should be able to be transferred between devices and software platforms, such as from the set-up to an editing platform.
  - **Installation** — Relates to the ease of use and installation of the software.

Camera Modes and Settings

- A camera mode is essentially a set of optimized settings for a camera to take pictures under different conditions, such as lighting conditions and the presence of increased motion.
  - For example, a “sports mode” has settings optimized (such as a higher shutter speed) so that one can capture motion easily. This is good for “action shots.” Modes for the raspicam also include “snow” and “beach”, which optimize for their respective environments.
  - For SkiNet’s purposes, sports mode would be useful. This would better obtain the action shots of skiers, which are more desirable and thus more profitable.
  - Cameras with modes are useful, as it adds a good amount of control on what picture one can take. More importantly, it is user friendly for individuals who are not professional photographers.
- For action shots, the settings of shutter speed and depth of field are important
  - A high shutter speed will give a better action shot. This is most important for cameras perpendicular to the area of travel.
  - A high depth of field becomes more important for action shots at angles other than 90 degrees.

Testing Conditions

- Most testing was done with outdoor, daylight action. Some was done in classroom lighting.
  - Only the Nikon was successful at night action (which occurred during a tubing trip to be mentioned later).
- Indoor Slot-car action was shot with the Nikon, but probably would have been successful with all Raspi modules at straight on or at ¾ views.
- High speed action shots under classroom lighting were unsuccessful with all but the Nikon.
- Shots where the distance from object to camera was unpredictable were only successful with Nikon and Raspicam modules.
  - ELP and ImageSource DMK are manual focus.
  - Raspicam is fixed focus with impressively long depth of field.
  - Nikon has fast auto-focus

On-Campus Camera Testing

- The USB camera was set-up using the *IC Capture 2.4* software. Settings were established for the camera that would work well under the test conditions (clear weather).
- The pi camera was set-up using a program coded to set the camera in “sport mode”. The program allowed the user to take burst photos or videos with a button-press input.
- On-campus testing was conducted to compare the two camera models.
  - Both cameras were set up along McCartney Street near the Watson Courts.
  - As cars approached on the roadway, both cameras were activated for burst photography and video.
  - This was done about fifteen times to have a collection of photos to compare.
  - Upon comparing the photos and videos, the pi camera photos were superior in quality to the USB camera.

Off-Campus Camera Testing

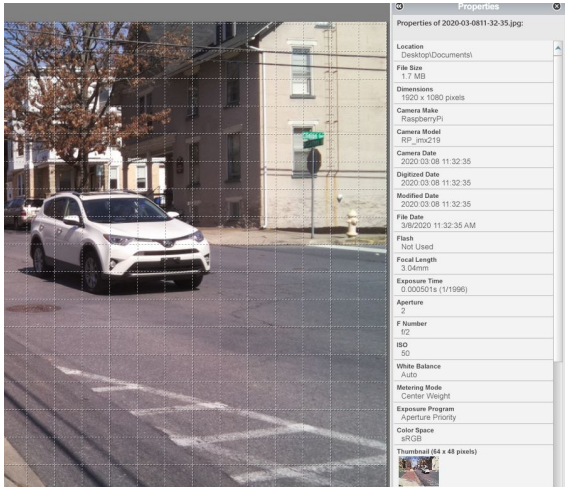
- Off-campus testing was conducted using the raspberry pi camera and its associated software. The testing was completed primarily at the residence of Dan Bauer, where the camera was set up on the porch of the building. It faced the road and took pictures when motion was detected.
- This testing was done primarily to compare the raspberry pi images with those of the USB camera. Testing of the USB camera was being conducted by Gabriel Jimenez of Pulse Innovations.
- It was found again that the pi camera was friendlier to the user, easier to control, and took crisper images than the USB camera.

Bear Creek Trip

Earlier this semester, our team visited Bear Creek Mountain Resort to analyze their customer management and possible SkiNet implementation. The focus was the snowtubing area. Following is what was learned:

- Obtained an overview of the physical layout of the ski resort, including the ski lift and the positioning of the snowblowers which affects the placement of SkiNet
- Analyzed best possible locations to take pictures in the snow tubing area
- Identified RFID implementation possibilities at the equipment renting area
- Examined variables at snow tubing that would affect the quality of pictures taken: number and depth of lanes, inefficient handling of the tubers, different paces at each lane
- Conducted testing related to the Nikon during this trip and pictures were taken of team members snow tubing.
  - During nighttime, Nikon pictures were the best of all other night pictures.
  - During the day, snow was reflecting light during the day. Sparse lighting was present in the form of floodlights on the tubing tracks.

Picture Comparison



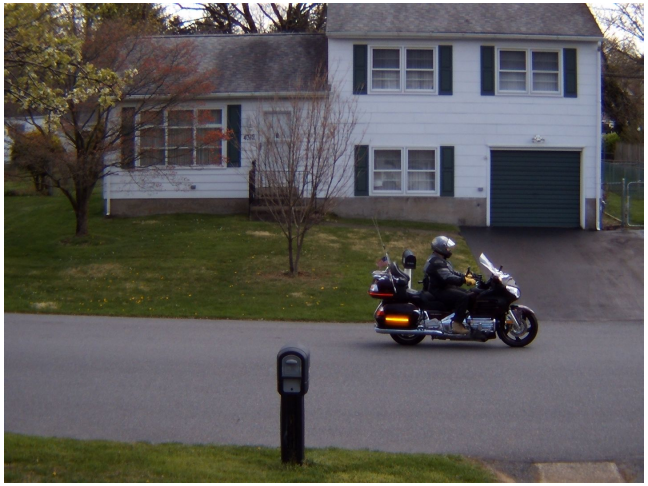
Shown above is an image taken with the USB Camera. Clear, sunny conditions. Taken on McCartney Street.

Shown above is an image of the ski slope taken with the Nikon Camera. Partly cloudy conditions with artificial snow on the ground. Taken from the tubing lanes of Bear Creek Ski Resort.

Shown above is an image taken with the Raspicam. Clear, sunny conditions. Taken Taken on McCartney Street.

USB Camera Picture Comparison

An interesting detail to note regarding the USB camera: Settings are not changing automatically with regards to light levels. For example, the sidings of the house are almost impossible to see in the left image when it is bright, but it is easily visible on the right when it is darker.

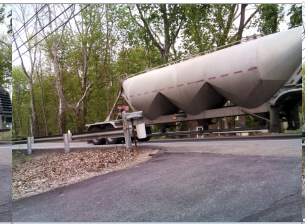


Both of the above pictures were taken and provided by Gabriel Jimenez of Pulse Innovations.

Motion Sequence with Raspicam

Below is an example of a set of pictures taken using the motion detection feature of the Raspicam v2:

- Travel Speed: 45-50 mph
- Camera Settings: Mode = Sport; Trigger = Elapsed time (0.1 seconds)
- Conditions: Overcast with light rain
- Still jpg image at maximum raspicam quality
- Resolution: 4k

					
0.0 seconds	0.1 seconds	0.2 seconds	0.3 seconds	0.4 seconds	0.5 seconds

Software Comparison: Wise Decider

White = Worst
Black = Best

Camera	Software	Power	Ease of use	Installation
IMAGESOURCE DKU	ImageSource	FPS, shutter speed, Little automaton, No focus, No Modes	Cannot focus the lense remotely. No Modes	Standard Win/IOS installers
ELP and other USB webcams	Wide variety available	No control of shutter speed auto exposure	Generally simply	Standard Win/IOS installers
Nikon SLR	Nikon Win/Mac Open source Raspberry Pi	Powerful control Modes!	Easy transfer of files. Modes!	Nikon Win and Pi-based install easily
Raspicam Modules • V.2, or • Arducam	Open source from eLinux	Powerful control Modes!	Full control laptop, tablet or phone, including file transfer. Modes!	Simple one-step installation

Above is a Wise Decider for a camera software. According to the chart, the Nikon SLR and the Raspicam Modules are the best for our purposes.

Camera Comparison: Wise Decider

White = Worst
Black = Best

Camera	Picture Quality	Operator friendly	Setup	Cost	Other...
SLR, Nikon, etc	Excellent	Very	110VAC, USB or BlueTooth	$1000-2000	Weather protection available $$
DKU Image Source	Good, under limited conditions. Low depth of field	..with limitations	Single USB, No WiFi or BlueTooth	$500-600	Weather protection must be added
Dome Webcam	Poor, low depth of field	No real control	Single USB, No WiFi or BlueTooth	$50-150	Weather protection built in
Raspicams	Very good, large depth of field	Very	5VDC or solar & wifi or ethernet	$125 w/Pi	Weather protection must be added

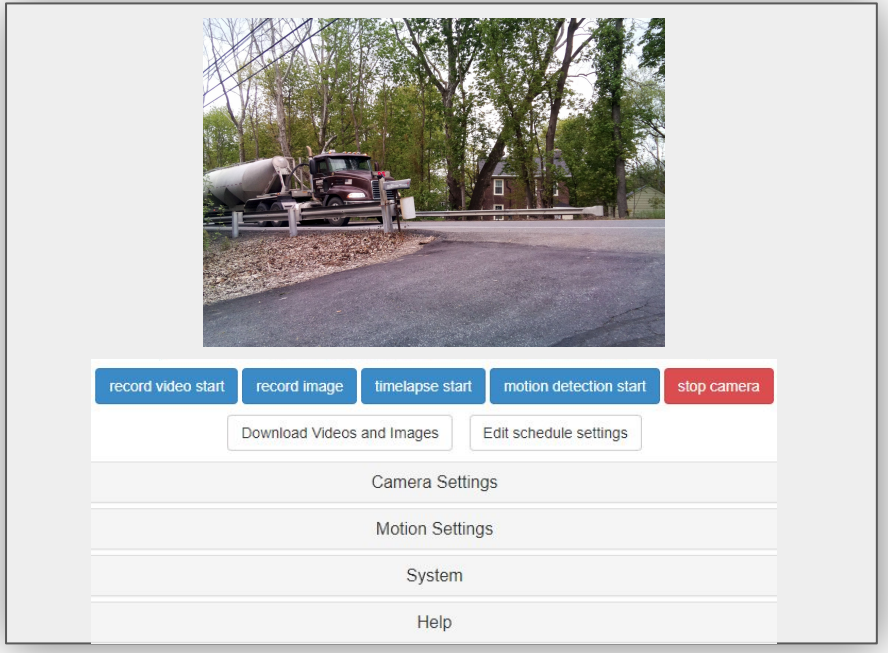
Above is a Wise Decider for a camera. According to the chart, the Raspicams are the best for our purposes. Combined with the software Wise Decider on the previous page, it is safe to say the Raspicams are the best option overall for this project.

RPI_Cam Interface Key Features

- Easy, single-package install
- Simple GUI (Graphical User Interface)
  - Easy tap or click control
  - Usable on many devices
    - Smartphone
    - Tablet
    - Laptop
  - Start/Stop in multiple ways
    - Still Image
    - Video
    - Time-Lapse: 0.1 second up to hours
    - Motion Detect
- Powerful Camera Controls
  - Modes (optimized algorithms and settings)
    - Sport, Beach, Snow, etc.
  - Manually set
    - Shutter speed, ISO, etc.
  - Chose capture size
    - 4k, 1080p, etc.
- No need to touch camera directly
  - All camera controls and file transfer done via WiFi or Ethernet cable

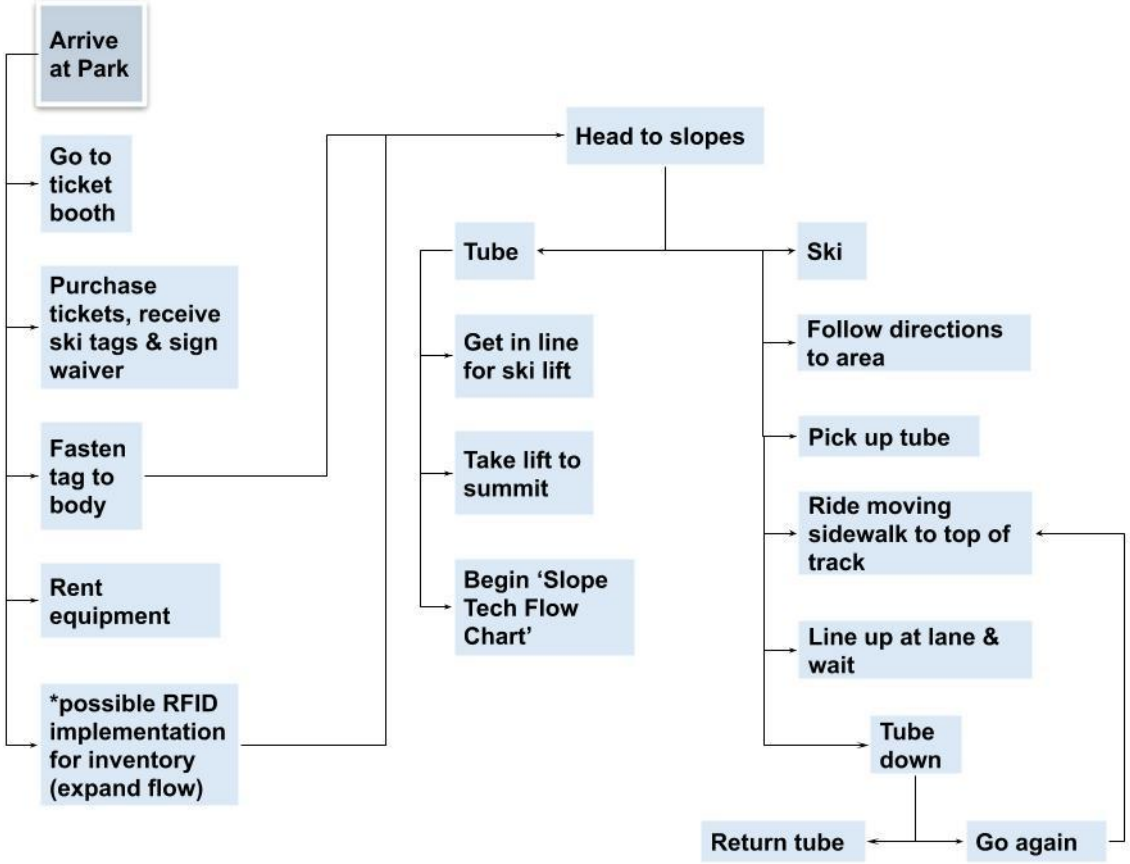
RPI_Cam Remote GUI

- Shown to the right is the RPI_Cam Remote GUI (Graphic User Interface).
  - The top of the GUI shows the preview window. This shows the picture one is about to take.
  - The bottom of the GUI are the controls, which allow the user to decide what they would like to do. They can alter settings, take videos, capture images, use motion detection, and start and stop the camera.



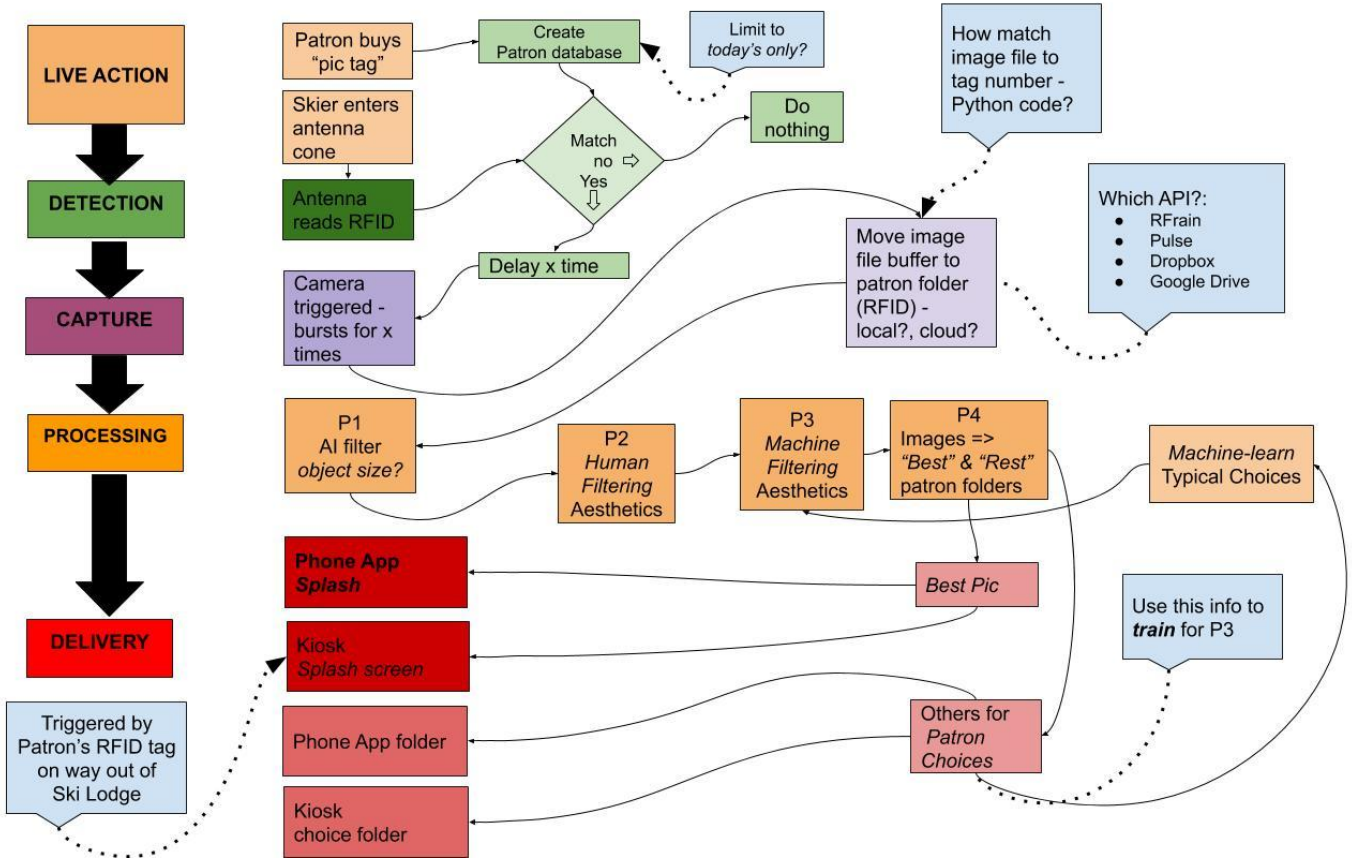
User Flow Chart

This flowchart serves to demonstrate the step-by-step process by which users will arrive & interact with the facility



Slope Tech Flow Chart

The flowchart at the right details how the technology will work and interact on the slope. Different process phases are shown in different colors.



Interconnectivity
with other RFID Systems

Skilift + Area Access:

RFID cards can be used to determine access to certain areas and slopes.

Companies like SKIDATA are building systems that can also integrate room keys and parking gates.

Rental + Convenience Shop:

RFID can be used to make a cashless and seamless exchange process in all facets of the renting and shopping acts.

Recommendations

- Tag
  - We recommend the **Dogbone Tag** because it was the easiest to detect, it was light, and it could be easily attached to different types of surfaces.
- Antenna
  - We recommend the **Yagi antenna** due to its range and directionality. The directionality is especially useful for only reading a single user, reducing the possibility of confusing users.
- Camera and Software
  - We recommend the **Raspicam** because it takes good quality pictures, is inexpensive, easy to install, has a large amount of control, and is user friendly.
  - We recommend **5-10 shots per second** for any burst photos to adequately capture the targeted skier.
- Triggering
  - We recommend further testing on more precise triggering methods. Due to our sudden shift to remote learning, we were unable to reasonably explore different triggering methods.

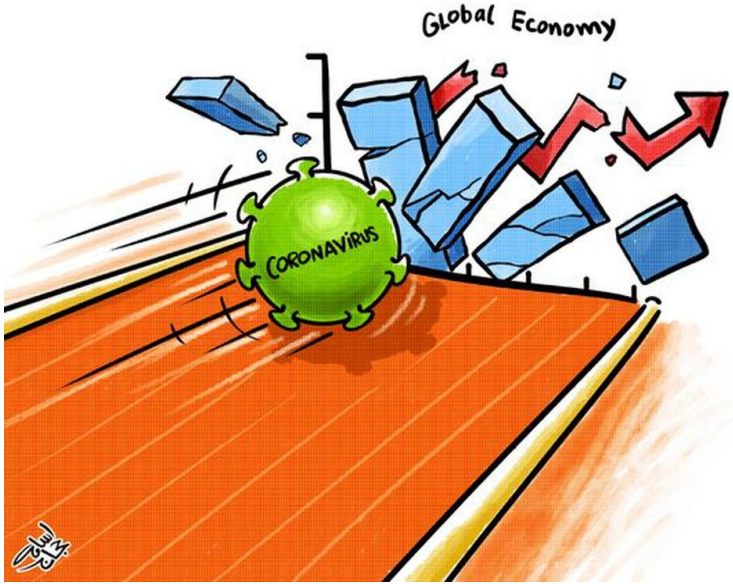
Program Changes

Due to global changes caused by the outbreak of the COVID-19 virus the scope of the Tech Clinic's work has changed to fit the needs of the current crisis.

Industry Impact

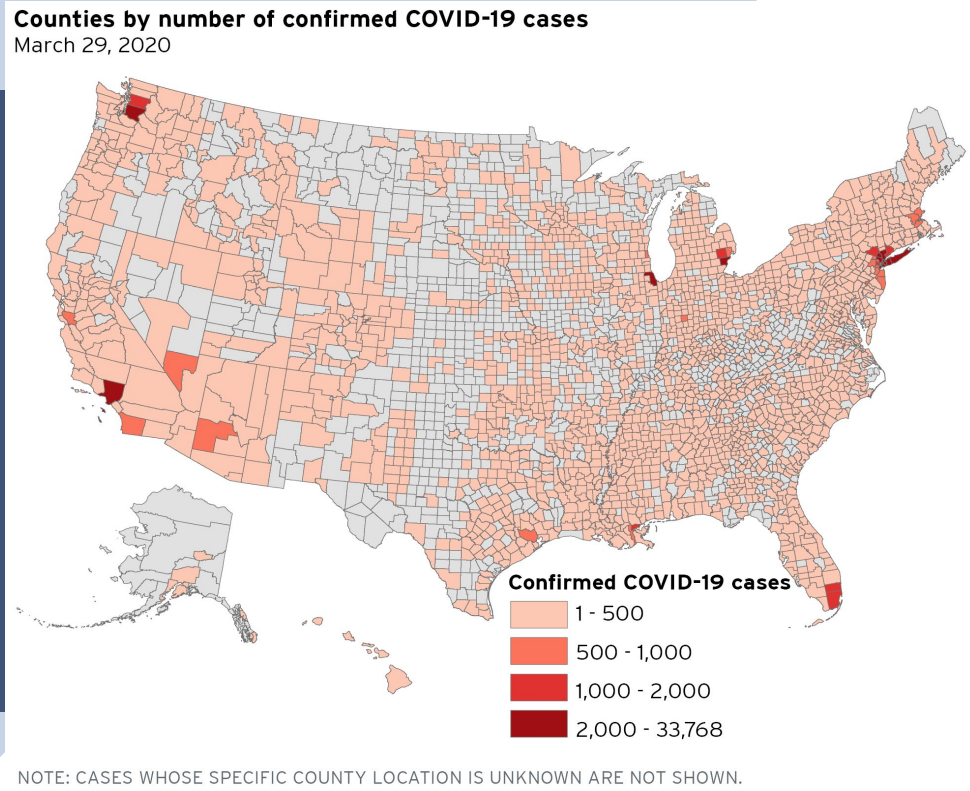
Impact on global economy expected to be severe with major reduction in consumer spending in non-essential areas, such as entertainment.

Likely that forced isolation will make travel and entertainment boom in the months after the end of the lockdown, if economic situation is not drastic.



“ *Force Majeure*

Emergence of Covid-19, and its rapid global spread has changed the way the team works and the scope of the project toward projects that can help in the fight against the global pandemic.



Identified Areas of Need

- **Transportation of Goods/Supply Shortages**
  - General panic about uncertainty surrounding virus led to frantic shoppers & item shortages. No item tracking in place → *could be a potential for RFID usage*
    - Medicine & Medical Items: Hydroxychloride, isopropyl alcohol, PPE for healthcare workers (Staging and storing w/ GHCM)
    - Everyday Items: Toilet paper, bread, grocery items, sanitizer
- **Modeling Spread of Virus**
  - Need more proactive contact tracking & predictive models to use for future pandemics
  - No way to know with 100% confidence whether or not outside sources are safe due to asymptomatic carriers
- **Economy**
  - Small business are struggling right now & unsure if they will be able to make up for profit loss
  - Unemployment rate quickly increasing as many non-essential industries are at a standstill and need to account for losses

Potential Focuses for TC

- **Virus Prediction & Prevention**
  - Installing thermal cameras at doorways of businesses and arenas to monitor temperature of incoming traffic allows for preemptive identification and swift removal of potential virus carriers. This type of screening could catch signs of illness earlier and is more cost effective than traditional test kits.
- **Disinfection Methods**
  - UVC could solve the sanitation problem. Using high frequency radiation to purify objects that are potential carriers for the virus decreases scope of spread and allows for complete confidence that PPE, groceries, etc are safe. Many applications.

Thermal Cameras

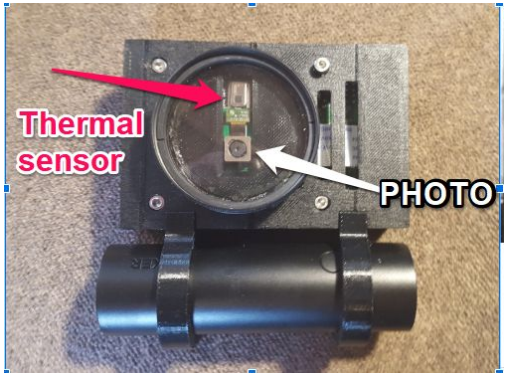
Thermal cameras could provide valuable information as to whether or not someone's health poses a threat to the people around them

Using thermal cameras to detect higher than usual temperatures of people who are entering crowded workplaces or arenas could lower the R_0, the number of healthy people one contagious person infects.

Thermal Camera Prototypes

Two Thermal cameras were created:

- Model I detects heat and displays color images of the heat it "sees"
  - Red = hottest while blue = coldest
  - Images can be viewed on smartphone, tablet, or laptop
- Model II detects heat and visible light of both what it can see and what you see
- Thermal patterns are detected by a Pioneer AMG8833 module
- Photo images are detected by Raspicam's Sony IMX219 4k Module



Pulse Purifier

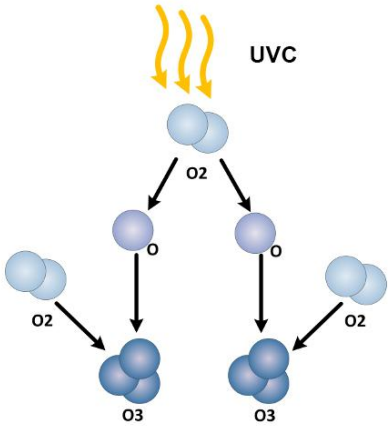
The Pulse Purifier is a self contained unit intended for the disinfection of items that have potentially come in contact with harmful microorganisms.

It’s modular design allows for use within many different industries and applications.

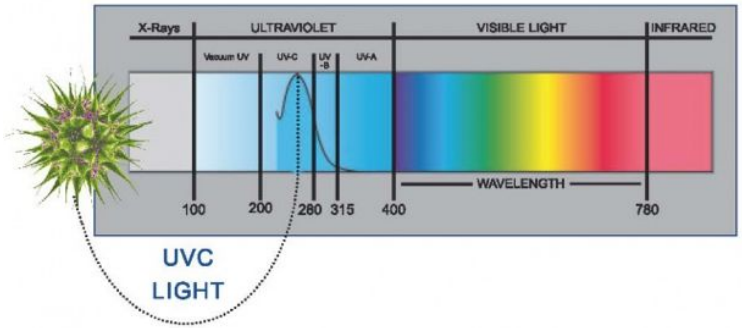
Disinfection Methods: Ozone

- Disinfects by oxidizing bacteria and virus
- 0.5–2.5 ppm for air disinfection
- Tested effective for SARS-CoV
- NIOSH human exposure limit of 0.1ppm
- Unstable gas, readily converts back to oxygen
- Commercially available air-fed ozone generators for 12-80ppm

Disinfection Methods: UVC



- UVC destroys microorganism nucleic acids and disrupts their DNA.
- Specifically tested and rated for coronaviruses
- Can be generated using available wands, bulbs, etc.
- UVC also generates ozone gas through radical reactions



Other Disinfection Methods

Heat

Temperatures above 75°C will kill coronaviruses, in a short time span.

While potentially useful, this method cannot be used on most plastics and generally results in food that is unfavorably overcooked or reheated.

Gamma Rays

Similar studies have shown that gamma rays can disrupt and deactivate the RNA in a virus, effectively killing it.

This process is currently being tested by several institutes and has had prior application in the agricultural and food industries.

Adverse side effects may result due to long exposure times. Insulation and exposure avoidance can eliminate any lasting health impacts or cell damage.

Door Control

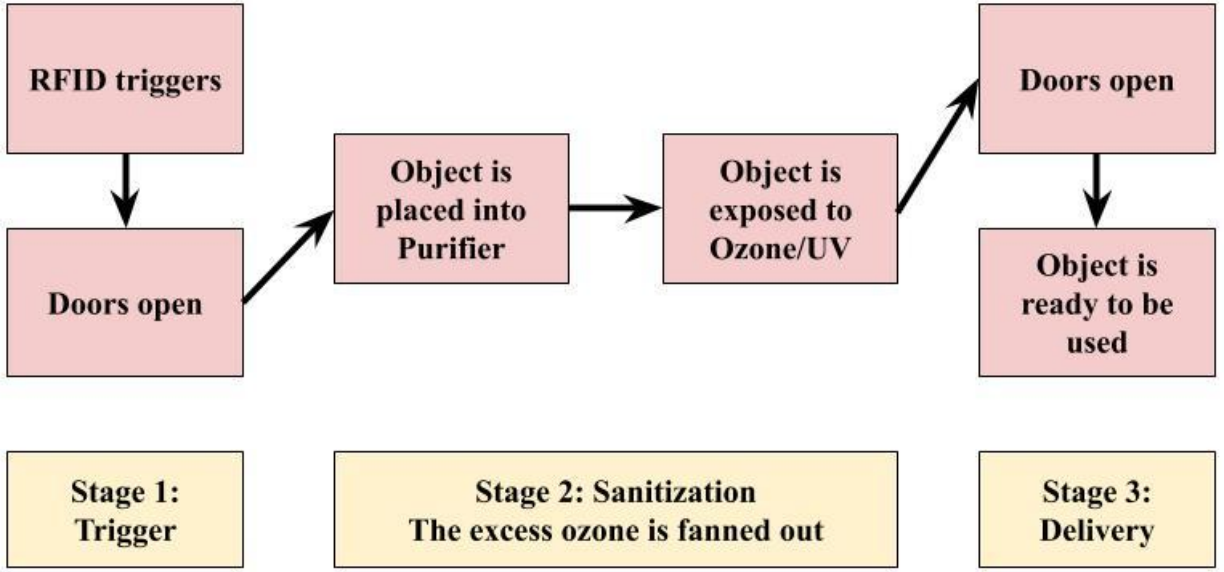
For disinfection purposes, it's important to have a contactless system to open the doors of the Pulse Purifier.

- **RFID tags** — Allows for easy tracking with time stamps of who is using purifier and when. Might be excessive since this is a small range application.
- **NFC tags** — Can be integrated with existing badges/member cards. Good for hospital application or communal shopping market model.
- **Phone bluetooth** — User connects with an app via bluetooth to trigger the open/close of PP doors.
- **Motion detector** — Detects people moving towards purifying unit and triggers the doors. Could be efficient for at-home usage.
- **Membership cards** — Grocery store membership cards can be implemented as a trigger to open the doors. Incentivizes customers to purchase membership cards. Can be free or have a fee.

Pulse Purifier Flow Chart

This flowchart displays the steps that the customer will take using the Pulse Purifier from beginning to the end.

It shows different stages the customer will go through using the Pulse Purifier from beginning to the end. The overview can be applied to the each combination of methods.

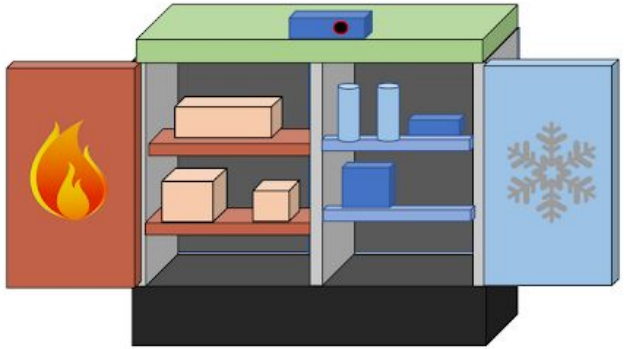


Design Inspiration

During the first semester, our team worked on the Hot Box concept to make the food delivery more efficient.

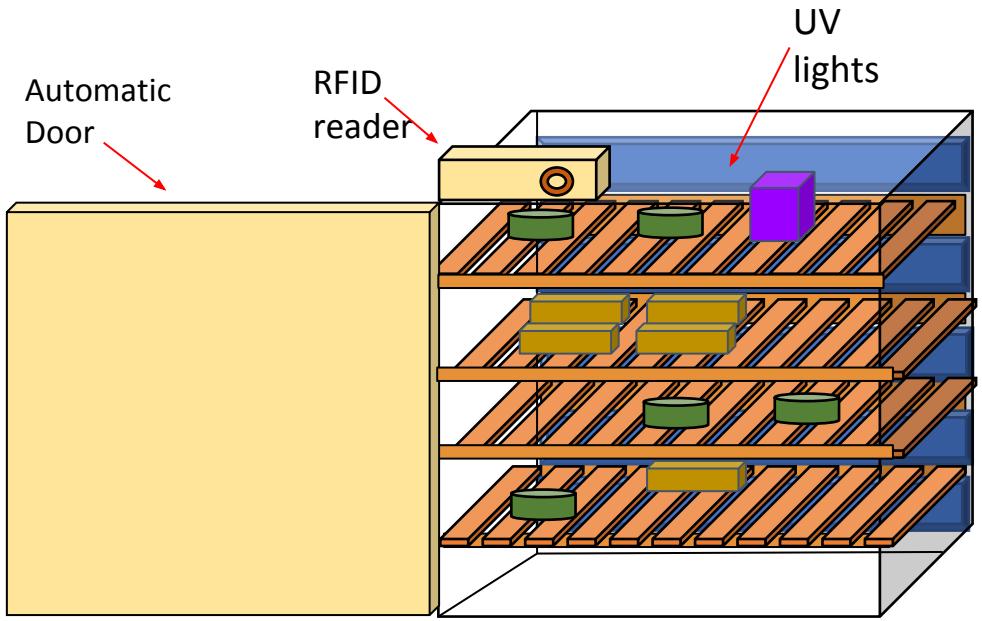
This concept was the inception of our Pulse Purifier design.

We have taken Hot Box's unit that stores food in different temperatures and expanded it to a purifying unit that will help sanitize a wide variety of objects in different applications.



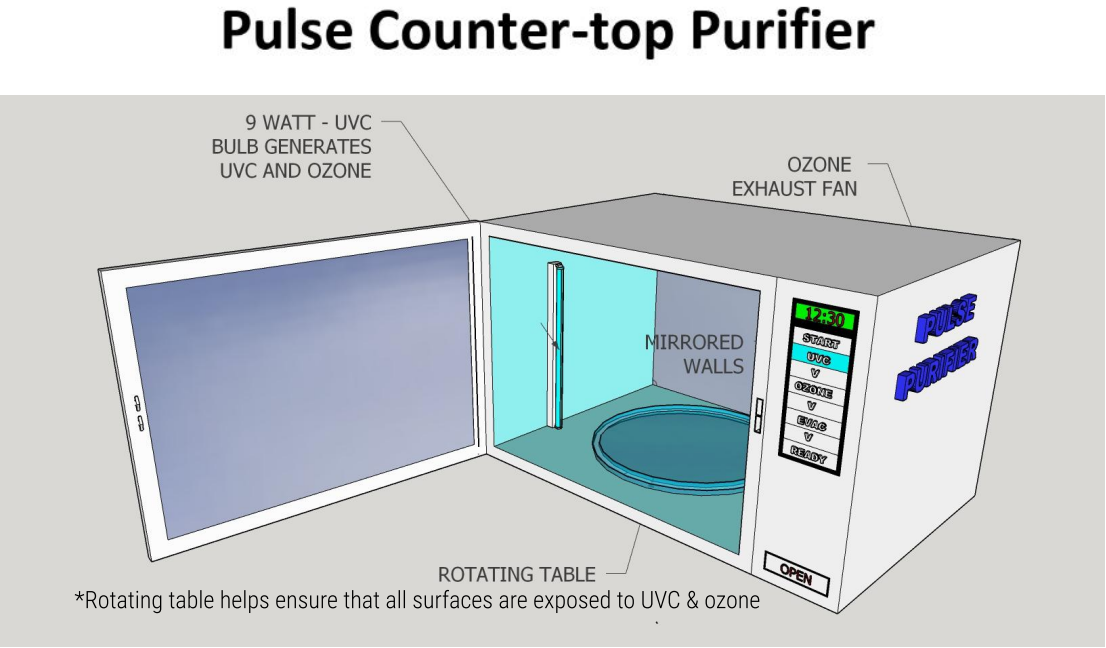
- Non-chemical cleaning methods have seen use in numerous fields for decades.
- With the recent Covid outbreak this means of decontamination and sterilization has exploded in popularity.

Preliminary Design #1



- This design is aimed to be used as a communal unit with the ability of sanitizing multiple items at once.
- The goal is to be able sanitize a bulk of items at once. For example:
  - Daily sanitization of the masks used by health professionals
  - Sanitizing groceries bought from supermarkets in the parking lot or in the supermarket

Preliminary Design #2



- This design is aimed to be used as a personal unit on countertops, similar to microwaves.
- The goal is to provide sanitizating of the items that households might use/receive daily. For example:
  - Sanitization of grocery items
  - Sanitization of package received in the mail
  - Sanitization of any household item that has been in contact with outside world (borrowed books, gifts..etc)

Monetization

- Opportunity for this system to be applied to the transport strategies of various food delivery companies.
- Could be used as loading points for premade food companies like Uber Eats or GrubHub.
- Could be used by grocery delivery services like that just established like by Walmart or Instacart.
- Partnerships could include utilizing the sterilization cubby as a drop off point, thus allowing an easy access point. In exchange for the service a percentage of each sale would be payment for the equipments use.
- Alternatively the product could be sold to the various delivery companies and a one time price paid.
- Regardless the method used, consumable components will make up a large portion of costs. Those being for new bulbs, battery packs, and RFID tags.

Monetization continued

RFID Sales

RFID tags can be used to check in delivered foods, send location updates, and store product data.

These RFID tags can greatly vary in size and quality, which will determine their exact usability with the system.

Regardless which tags are used, they can be sold through Pulse to various users, like UberEats or Grubhub, creating a constant source of revenue, as the tags are highly consumable, and will only be used one time prior to being discarded.

Unit Sales

Depending on final design and implementation strategy we can sell units for both home and industry use.

Industry units can be leased to companies or paid for on a usage basis.

A considerable portion of revenue can come through the sale of consumable parts and replacement components like heaters, refrigeration units, UVC bulbs, ozone generators and more.

Recap

- Ski Net:
  - Overall, our work done with SkiNet has resulted in recommendations for technology:
    - The Dogbone tags read further and more consistently. The Yagi antenna was more directional, which works well for detecting single users.
    - The Raspicam had best overall performance for its cost. It is user friendly and can take clean, crisp action shots.
- Pulse Purifier:
  - Models for personal, communal, and industrial use
  - Disinfection through UVC, ozone, heat, gamma
  - Contactless door control

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