Department of Computer Science & Engineering
The University of Texas at Arlington

System Requirements Specification
CSE 4316: Senior Design I
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Team Mercury
ARGOOSE-Counter Drone Tracking

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Revision History

Revision	Date	Author(s)	Description
0.1	9.23.2022	AN	document creation
0.2	10.23.2022	AN, JG, SP, NS, MR	complete draft

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1 Product Concept

This section describes the purpose, use and intended user audience for the ARGOOSE drone detection product. ARGOOSE is a system that performs drone detection via sensors. Users of ARGOOSE will be able to set up a perimeter detection zone and receive information on detected drones within the area of operation.

1.1 Purpose and Use

The ARGOOSE system detects drones and sends back information on detected drone to users via web interface. System is designed to perform in an open space with acoustic detection.

1.2 Intended Audience

The system is designed to address general drone safety concerns. By providing feedback on drones located in the area, customers can be informed of drone behavior around sensitive locations. General customers are defined as anyone in need of this system's capabilities.

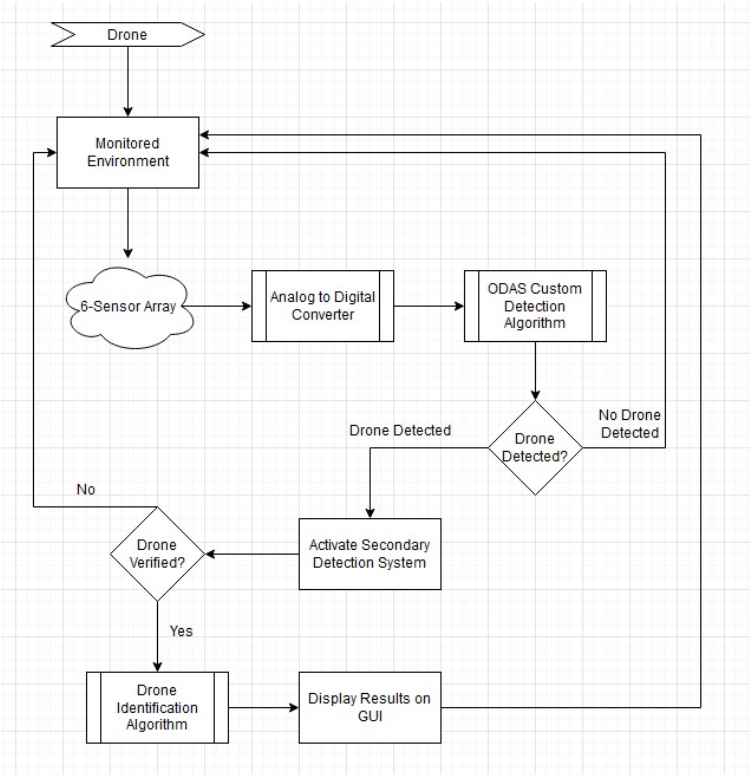

Figure 1: system conceptual drawing

2 Product Description

This section provides the reader with an overview of the ARGOOSE product. The primary operational aspects of the product, from the perspective of end users, maintainers and administrators, are defined here. The key features and functions found in the product, as well as critical user interactions and user interfaces are described in detail.

2.1 Features & Functions

Product shall be expected to detect at least some commercial level drones. There is no guarantee of detection in military level drones, nor is there any guarantee that all commercial level drones will be detected. The main detection method is the mode of flight, with spinning rotor being the most ideal– relying on acoustic sensors. The system shall comprise of at least two sub-systems: a drone-detecting edge device and a web-application. Breaking down the system into two helps with remote access for the customer, than let's say a physical alarm system that sounds off. It also introduces the possibility of scaling the system up (ie. making a network of drone detecting devices). The hardware components of the system will contain a raspberry pi connected to a GPS, battery and audio sensor system. The audio sensor consists of six microphones aligned in a circular pattern. In terms of external elements, internet will be utilized, GPS information will be assessed and used, and our web application is an external web server.

2.2 External Inputs & Outputs

Name	Description	Use
Drone	Environmental source of sensory data	Processed for detection
Six-sensor Array	Processed analog audio	Converts analog to digital for system
ODAS	Takes digital signal input	Runs algorithm to detect source of sounds
Secondary Detection System	Self-contained detection	Verify false positives
Drone ID Algorithm	Takes all system input	Decides whether or not something is a drone
GUI	Outputs data in graphical form	notifies users on drone activity

2.3 Product Interfaces

Web application UI shall be readable to an acceptable degree. The web application doesn't need to be well designed or aesthetically pleasing; however, it needs to at least be readable and understandable for customers and developers.

Figure 2: Main Detection Page Mock Up

3 Customer Requirements

This section outlines how customers should expect a simple and easy to use drone detection system. It should be able to detect drones within a certain radius and display information for the user to view. The look and feel is like google maps with drone detection.

3.1 System will accept verification of false positives by user

3.1.1 Description

Utilizing the web interface, whenever a positive drone detection has been emitted by the system: The user will be able to manually identify that the drone is not present where detected and inform the system that it is a false positive result. After the system acknowledges this change, it will no longer track the false positive result and store an identifier so that rates of false positives can be assessed by the end user.

3.1.2 Source

Customer Requirement

3.1.3 Constraints

There are no realistic constraints to this requirement. Utilizing the web interface to remove detections and storing results should be accomplished without incident.

3.1.4 Standards

There are no intrinsic standards to meet this requirement.

3.1.5 Priority

This is a priority Low requirement.

3.2 System will be able to actively track an individual drone

3.2.1 Description

Utilizing the web interface, when the system has positively identified a drone, the user will be able to select that drone. Upon selection, the tracking system will switch to an active tracking mode and attempt to track the selected drone in as close to real time as possible.

3.2.2 Source

Customer Requirement

3.2.3 Constraints

Degraded performance due to weather effects may impact performance.

3.2.4 Standards

There are no intrinsic standards to meet this requirement.

3.2.5 Priority

This is a Critical requirement.

3.3 System will detect multiple drones with passive scanning

3.3.1 Description

Utilizing the web interface, the system when not actively tracking an individual drone will passively scan the area. During these scans it will return sweep ping results of potential drones it detects with the acoustic + subsystem algorithm.

3.3.2 Source

Customer Requirement

3.3.3 Constraints

Degraded performance due to weather effects may impact performance.

3.3.4 Standards

There are no intrinsic standards to meet this requirement.

3.3.5 Priority

This is a Critical requirement.

3.4 Product shall be delivered by the end of May 2023 school year

3.4.1 Description

The product must be in a minimum viable state by the end of May 2023 school year, in time to present and demonstrate. Minimum viable state means a state in which the product can reach at least 60% of its main functionalities as described in the product description, performance requirements, and other customer requirements, on top of having ALL the packaging requirements.

3.4.2 Source

Augustine Nguyen

3.4.3 Constraints

The biggest constraint is the document itself.

3.4.4 Standards

UTA academic codes

3.4.5 Priority

Critical

3.5 The system shall be developed within a production budget of $800

3.5.1 Description

Since this system is being developed as a Senior Design project funded by UTA, there is a budget constraint that can factor into functionality and long-term maintenance limitations.

3.5.2 Source

CSE Senior Design Specifications mention this general budgetary constraint on most projects.

3.5.3 Constraints

Exceptions require permission from the CSE department on a case-by-case basis.

3.5.4 Standards

N/A

3.5.5 Priority

Critical

3.6 The system shall show the current location of the device placed

3.6.1 Description

The system will track the current location using maps and display it through API.

3.6.2 Source

Customer Requirement

3.6.3 Constraints

There is no realistic constraint for this requirement. Our web app should accurately display the location of the tracking devices placed.

3.6.4 Standards

There are no intrinsic standards to meet this requirement.

3.6.5 Priority

This is a critical priority for the project.

3.7 The system shall notify the customer if a drone passes by

3.7.1 Description

The system will give a message alert to the customer and the point at which the drone signal was captured if a drone is detected in the radius of the device.

3.7.2 Source

Customer Requirement

3.7.3 Constraints

The device should be turned on and ready to process the auditory and RF.

3.7.4 Standards

There are no intrinsic standards to meet this requirement.

3.7.5 Priority

This is a high level Priority for the project.

3.8 The system shall show the path in the web application in which the drone travels

3.8.1 Description

The system marks the path on the maps along which the drone passes by in the radius of the device.

3.8.2 Source

Customer Requirement

3.8.3 Constraints

The path will only be visible temporarily.

3.8.4 Standards

There are no intrinsic standards to meet this requirement.

3.8.5 Priority

This is a low level Priority for the project.

3.9 The system shall categorize the data input from the sensors into potential drones and non drone objects.

3.9.1 Description

The system will use machine learning concepts for this categorization.

3.9.2 Source

Customer Requirement

3.9.3 Constraints

The sensors should be placed in an open area without any significant disturbances.

3.9.4 Standards

There are no intrinsic standards to meet this requirement.

3.9.5 Priority

This is a critical level Priority for the project.

3.10 UI Requirements

3.10.1 Description

The user will have to register and login to the system in order to use it. The registration system will be delivered to correctly identify the user logs. The passwords shall be encrypted using SSL.

3.10.2 Source

Customer Requirement

3.10.3 Constraints

The password will have standard constraints: 7 letters, one capital letter, one small letter, one number and one special character.

3.10.4 Standards

Registration username will be email address that will need to be verified

3.10.5 Priority

This is a low level Priority for the project.

4 Packaging Requirements

This section specifies how the system will be packaged in an internal enclosure with sufficient protection from weather events. When deployed, the system will be on a tripod stand with the enclosure on top. All operations will be contained within the web interface.

4.1 System will be enclosed and equipped with a tripod

4.1.1 Description

The raspberry pi, associated circuitry and other components will be enclosed in such a manner that they are protected. The system will also feature a tripod base to elevate it above ground level for better sensor perception.

4.1.2 Source

Packaging Requirement

4.1.3 Constraints

There are no applicable constraints to this requirement.

4.1.4 Standards

There are no applicable standards to this requirement.

4.1.5 Priority

This is a Medium priority requirement.

4.2 Source code shall not be given to customers immediately

4.2.1 Description

Right off the bat, the source code shall be disputed upon and owned by any number of developers, but it won't be something customers can own immediately. Customers are simply users of the product, not its owners; however, a single entity customer can purchase the rights to the source code, just like anyone else, so long as it is agreed upon by the current owners.

4.2.2 Source

Augustine Nguyen

4.2.3 Constraints

Ownership is constrained by the present's laws on copyright and intellectual property ownership.

4.2.4 Standards

Copyright Law of the United States (Title 17)

4.2.5 Priority

High

4.3 The delivered product will be in form of a ground based sensor device and a web application.

4.3.1 Description

The ground based sensor device shall capture the acoustic signals and provide it to the system and the web based application would show the results of the inputs

4.3.2 Source

Sanyogita Piya

4.3.3 Constraints

N/A

4.3.4 Standards

In order to run the web application, the user should have access to internet.

4.3.5 Priority

Critical

4.4 The ground based drone detection sensor system shall weigh less than 50 lbs

4.4.1 Description

The only hardware system that is presented to the customer is the ground based sensor system hence there is a weight limit associated to it.

4.4.2 Source

Sanyogita Piya

4.4.3 Constraints

N/A

4.4.4 Standards

N/A

4.4.5 Priority

High

4.5 The integration setup of the system shall be simple and easy to follow

4.5.1 Description

The user manual shall be provided to the customer which would have a step by step set up guideline to start the system.

4.5.2 Source

Sanyogita Piya

4.5.3 Constraints

N/A

4.5.4 Standards

N/A

4.5.5 Priority

High

5 Performance Requirements

This section outlines how well the system performs, in which environment it performs best in, thing like open space and low volume areas really benefit the system. The system will perform required functionality in fair weather with good visibility such as flat terrain. It will accurately detect drones 60% of the time with a 15% false positive rate or lower. All functionality will perform consistently on the network without intermittent failures. The system will give approximations on detected drones locations and other factors.

5.1 System will maintain a false positive rate below 15 percent

5.1.1 Description

When passively detecting drones, the system will not identify incorrectly by pinging the web interface more than 15 percent of the time. False positives will consist of any detection alert that identifies an item in space that is not a drone or drone similar object.

5.1.2 Source

Performance Requirement

5.1.3 Constraints

Degraded performance due to weather effects may impact performance.

5.1.4 Standards

There are no intrinsic standards to meet this requirement.

5.1.5 Priority

This is a High priority requirement.

5.2 System shall verify drones with acoustic detection with a subsystem backup

5.2.1 Description

After detecting a drone utilizing it's primary acoustic system, the system will utilize a secondary detection system to verify it's possible drone detection. When both systems return a positive result, the web interface will be informed of a drone detected.

5.2.2 Source

Performance Requirement

5.2.3 Constraints

Degraded performance due to weather effects may impact performance.

5.2.4 Standards

There are no intrinsic standards to meet this requirement.

5.2.5 Priority

This is a Critical requirement.

5.3 The system shall be operable in all times of the day

5.3.1 Description

There will be no regard to day and night. The system will be operable 24 hours according to the power supply provided

5.3.2 Source

Sanyogita Piya

5.3.3 Constraints

N/A

5.3.4 Standards

N/A

5.3.5 Priority

Critical

5.4 The system shall not decode or demodulate signals

5.4.1 Description

If a system 'decodes' or 'demodulates' the signal to extract the drone type, serial number, GPS coordinates or the 'Return to Launch' GPS coordinates, it violates U.S. Federal Wiretapping laws. Therefore this system shall be a passive system that uses physical characteristics of the drone example: RF and acoustic

5.4.2 Source

Sanyogita Piya

5.4.3 Constraints

N/A

5.4.4 Standards

The system shall abide by the US federal wiretapping laws

5.4.5 Priority

Critical

5.5 The system shall not give precise results depending on the weather condition if operated outdoors.

5.5.1 Description

Places which have sound disturbances will cause to imprecise results because of the use of acoustic sensors.

5.5.2 Source

Sanyogita Piya

5.5.3 Constraints

N/A

5.5.4 Standards

It is affected by lighting, sound, rain, clouds, fog, background clutter, or line of site

5.5.5 Priority

Moderate

5.6 The system shall show at least 60 percent accuracy in detection of the drone

5.6.1 Description

The system shall correctly identify the drone 60 percent of the time. This requirement is a subject to change if the accuracy of the system increases.

5.6.2 Source

Sanyogita Piya

5.6.3 Constraints

N/A

5.6.4 Standards

N/A

5.6.5 Priority

High

5.7 The system shall show reliable results with response time of at most 30 seconds

5.7.1 Description

The process of collecting input, machine learning model and displaying the output should not be more than 30 seconds. This requirement is subject to change.

5.7.2 Source

Sanyogita Piya

5.7.3 Constraints

N/A

5.7.4 Standards

N/A

5.7.5 Priority

High

5.8 The system shall be able to maintain persistent wireless/Internet access

5.8.1 Description

The system should be able to communicate any alerts to the web application instantaneously so a stable and persistent connection is critical.

5.8.2 Source

Mahin Roddur

5.8.3 Constraints

Might be difficult or costly setting up persistent connections in remote, open areas.

5.8.4 Standards

N/A

5.8.5 Priority

Critical

5.9 The system shall have the best functionality on flat, open terrains

5.9.1 Description

Since acoustic analysis is a major criteria for drone detection, the system is not being developed for use in uneven, enclosed areas.

5.9.2 Source

Mahin Roddur

5.9.3 Constraints

Indoor testing, especially with acoustic sensors, may not result in optimal performance by the system.

5.9.4 Standards

N/A

5.9.5 Priority

Medium

5.10 Detection of UAV perimeter

5.10.1 Description

The device will detect and track drones flying within 10 meters omnidirectional distance from the device perimeter.

5.10.2 Source

Performance Requirement

5.10.3 Constraints

Since acoustic analysis is a major criteria for drone detection, the system will perform better in open and even environment without any major disturbances.

5.10.4 Standards

There is no applicable standard for this requirement.

5.10.5 Priority

High Priority

5.11 Detection of UAV method

5.11.1 Description

Because the system uses the physical signature of a sound signal to identify drones, it can detect both known and unidentified drones.

5.11.2 Source

Performance Requirement

5.11.3 Constraints

A simple drone with identifiable and distinct acoustic signal should be used for testing purpose.

5.11.4 STANDARDS

There is no applicable standard for this requirement.

5.11.5 PRIORITY

High Priority

6 Safety Requirements

Detection system conforms to all applicable UTA standards and federal law

6.1 Laboratory equipment lockout/tagout (LOTO) procedures

6.1.1 Description

Any fabrication equipment provided used in the development of the project shall be used in accordance with OSHA standard LOTO procedures. Locks and tags are installed on all equipment items that present use hazards, and ONLY the course instructor or designated teaching assistants may remove a lock. All locks will be immediately replaced once the equipment is no longer in use.

6.1.2 Source

CSE Senior Design laboratory policy

6.1.3 Constraints

Equipment usage, due to lock removal policies, will be limited to availability of the course instructor and designed teaching assistants.

6.1.4 Standards

Occupational Safety and Health Standards 1910.147 - The control of hazardous energy (lockout/tagout).

6.1.5 Priority

Critical

6.2 National Electric Code (NEC) wiring compliance

6.2.1 Description

Any electrical wiring must be completed in compliance with all requirements specified in the National Electric Code. This includes wire runs, insulation, grounding, enclosures, over-current protection, and all other specifications.

6.2.2 Source

CSE Senior Design laboratory policy

6.2.3 Constraints

High voltage power sources, as defined in NFPA 70, will be avoided as much as possible in order to minimize potential hazards.

6.2.4 Standards

NFPA 70

6.2.5 Priority

Critical

6.3 RIA robotic manipulator safety standards

6.3.1 Description

Robotic manipulators, if used, will either housed in a compliant lockout cell with all required safety interlocks, or certified as a "collaborative" unit from the manufacturer.

6.3.2 Source

CSE Senior Design laboratory policy

6.3.3 Constraints

Collaborative robotic manipulators will be preferred over non-collaborative units in order to minimize potential hazards. Sourcing and use of any required safety interlock mechanisms will be the responsibility of the engineering team.

6.3.4 Standards

ANSI/RIA R15.06-2012 American National Standard for Industrial Robots and Robot Systems, RIA TR15.606-2016 Collaborative Robots

6.3.5 Priority

Critical

6.4 UTA UAV Flying Guidelines

6.4.1 Description

The project has to obey UTA's Guidelines on unmanned aircraft vehicles, so long as we are conducting under the school space.

6.4.2 Source

UTA Drone Policy

6.4.3 Constraints

UTA defines its safe fly zones and outlines its guidelines on how to conduct one's self when flying under UTA's jurisdiction.

6.4.4 Standards

CO-CS-PO-07 Unmanned Aircraft Systems Policy

6.4.5 Priority

Critical

6.5 FAA UAV Flying Laws

6.5.1 Description

The project must obey FAA laws involving unmanned aircraft vehicles

6.5.2 Source

Federal and State Drone Laws

6.5.3 Constraints

FAA descibes who is qualified to pilot, responsibilities of pilots, and pretty much any outlines every guideline on how to handle drones.

6.5.4 Standards

SMALL UNMANNED AIRCRAFT SYSTEMS (PART 107)

6.5.5 Priority

Critical

7 Security Requirements

Source code and collected data will be privatized. Web application will be secure when handling user information.

7.1 Code base contained in repository shall remain private once product is finished

7.1.1 Description

Code base is contained in git repository and will become private in terms of viewing and editing once the product is released. For now, the product is able to be viewed publicly. Only owner(s) and individuals appointed by the owner(s) may have access.

7.1.2 Source

Augustine Nguyen

7.1.3 Constraints

Private means no viewing or editing. Access is given through the discretion of the owner(s).

7.1.4 Standards

N/A

7.1.5 Priority

Medium

7.2 Tested security for data stored by the web application

7.2.1 Description

The web application shall have some form of user verification (ie. 2FA) for suspicious login attempts or hijacking attempts.

7.2.2 Source

Mahin Roddur

7.2.3 Constraints

If security insurance becomes too burdensome during development, there should be a plan to offload it to third-party logins like Google Sign-in

7.2.4 Standards

N/A

7.2.5 Priority

Medium

8 Maintenance & Support Requirements

Updates in technologies (hardware or software) should be applied to the system when appropriate.The system maintenance schedule will require product owners to facilitate the code base. Owners are also required to update web applications and design the system such that withstands typical weather effects with it's enclosure. On the customer end, the user will be provided a self analyzing system that will inform them of errors, as well as an expectation of maintenance checks every two years.

8.1 System will have a self diagnostic bootup sequence

8.1.1 Description

When first activating the system, it will perform an internal, self diagnostic sequence to verify all components are functioning as required. This information will display and assess results on the web interface. Detailing all critical components and if they passed or failed self diagnostic checks.

8.1.2 Source

Maintenance Requirement

8.1.3 Constraints

There are no applicable constraints to this requirement.

8.1.4 Standards

There are no applicable standards to this requirement.

8.1.5 Priority

This is a High priority requirement.

8.2 System will withstand typical weather effects without failing

8.2.1 Description

The shell and encasing structure of the equipment will be of such a design that typical weather scenarios, such as rain, will not penetrate and damage or cause short circuit failure of internal components.

8.2.2 Source

Maintenance Requirement

8.2.3 Constraints

There are no applicable constraints to this requirement.

8.2.4 Standards

There are no applicable standards to this requirement.

8.2.5 Priority

This is a High priority requirement.

8.3 Current product owners shall maintain code base and update system

8.3.1 Description

Whomever owns the product is responsible for maintaining it, whether that be for system updates or feature updates.

8.3.2 Source

Augustine Nguyen

8.3.3 Constraints

Product shall strive to be in working order at all times. Owners will determine who exactly is responsible for maintaining product.

8.3.4 Standards

Software Engineering standards

8.3.5 Priority

High

8.4 The system maintenance and inspection should take place at least twice a year.

8.4.1 Description

The sensors may ware out hence it should be replaced or inspected at least twice a year.

8.4.2 Source

Sanyogita Piya

8.4.3 Constraints

N/A

8.4.4 Standards

N/A

8.4.5 Priority

High

8.5 Web Application Updates

8.5.1 Description

As long the system has an active customer base, there should be a schedule to check for and implement updates on the webapp, whether they pertain to UI, security, or functionality.

8.5.2 Source

Mahin Roddur

8.5.3 Constraints

There might not be an active team monitoring the app's functionality and performance within a year of development.

8.5.4 Standards

N/A

8.5.5 Priority

Medium

9 Future Items

Possible future implementations may, if possible, include advancements in the current system specifications. The system does not address historical data factors and may be included in future updates. As well as this, the ability to real time track, and also to track in real time multiple drones will not be included in the base model design. Altitude detection may, depending on time, be included but is restricted to a future implementation as it is a possible blocker for other core implementations at this time. Tertiary detection methods may also be added after initial system is completed and expandability is addressed.

9.1 System will track multiple drones at one time

9.1.1 Description

The system will be capable of selecting and actively tracking multiple drones it detects at any given time.

9.1.2 Source

Future Requirement

9.1.3 Constraints

Degraded performance due to weather effects may impact performance.

9.1.4 Standards

There are no intrinsic standards to meet this requirement.

9.1.5 Priority

This is a possible Future implementation.

9.2 System will provide real time response to multiple drone scenarios

9.2.1 Description

While actively tracking multiple drones, the system will provide close to real time data updates to be displayed.

9.2.2 Source

Future Requirement

9.2.3 Constraints

Degraded performance due to weather effects may impact performance.

9.2.4 Standards

There are no intrinsic standards to meet this requirement.

9.2.5 Priority

This is a possible Future implementation.

9.3 The system shall be able to detect altitude of UAVs

9.3.1 Description

On top of determining the top-down location of drones, the system should also be able to determine the height of where the drones are. The technique for this has yet to be determined, but the output shall simply be a number and metric displayed somewhere on the user interface (e.g., 70 meters, 120 ft); more than likely, this feature will only be implemented for one drone at a time.

9.3.2 Source

Augustine Nguyen

9.3.3 Constraints

Altitude calculation will be for drones within a set area (yet to be determined), most definitely within the radius of the main detection system. It will also be done for one drone at time.

9.3.4 Standards

N/A

9.3.5 Priority

Future

9.4 The system shall send an email for the alert if a drone passes by the perimeter.

9.4.1 Description

The user will have choice to select the medium of alert as email or text. Alerts are configurable and can also be sent to local law enforcement for a coordinated response.

9.4.2 Source

Sanyogita Piya

9.4.3 Constraints

N/A

9.4.4 Standards

N/A

9.4.5 Priority

Future

9.5 Third Detection Layer: Computer vision implementation

9.5.1 Description

If time and budget allows for it, detection through visual data stream can add another layer of drone detection verification. Although it seems unviable at the moment, a future implementation would add to the system's functionality.

9.5.2 Source

Mahin Roddur

9.5.3 Constraints

Budgetary and time constraints are the most apparent one here.

9.5.4 Standards

N/A

9.5.5 Priority

Future

9.6 The system shall store the history of drones detected

9.6.1 Description

The system makes a log of time and the location of when a drone detected.

9.6.2 Source

This is a customer requirement.

9.6.3 Constraints

The history data will only be shown for the previous 7 days.

9.6.4 Standards

There are no intrinsic standards to meet this requirement.

9.6.5 Priority

Low Priority

9.7 UI upgrade

9.7.1 Description

The system should display the profile of the user with the option to change email address and change password. The system will have a profile database which stores the history of drone tracking, gives an option for the user to change their username and password.

9.7.2 Source

This is a customer requirement.

9.7.3 Constraints

The password will have standard constraints: 7 letters, one capital letter, one small letter, one number and one special character.

9.7.4 Standards

There are no intrinsic standards to meet this requirement.

9.7.5 Priority

Low Priority

REFERENCES