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1. Introduction

1.1. Overview

Many lifeguards in the world face a real problem in which they struggle to watch after the bathers in real-time both in the water and on the beach since they have to supervise vast areas.

Creating a system for lifeguards in order to help them prevent drownings as well as problems such as fights that may occur on the beach. DroneGuard will help lifeguards do their job efficiently and provide them with the ability to interrogate past scenarios and learn from them.

1.2. Problem Description and Motivation

Today, lifeguards have binoculars and a megaphone, in order to scan the swimming area, and to communicate with the bathers to ensure they remain within the limits defined as safe.

We are trying to solve three main problems:

1. The inability to monitor the bathers on the beaches and in the water in a large area, and the long response time to an emergency event.
   The drone will give us a better and faster way to monitor the shore and the water area with the ability to focus on the event faster and better.

2. The inability to interact with the bathers without disturbing the whole beach.
   With the help of the drone, we are improving our ability to quickly access the bathers and make personal contact with them in a way that does not bother the other bathers.

3. An additional problem that comes with emergencies is interrogating them. Since the evidence available to the investigators are subjective, the testimony of lifeguards or bathers who have been at the scene can be relied upon, but there is no possibility of tracking the sequence of the events.
   In many cases the testimony may be wrong in some parts which may mislead the investigators.
   Using a digital system that stores data in real-time will allow quality and reliable investigations.

1.3. Goals

The main purpose of the system is - to provide lifeguards with a tool that enables them to monitor the water area and the beach, detect any problems, zoom in to swimmers that are in danger or potential danger, and communicate with the relevant swimmers.

The system will allow the lifeguards to investigate the videos of the incident in order to understand what happened and learn how to deal with emergency or near emergency situations better.

The system will allow the lifeguards to patrol the beach and communicate with people using a microphone and speaker.
In addition to the main goal we have sub-goals regarding the functionality of the product:

- The system will have an intuitive interface for non-technical users
- The system will have an automatic functionality that will call 101(Ambulance) in the shortest time possible.
- The system will enable clear communication with the swimmer.
- Real-time display the drone's view and the ability to move to a specific location by touching a specific area on the screen by the LG (touch & go).
- In order to perform and implement the drone movement from point A to B, we will calculate the difference between these two points and the transformation we should output to the LG's screen with the minimum deviation possible.
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From the lifeguard side -

- The system will allow the lifeguard to control the drone using a GUI interface, without the need to know how to fly a drone.
- The system will allow the lifeguard to call the emergency services in case they are needed.
- The system will provide the lifeguard a way to communicate with bathers in a more efficient and personal manner.
- The system will function as means of recording and monitoring emergency events for the purposes of interrogation.

From the bathers side -

- The system will allow bathers to communicate with lifeguards using the microphone on the drone.

1.4. Scope

Our system is capable of monitoring, communicating with the bathers and documenting emergency events for further interrogations.

2. General Description

2.1. User Characteristics

Our users will be lifeguards, each rescue station on the beach will have a drone and ipad with the system app.
The system is specifically designed for life-guards. However, it is clear that a system which enables the monitoring of a large area together with the ability to zoom in and out easily, and communicate with a person, can be used in many other situations.

2.1.1. Stakeholders: Client Description

Although we will not have any third-party customers, city councilors and local authorities might be paying customers when the system heads into its final phase.

2.1.2. End-Users Description and Scenarios

Yaron, 46, a lifeguard on a beach in Ashdod.
On a summer day the beach is crowded with bathers and it is difficult to keep track of all the happenings. Suddenly shouts are heard from the direction of the bathing area.
Yossi turns to the user interface to focus on this area. He navigates the drone to the area and examines the occurrence to determine how to operate.
Realizing that this is a joke by a number of teenagers and not an emergency, he descends the height of the drone, addresses the teens using the microphone in his possession, and asks them to be extra careful.
The teens hear his appeal through a speaker connected to the glider, and head back to the beach.

Avraham, 49, last week a person drowned at his beach.
The person's family decided to sue Avraham and he needs some evidence that it is not his fault that the person died, he did the best he could.
Avraham reaches the DB of the drone, where all footage is kept and uses the footage to protect him in court.
Dekel, 57, is the Vice President of Technological Renewal in the Tel Aviv Municipality.
He was recently approached by a number of neighbors from the beach who complained that the rescue calls were interfering with them at noon.

Lifeguards complained that the bathers did not respond to them quickly enough until they realized they had been approached, thus reaching life-threatening situations. He decided to find a new way to help the lifeguards to monitor the beaches with less noise and public interferens.

2.2. The Approach

Our product will include -

A controllable Drone with facilities for monitoring the area and communicating with swimmers.
An application with a GUI that enables managing the drone easily without knowing how to fly one.
We will do this by defining an observation zone and the drone will be configured to fly there by clicking the home button.
The lifeguard will touch the real-time display and the drone should move to the selected location (touch & go).
This will happen by calculating and converting the image pixel coordinates on the LG's screen to real-world coordinates in terms of direction, acceleration and speed with the minimum deviation.

In order to have the best fit we will meet lifeguards, elicit their specific needs and present them with our idea so that our system satisfies their needs.

- The system will allow the users to control the drone and all its functionality from the web app.
- The system will include a GUI- drone control and additional features.
- The system will display all video streams live with no delay.
- The hardware of the system will include a drone with a video camera, a microprocessor with a speaker and a microphone.

2.3. Constraints

- Drone - The project depends on the existence of a drone which will provide a better image of the beach area to the lifeguards.
- Microprocessor
- Web App - We must have a web app which will allow the end-user to control the drone and all of its functionalities for better and faster assistance.
- Open API - We need to assure that the chosen drone will allow us to use its API for our needs.

3. Functional Requirements

Monitoring	
Description/Functionality	Number
The drone will report its location.	3.1.1
The drone will share live stream video.	3.1.2
The system will allow the user to return the drone to its charging station.	3.1.3
The System will allow the LifeGuard to communicate with the bathers.	3.1.4
The drone will have predefined borders of monitoring.	3.1.5
The system will have a predefined Observation Point.	3.1.6

Emergencies situations	
Description/Functionality	Number
The drone will be able to return to its charging station when it recognizes a low battery situation.	3.2.1
The drone should be big enough to withstand the high winds of the sea, and carry the extra weight of the add-ons.	3.2.2
The system will allow the end-user to move the drone to a selected location by clicking on a specific point on the visual picture received from the drone.	3.2.3
The system will allow the user to control the drone on the horizontal & vertical axes.	3.2.4
The system will prevent the user from descending too low (lower than 4 meters) to avoid collusion with bathers or other obstacles.	3.2.5
The application will enable the user to turn on the external audio devices.	3.2.6
The system will send coordinates/directions according to the area the user clicked on the screen.	3.2.7

Post Mortem	
Description/Functionality	Number
The system will allow the user to view all previous drone videos.	3.3.1
The system will allow the user to crop edit and delete the videos.	3.3.2
The system will allow the user to have access to the Post Mortem videos any time.	3.3.3
The system will save the drone footage automatically to the DB.	3.3.4

General	
Description/Functionality	Number
The system will allow the lifeguard to login and identify himself.	3.3.1
The system will display statuses such as battery percentage and drone altitude.	3.3.2
The drone will report its location.	3.3.3
The system will save the drone footage automatically to the DB.	3.3.4

4. Non Functional Requirements

Application	
Number	Description/Functionality
3.1.1	The data will be stored in the database for a period of time selected by the user.(With a time limitation of 90 days).

Drone	
Number	Description/Functionality
3.2.1	The drone will have the capability of carrying the add-ons equipment weight.
3.2.2	A camera, speaker and microphone will be installed on the drone.

Hardware	
Number	Description/Functionality
3.3.1	Video streams will have minimal latency.
3.3.2	The drone will include a GPS sensor that indicates its location.
3.3.3	Camera, speaker and microphone will use an external battery.

5. System Flow

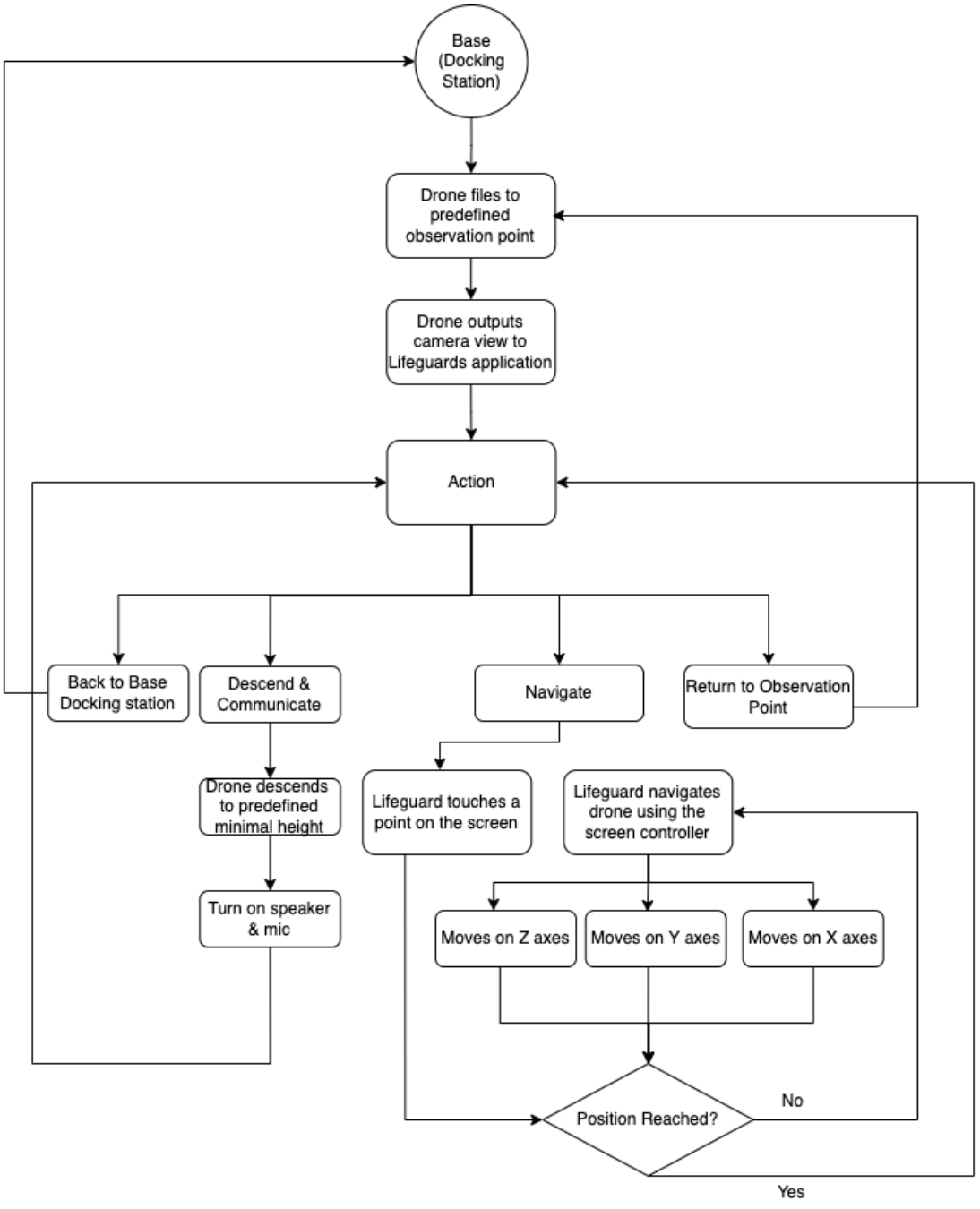

Figure 5.1: Drone basic flow.

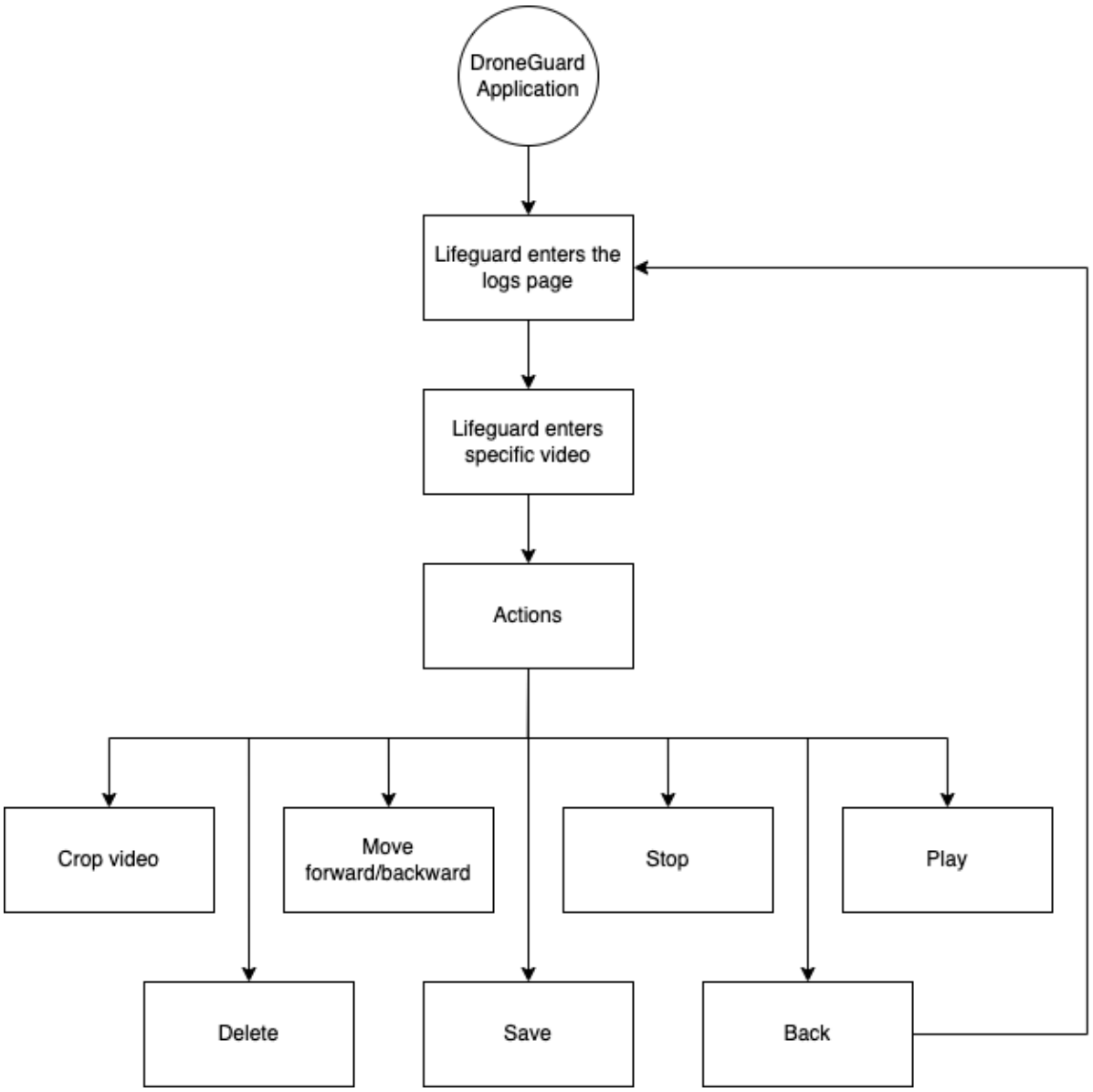

Figure 5.2: Post Mortem diagram.

6. Risks Management

Hardware:

- A potential risk is that the hardware components that we will choose won't work properly together or won't satisfy our needs for the project. We'll need to investigate them carefully and do a lot of research about the best components for our project.
- The delivery time of the hardware component, due to the world wide shipping issues and the lack of chips, there is an option that the component will arrive later than expected. We will need to do the ordering as quickly as possible or buy it in Israel(though prices will be much higher..).
- The drone can crash while testing its functionality when it tries to land for reasons such as strong wind, human mistake, or software error. We'll do our best to test the drone carefully.
- Assemble the drone (we will buy the parts separately - reduces costs) which is a knowledge we do not have. We will deal with this with the help of a drone expert, the hardware lab at Shenkar and guides from the Internet.
- Another big risk is the voice communication between the LG and the drone. We will do research if it's possible and if it is we will check whether we can buy the required equipment with our limited budget.

Software:

- Issues can occur due to a lack of API's documentation or incoherence. In this case, we'll try to have a reference from a working project on GitHub (or any other open source code platform) and figure out its use.
- A complex action to perform is when the lifeguard touches the real-time display and the drone should move to that location (touch & go).
  The complexity that comes with that action is how to calculate and convert the image on the LG screen to 'real-world' coordinates.
  We will handle the risk by preliminary proof that converting the coordinates from the touch screen to the coordinates in real life is possible.
  Once we succeed, we will move on to pulling the data from the touch screen click and synchronize the movement of the drone to the point without any actual operation of the LG.

Interpersonal:

- Since all of us have jobs, planning and availability can be difficult to manage and overcome. We'll use a detailed schedule (using a dedicated management system such as Monday) in which we divide the work so that missions won't be missed.

7. System Screen Specifications

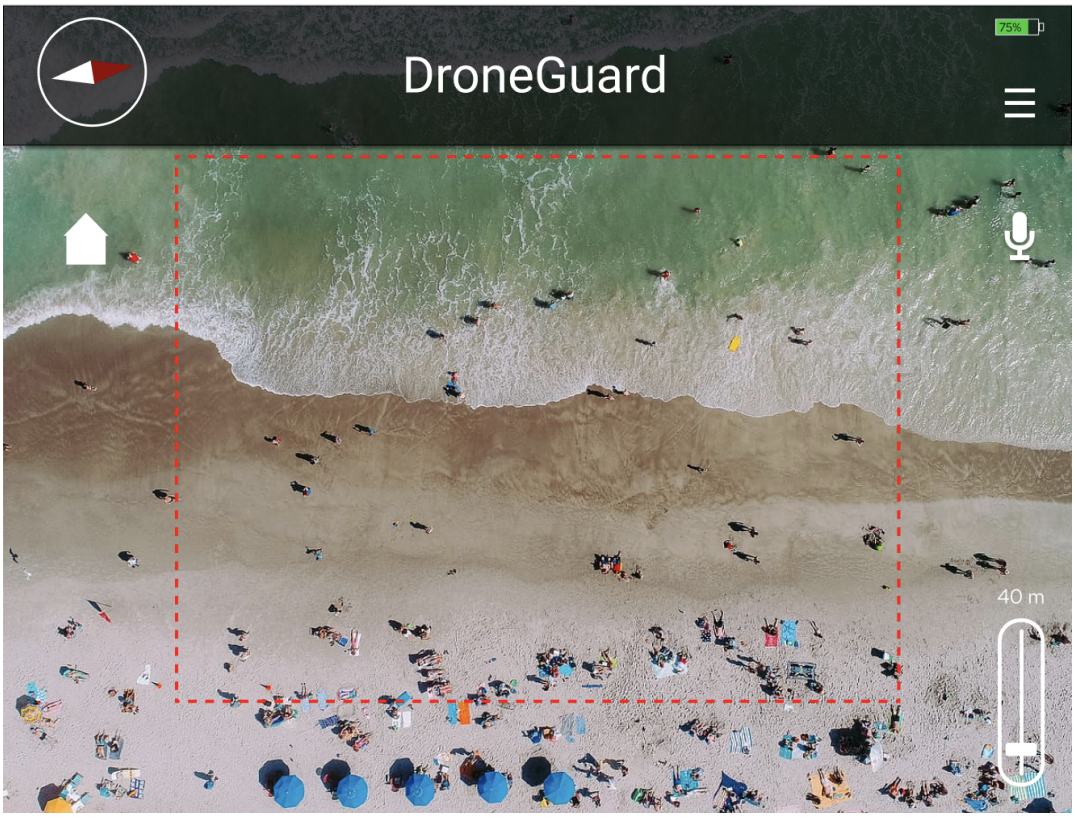

Figure 7.1: DroneGuard located at the observation point.

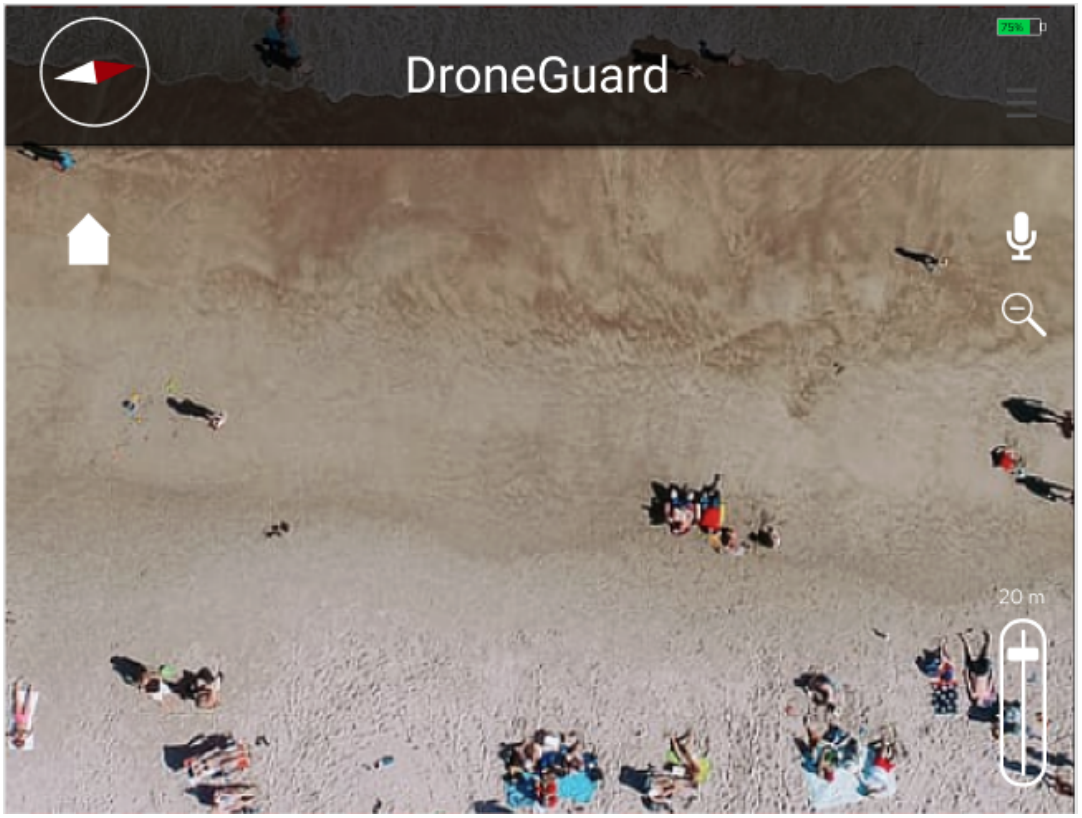

Figure 7.2: DroneGuard located at the chosen location (Zoomed In)

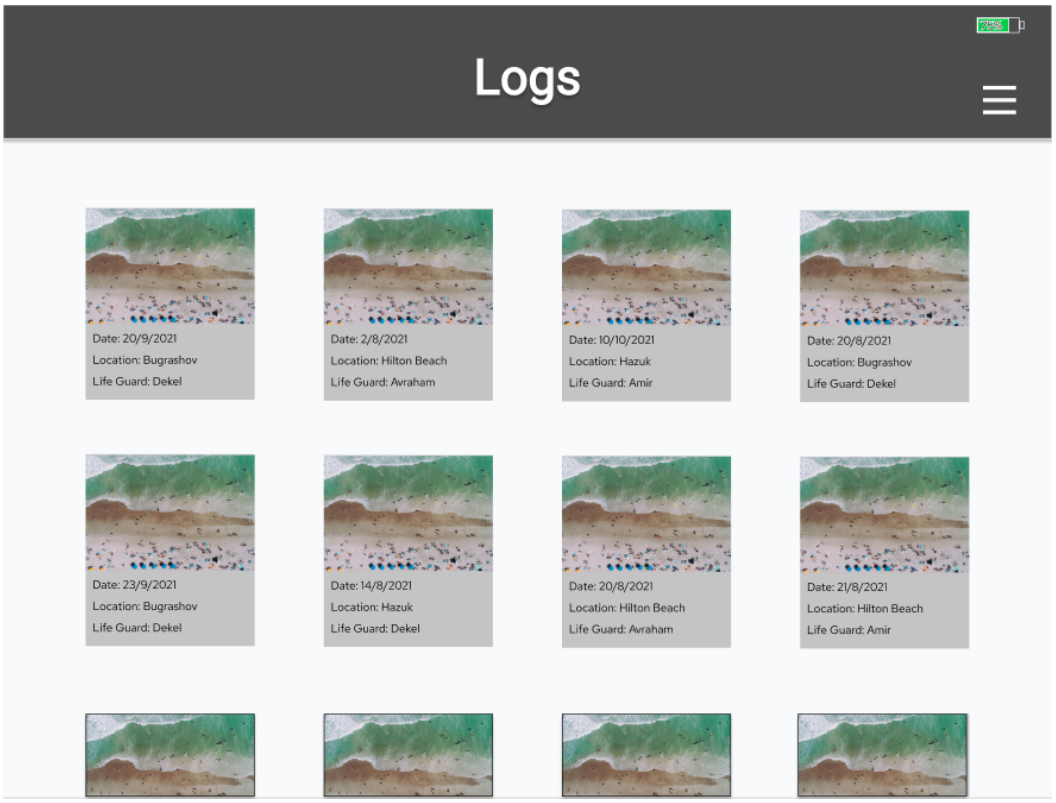

Figure 7.3: Post Mortem page with all of the previous DroneGuard records.

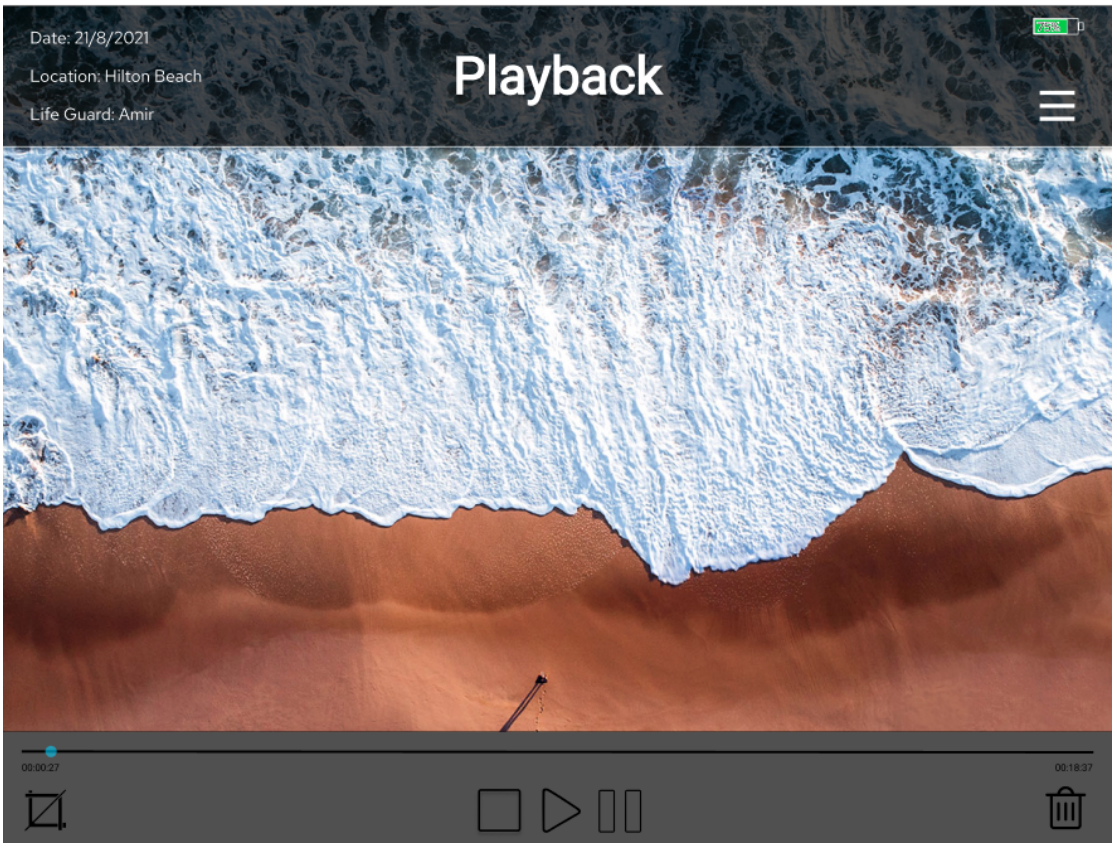

Figure 7.4: Post Mortem, video editing page.

8. Non Goals

- The drone will not actively save bathers' lives, but will allow the lifeguards to monitor the beach better than before.
- The Drone will not use Image Processing.
- The drone will not throw life saving objects.

9. Open Issues

Hardware - we are still investigating which drone and which microprocessor is the best fit for our intention.
Software - We are not sure if the APIs of the drone we will get will give us all the functionality we need for the project.

10. References

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