Realtime Earth

IQP REPORT

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DEVELOPING A USER INTERFACE FOR LIVE TRACKING OF WILDFIRES

An Interactive Qualifying Project
Submitted to the Faculty of

Worcester Polytechnic Institute

In partial fulfillment of the requirements of the Degree of
Bachelor of Science

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Submitted to
Professors Balistrieri and Eddy
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Cover photo by Ted Clifford

ABSTRACT

Wildfires are on the rise. However, our project aims to reduce public fear surrounding these burns. Our team created a mock-up of a FireTracker web application. This application will allow the general public access to live and updated information about wildfires as they occur. By making the behavior of wildfires predictable, we hope to reduce public fear that is produced by the unknown.

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Stephen Guerin and the Simtable Team

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Professors Thomas Balistrieri and Zoe Eddy

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Worcester Polytechnic Institute

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CONTRIBUTIONS

This report was written by Abigail Leonardi and Hayden Smith.

The user interface and user experience digital mock-ups were created by Dylan Gerisch, Abigail Leonardi, Collin Levin, and Hayden Smith.

The user interface and user experience interactive mock-up was made by Abigail Leonardi and Hayden Smith.

The instruction guide for the user interface and user experience mock-up was created by Dylan Gerisch, Abigail Leonardi, Collin Levin, and Hayden Smith.

The content of the installation video was written and created by Dylan Gerisch, Abigail Leonardi, Collin Levin, and Hayden Smith.

The production of the installation video was completed by Dylan Gerisch and Collin Levin.

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Executive Summary

Wildfires are surrounded by an atmosphere of uncertainty and fear, due to their destructive nature. In times of crisis, the public lacks critical up-to-date information to understand the location and movement of fires. In addition to the general public, first responders are often undersupplied with information about the movement of the wildfires they are fighting. In a society filled with technology and image-capable devices, there is a faster way to retrieve information in comparison to current news sources. By turning all points of focus to a wildfire within the first few hours of its development, the wildfire can be readily located, observed, and analyzed. Analyzing wildfires is crucial as it is possible to predict the future movement of fires and strategize a solution to extinguish them. Populations are negatively affected by a lack of information when it comes to forest fires. Such missing and late information can lead to unwarranted panic and anxiety. Therefore, people stand to gain significant benefits from increased wildfire awareness and tracking. Fear and wildfires appear to be inherently linked concepts, however, one company in New Mexico is creating technology as a way to change this. People working in unison with technology have the potential to create a collectively intelligent society, absent of fear generated by the unknown.

Our team had the privilege to work with Simtable, a small technology company located in Santa Fe, New Mexico. Simtable is a company on the cutting edge of visual data modeling. Their most notable product, as indicated by their name, is the Simtable. The Simtable is essentially a sandbox onto which many different simulations are projected. The ordinary sandbox is thereby turned into an interactive surface that users can engage with and model a variety of scenarios. The most typical use of modeling is constructing terrain using the sand, and simulating wildfire progressions. This tool is currently in service to train fire departments to become adept at handling a number of different wildfire scenarios.

Stephen Guerin is the CEO of Simtable and served as the sponsor for our team. Guerin and his company are in the midst of developing the next generation of wildfire modeling technology. The latest version is intended to be virtual and accurate to model real-time wildfires as they occur. This technology would revolutionize the current information behind wildfires, as there is currently a severe deficit of fast accurate information. The software in development is called Realtime Earth. Realtime Earth appears as a google earth 2D/3D model of the world. However, the application will have the capability to predict and display real-time events, such as wildfires, onto the model. The outcome of such technology is that the public will have access to critical information at a speed unmatched by current news sources.

We were tasked by Simtable to create an application concept that would facilitate the spread of emergency information about wildfires. During our time in Santa Fe, New Mexico our group had a chance to experience first hand the current shortcomings of the fire information system. On October 27th, 2021, we looked out the window from our Fort Marcy Hotel and saw smoke rising from the hills. There was a fire burning. No information up to this point had been released to us about its presence or what actions to take next. Luckily, our sponsor notified us that it was a prescribed burn. This meant it was a fire that was started and controlled by the fire department so we had nothing to worry about.

However, if this were the case of an uncontrolled burn, it is clear how quickly the situation could spiral due to the lack of information provided to the public by governmental services. This public unawareness in times of wildfire was the clear pain point Simtable's technology was looking to target. Their solution involved crowdsourcing the public for information in order to learn about fires as soon as they occurred. By calling upon this concept of collective intelligence, where many individuals work to assemble data together, information can move at a pace unrivaled by current government news sources.

Executive Summary

We decided to create a user-interface user-experience (UI/UX) mock-up for a web application called FireTracker. FireTracker was designed for the public to be able to report a fire, see where a fire is located, and upload images of fires with ease on their mobile device. It relies on public submission of images to generate data for the application, employing collective intelligence. The web application then will use those images as input data to the software. The application will go through a number of processes using annotation, calibration, and triangulation to extract key information about the wildfire. The end product results in the ability to accurately locate the fire. With a continuous stream of information, a fire's location can be continuously updated and released to the public.

Much of the fear surrounding wildfire stems from their unpredictable nature. We hope that giving fast, accurate information to the public will help reduce the fear regarding wildfires as they will become calculable. Individuals will know in advance whether they are in danger and will be able to make plans before the wildfire becomes an imminent threat.

In order to accomplish our deliverable, we utilized semi-structured interviews and focus groups. We interviewed Simtable employees about FireTracker to gain insights into the important features of the app. Every employee had a unique perspective on the app concept and provided useful information. After the interviews, based on their answers, we were able to efficiently create our first iteration of the mock-up.

We then held a focus group with the entire Simtable team to present our mock-up. They analyzed our mock-up using a modified SWOT analysis. The focus group was conducted by asking the group what the strengths, weaknesses, opportunities, and technical aspects of each feature were.

From their feedback, we recreated our entire mock-up. We revitalized the design and added features that members of the group deemed important.

Our group was successfully able to complete our UI/UX web application mock-up relatively early within the IQP process. As a result, we aimed to expand the reach of our project. Our team came up with the idea of an installation to be displayed at Worcester Polytechnic Institute (WPI). The installation is meant to provide a cross-disciplinary connection on campus, and showcase the revolutionary technology created by Simtable. The original installation idea consisted of four components: a miniature simtable, a video, a map, and portrait images. Each element within the display was meant to be in direct relation to the web application mock-up which was created for Simtable. The display would simplify the application down to fundamental concepts and practices and display them in a visually interactive way.

With Simtable's latest technology, the behavior of wildfires can be displayed and predicted. As a result of public understanding of how wildfires spread, the fear surrounding such natural disasters can be reduced. With our FireTracker application, the public can engage with the community to monitor wildfires. By sharing information, the public eliminates the dangerous uncertainty around wildfires. Our group was successfully able to complete our deliverable in the form of a UI/UX web application mock-up for a FireTracker app. Additionally, our group created an instruction guide for how to navigate the app and produced an interactive mock-up for Simtable. Beyond our deliverables for Simtable, our team also completed an installation for Worcester Polytechnic Institute (WPI) in a tribute to Simtable's technology and global projects. In the future, our project aims to reduce panic about wildfires and make the world collectively intelligent.

Background

Wildfires are dangerous natural disasters that happen around the world, but there are ways technology and the local communities can work together to help keep people safe. Areas all over the world including Europe, Australia, North America, and the Amazon have been significantly impacted by wildfires (Brajkovic et al., 2021). Changing environmental factors have an impact on the frequency and severity of wildfires. These wildfire-inducing factors include climate change, dry environments, and human interference (Brajkovic et al., 2021). Globally, climate trends have impacted wildfire risk due to global increases in average temperature, the extent of heatwaves, and the frequencies of droughts (Jones et al., 2020). The impacts of wildfires go beyond physical objects; they also involve what people cannot see. When people lose homes due to wildfires, the memories associated with those homes are destroyed as well (de Vet et al., 2021). Lives are severely altered after encountering such a disaster, and with environmental factors on the rise, more individuals will be placed in danger.

New Mexico and Santa Fe are locations indicative of this wider problem. In recent years, wildfires have been getting increasingly worse, especially in Santa Fe (Smallwood, n.d.). The city of Santa Fe has long experienced wildfires due to its dry forest ecosystem (Mueller et al., 2020). However, before European settlement in the region, there were only recurring surface fires that had low severity (Mueller et al., 2020). In order to clear excess brush and oils from the forest floor, fires must occur naturally in small surface fires. However, due to a fear of wildfires, humanity has tried to stop them from happening. From wanting to mitigate wildfires, fire departments have allowed a surplus of fuel to gather on forest floors. If a fire started in an area with high fuel levels, it would turn into an uncontrollable wildfire. In realization of this, many areas have started conducting prescribed burns to keep the number of combustibles in the forest low. Prescribed burns, also known as Rx burns, are fires that are purposefully started by the fire department to burn a specific part of a forest. If a natural wildfire started near an Rx burn area, it would slow down or stop because there would not be enough fuel for it to continue. Santa Fe is one of the cities that have been using prescribed burns to lessen the severity of their wildfires. The Santa Fe Fire Department predicted that Santa Fe wildfires would be severe this year [in 2021] (Traxler, 2021). Due to an ecological drought, these predictions have proven accurate (Traxler, 2021). Recently, New Mexico has been affected by multiple wildfires. In June 2021, a fire northeast of Santa Fe in the Pecos Wilderness destroyed about 150 acres of forest (Ruggles, 2021). This fire was “at least the third major wildfire in recent weeks in New Mexico and the second in Santa Fe National Forest” due to the extended drought (Ruggles, 2021). Unfortunately, some fires end up taking the lives of people. In 2013, nineteen Arizona firefighters lost their lives protecting citizens from the Thompson Ridge Fire in the Jemez Mountains (Jadrnak, 2013). This frequent wildfire activity shows that Santa Fe, and the areas around it, are in need of real-time wildfire information to make sure that people can stay safe and away from fires.

Stephen Guerin, the CEO of Simtable, served as the sponsor for the Realtime Earth project. Simtable LLC is a small technology company based in Santa Fe, New Mexico. Simtable is known for their cutting-edge developments in the world of modeling utilizing concepts like agent-based modeling and data visualization. Simtable’s mission involves educating the public about the behavior of fires and how to manage hazards in their neighborhoods.

Since Simtable LLC is in Santa Fe, they have experienced the significant threat of wildfires in the Western parts of the United States and understand the critical nature of fires. One major piece of technology Simtable is known

Background

for is its sand simulation table. This literal "Simtable" is used to assist with firefighters' understanding of how fires will spread given a specific terrain and environmental scenarios. Their current technology is highly effective and successfully engages users. The table's 3D interactive experience helps convey their messages of the urgency behind managing wildfires.

Simtable's latest iteration of their wildfire visualization technology is Realtime Earth. Realtime Earth involves engaging the community to help provide coverage of wildfires as they occur; the application then synthesizes this critical information within a 3D modeled Earth. The modeled Earth is planned to then be accessible online to the public. The Realtime Earth application would allow for instantaneous informational updates on the movement of wildfires as they occur. The application will be used to broadcast real-time information in order to help public safety officials and the local community stay informed during potentially life-threatening natural disasters.

FIGURE 1.

Realtime Earth Team Photo

Note: From left to right Abigail Leonardi, Dylan Gerisch, Collin Levin, Hayden Smith

THE PLANNING

Week One

	10/17/2021	10/18/2021	10/19/2021	10/20/2021	10/21/2021	10/22/2021
		Team meeting with prof B	Team meeting with prof B	UIUX Readings Due	Team meeting with prof B	12pm meeting with prof B
		10:30 Simtable Team Meeting	Create presentation	Create presentation	Create presentation	2pm meeting with prof B and stephen
		Visit Simtable - meet Kaz and Stephen				Revise proposal
1						

The original project that was assigned to our team was very different from what we accomplished in our time here in Santa Fe. It started as a user interface and user experience (UI/UX) project, similar to what our project ended up being. However, we were going to provide recommendations for Simtable about their UI/UX for their calibration software in Realtime Earth. Realtime Earth is an unfinished web application in which users will be able to view information around the world in real-time. It is akin to Google Earth, but it is more modern and will provide live updates. By the time we arrived in Santa Fe, the Simtable team planned on completing their calibration system for us to test. The calibration system was created in order to calibrate Alert Wildfire (AWF) cameras. AWF cameras are scattered around the west coast dedicated to spot wildfires.

Before coming to Santa Fe, our team had several meetings with our sponsor Stephen Guerin, the CEO of Simtable, in order to establish a clear understanding of our project. Each week Stephen would introduce to us a new facet of his software and the potential impact it could bring to the world. He showed us how image calibration of cameras could be mathematically figured, overlays of constellations to deduce timestamps of images, the Realtime Earth modelling software of lava flows, and more. He explained who would benefit from the software by describing the emergency response personnel system, talking about how the public could be involved through gamification, and how even insurance companies would be impacted. Every week our field of view appeared to get bigger. We began to feel overwhelmed at the scope of the project and tried to hone in on a singular point of focus that we could orient our project towards. It wasn't until after all of the meetings that we realized he just wanted us to understand why what we were doing mattered.

When we got to Santa Fe, our team quickly realized the idea which we had latched onto following our Simtable meetings was not representative of the project we would be tackling. More different ideas surrounding Realtime Earth were introduced to us, and we found that the software was subdivided into several different components. The development process was still underway for Realtime Earth's calibration software and "observer" software and public engagement was a goal the team had envisioned for the future.

Our team ended up conferring with our advisors to try to help hone in on a singular focus for the project.

FIGURE 2.

Realtime Earth Software

Note: Simtable's Realtime Earth software screenshot of homepage

FIGURE 3.

Stellarium Constellations

Note: Stellarium constellation overlay used by Simtable to calibrate images in the manual process

FIGURE 4.

Worcester Stars

Note: Image taken from Worcester park used to walk-through manual calibration process with EXIF data

We came up with a few tentative proposals of what we felt we could successfully contribute to Realtime Earth over the course of a 7-week project. We drafted up a brand new proposal to present to Guerin. The proposal contained plans to engage with the public in order to determine what type of features they would find useful in the Realtime Earth software. However, Stephen Guerin informed us that these plans would not be beneficial to his ultimate product. He had already been in communication with his main stakeholders, firefighters, and felt that he accurately understood what would and would not benefit the current system. We then continued to discuss about what our team could realistically achieve in seven weeks that would benefit Simtable. Our criteria was strict that we needed a deliverable and had to incorporate social science into our methodology in order to satisfy the IQP requirements for our school. With this criteria in mind, Stephen thought of new forms for the project to take.

Our proposal consisted of a single deliverable: a UIUX mock-up for a future "cloud capture" application in the form of a google slides presentation. The purpose of this imagined cloud capture application would be a training tool for the public. It would provide the public with a platform to take images of clouds and calibrate them. The calibration of multiple images of the same cloud would enable the cloud to be represented in 3D space. Ultimately, this application would be expanded. Instead of clouds, images of smoke plumes from wildfires could be submitted. The 3D representations would then be able to be accurately transferred to the Realtime Earth software in order to show a visual model of fire progression as it occurred.

In order to accomplish this, we intended to go through the process of manual calibration with the Simtable team to get a clear understanding of the process. We then intended to take images ourselves, in an attempt to triangulate a cloud and then follow the manual calibration process. Following this, we would meet with the Simtable team individually and conduct interviews to discuss what CloudCapture was in their perspective. Our team would then produce a UIUX mock-up based on the interviews, and finally host a focus group with the Simtable team to review our deliverable.

Our team contacted Stephen with a written document outlining our aforementioned goals and waited to hear back. We were hopeful that our sponsor would approve our improved project proposal. While we were waiting for him to reply, we decided to embrace CloudCapture and capture some clouds ourselves. We went into the gorgeous Santa Fe mountains and took a few time lapses of the clouds, along with photos. However, we did not receive a response from him that evening. This is where our advisor, Thomas Balistrieri, stepped in. He held a meeting with our sponsor the next day, on a Saturday, to talk to him about our proposal. The meeting lasted about three hours. The events of this meeting are unknown, but they were successful. A few hours later, we received a document from our sponsor defining our project along with his expectations of us. After receiving the document, we all felt a sense of relief. We could finally start working on our IQP.

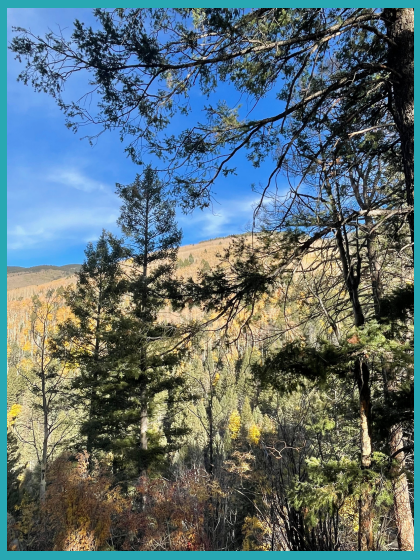
FIGURE 5.

Hyde Park Cloud Timelapse

Note: Team imagery of clouds at hyde park road using a tripod

FIGURE 6.

Hyde Park Cloud Still



Note: Image of clouds at hyde park road

THE BEGINNING

Week Two

	10/24/2021	10/25/2021	10/26/2021	10/27/2021	10/28/2021	10/29/2021
		Work on presentation	9:00 Prof B Presentation	Respond to Simtable employees via slack	10:00 Advisor Meeting	
		10:30 Standup meeting	10:00 Kaz Calibration meeting - - Passcode: 5Z91^h1	9:30 Standup Meeting	10:30 Fire Meeting	10:15-11:05 Venice Fabio Meeting
		3:00 Stephen Meeting	Extrinsics video: https://www.youtube.com/watch?v=LRAj21y23r8	2:00pm Interview Marcos (at office)	11:00 Zoom Meeting with Emma	11:15 Stephen Zoom Meeting
2			Calculate the minimum camera distance	Calibrate images	2:00pm Zoom meeting with Cody	Work on Mock-up
			Send slack out to all simtable employees	Pictures of perscribed burn	10 minute presentation run	3:30 Show and Tell Meeting
			3:00pm Meeting Advisors + Sponsors	~~6:30 Presentation~~	Message Stephen	Practice Presentation

At the start of week two, we were excited to begin our newly defined project, so we did not waste any time. First, we contacted six Simtable employees that we wished to interview. During the briefings we attended, we discovered that only four employees understood the CloudCapture app. Nevertheless, we decided to conduct semi-structured interviews with six out of seven employees (See Appendix A). During the first half of the week, we were able to conduct three interviews. The results of the interviews helped us gain an understanding of what features and ideas the employees imagined in the CloudCapture app. Every employee had valuable insights, from what software to use to make our digital mock-up, to what the app's purpose would be. From these first interviews, we realized that a camera, a map, and a group feature were going to be three of the most important parts of the app. A camera would be useful to take pictures of clouds, a map would be useful to see what clouds have been captured in the sky, and the group feature would allow people to take photos of the clouds at the same time, making the calibration process easier.

The calibration process is intensive. In order to calibrate properly, the intrinsic and extrinsic data of the camera are needed. Extrinsic data involves the orientation and location of a camera. Intrinsic data involves the focal length and field of view of a camera. After this information is collected through Exif data given by the photo, the manual calibration process can begin using Simtable's calibration software. Exif data is the intrinsic and extrinsic information that is associated with a photo.

However, it is easier to calibrate there are multiple pictures of a cloud that were taken around the same time. With at least three photos, triangulation can be used to locate where the cloud is in a 3D space. By making each pixel from a photo into a vector, points will intersect with vectors from other photos, which we are then able to locate in a 3D space. Photos taken at the same time are easier to calibrate with each other since clouds move quickly and change shapes.

After learning about how calibration works, we decided to

FIGURE 7.

Sun and Moon Mountain Pecos Trail Camera

Note: Dylan Gerisch and Collin Levin's photo of the Sun and Moon mountains

FIGURE 8.

Sun and Moon Mountain Cross of the Martyrs Camera

Note: Abigail Leonardi's photo of the Sun and Moon mountains.

FIGURE 9.

Sun and Moon Mountains Alert Wildfire Camera

Note: Hayden Smith's photo of the Sun and Moon mountains from the Alert Wildfire camera.

exercise the concept of collective intelligence and demonstrate the calibration process ourselves. Collective intelligence is the process by which individuals gather data for the purpose of solving a larger societal issue. Our team photographed three images of the clouds around the Sun and Moon Mountains, the name of two mountains in Santa Fe, from different vantage points at the same time. All of the members of our team dispersed around Santa Fe to take photos. See Figure 9. Collin and Dylan went to downtown Santa Fe, Abi took a photo from the Cross of the Martyr, and Hayden took a screenshot of the live camera feed from an Alert Wildfire camera. The images were taken from different positions to simulate how the public would take photos of the clouds using the web app. The photos were taken within the same minute, so that it would be easier to calibrate the images and find similarities in the clouds, as previously mentioned. This process made it more clear that a camera, a map, and a group feature would be very useful to include in our mock-up of CloudCapture.

Halfway through the week, on October 27th, the City of Santa Fe Fire Department (SFFD) started a prescribed burn around 10 in the morning. The wildfire burned within the Santa Fe Watershed, which was visible from our housing at the Fort Marcy Hotel Suites. Our liaison, Stephen Guerin, sent us a message around 11am, informing us that the wildfire was a prescribed burn. Before that, we did not know what was causing the vast amounts of smoke. But, we were not the only ones, since there was a little amount of information released about the burn. The controlled burn was mentioned in the town hall meeting the day before, of which there was minimal attendance. Then on the day of the fire, the SFFD sent out a text alert via Alert Santa Fe, an emergency notification system the City of Santa Fe uses to make its citizens aware of emergencies. However, this alert was sent out hours after the prescribed burn started and was only sent to those who were already signed up for Alert Santa Fe. This meant tourists, like us, and others who did not sign up for the notification system were not informed about the burn. Due to a lack of fast, widespread information, there were 92 phone calls made to 911 on that day to report the fire. Most of those calls could have been avoided if they had a better system to report and view fire information.

After our experience with the prescribed burn, and during our fourth interview later in the week, our sponsor suggested that we take CloudCapture in a new direction. We all felt that the information flow from the City of Santa Fe was too slow and that the 92 emergency calls were unnecessary, so we decided to create FireTracker. Instead of locating clouds, FireTracker will locate fire plumes and wildfires. Using collective intelligence, users will be able to report, locate, and track wildfires in real-time. With this app, citizens will no longer have to wait hours to get important information about wildfires. Instead, they will have that information constantly at their fingertips. That way, if the fire has already been reported, there will be fewer phone calls to 911, so then they can respond to other pressing emergencies.

FIGURE 10.

Camera Triangulation of Sun and Moon Mountains

Note: Map of camera locations to photograph the sun and moon mountains

FIGURE 11.

October 27th Prescribed burn

Note: Photo of the prescribed burn from Fort Marcy Hotel Suites.

FIGURE 12.

92 Emergency Calls

Note: On the day of October 27th, there were 92 phone calls made to 911 about the prescribed burn

FIGURE 13.

Prescribed Burn on the Ground

Note: Photo of the burned forest floor that is now clear of brush and oils.

Week Three

	10/31/2021	11/1/2021	11/2/2021	11/3/2021	11/4/2021	11/5/2021
		9am Practice Presentation	Confirm focus group time/date	9:30 Stand-up Meeting	9:00 Website Meeting	Outline/Prep for final IQP deliverable
		10:30 Standup meeting	Work on Mock-up	Work on Presentation	10:00 Advisor Meeting (Show mock-up)	Confer about Stephen attendance
		Meet w Advisors about final pres idea	Code Stephens Interview	Kaz Interview 2:00	10:00 Advisor Meeting (Show mock-up)	B and Eddy Meeting
3		Stephen Interview (2pm - in person)	1:00 PM Josh Inteview	Code Kaz Interview	Define focus group features and questions	3:30 PM Show-and-tell meeting
						Work with Calibration software (test group for Simtable)
						Revise executive summary
		3pm Advisor Meeting	Consolidate Interview Information	Revise Mock-up	Prep for focus group (email all simtable employees)	Presidential award research
		6:30 Presentation	Work on Mock-up	6:00 Update Presentation	Executive Summary	Cloud Pictures

During week three, our team began to find our rhythm and make significant progress within our project. Our first task was completing the second half of our interview with the Simtable CEO, Stephen Guerin. Following Stephen Guerin's interview, we intended to meet with Josh Thorpe, Simtable Chief Technology Officer. Guerin and Thorpe were the founding thinkers behind the "CloudCapture" application concept. Both of their interviews provided critical information to clarify the purpose of the "CloudCapture" application.

Before we could attempt the design of the mock-up, we needed to understand the goals and intentions from the creators. Both Guerin and Thorpe's interviews provided critical information to clarify the purpose of the web application.

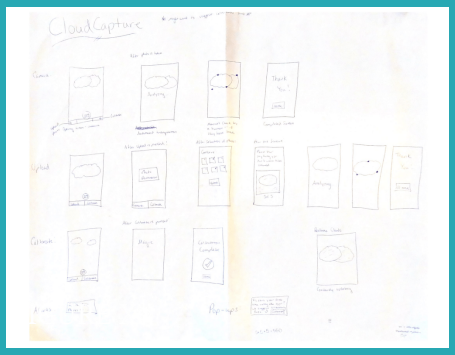
Following these interviews, our group had a near-tangible vision of our intended user interface user experience mock-up. The application was meant to be a training tool for the public. The ultimate goal was to track wildfires in real time, by relying on the public for image submissions of wildfires. All the previous work our group had put into photographing images of clouds and smoke plumes suddenly had a renewed purpose. Our group had been walking through the future path of the general public who would be tasked with taking similar images.

The benefits of the technology would be far-reaching. The application would be used to realize an accurate and real time model of wildfires. With the availability of this model, firefighters would have access to the most up-to-date information. As a result, they could confidently adjust their plans for containing the fire as the situation evolved. The public themselves would be able to have access to news about the fire immediately. They would no longer have to wait hours for a local government or fire department to provide coverage on the event. Individuals would be able to open up our fire tracking application and instantly determine whether they were in danger and could make plans.

The interviews provided a mutual understanding of the application's purpose amongst our team. Following the conclusion of the

FIGURE 14.

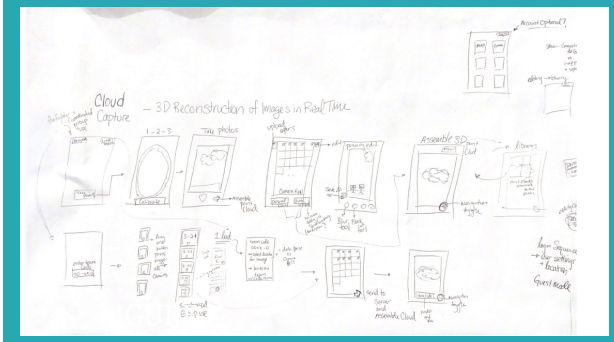
Smith Individual Mock-up



Note: Hayden Smith original paper mock-up draft

FIGURE 15.

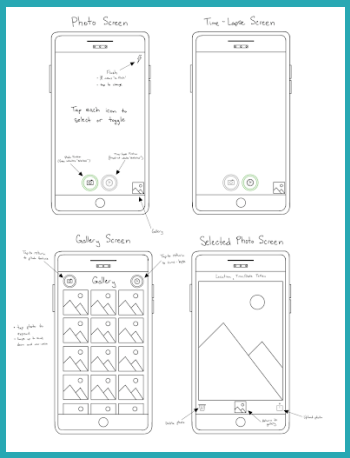
Leonardi Individual Mock-up



Note: Abigail Leonardi original paper mock-up draft

FIGURE 16.

Levin Individual Mock-up



Note: Collin Levin original paper mock-up draft

interviews, each member of our group was tasked to create their own individual mock-up. As evident in Figures in 13, 14 and 15 we made a point to create these mock-ups independently, based on the results of our interviews and conclusions from the coded results.

As a team, we decided that each of us would create a mock-up separately in order to minimize group bias. Afterwards, we came together to share ideas in hopes to maximize the creativity of the group. We came together the following day to share our individual ideas, with the intention of taking the best pieces of each mock-up and creating the final draft as a group.

We deliberated over every detail of the mock-up and drawing out a larger scale copy onto a whiteboard. Once a screen design was finalized it was copied onto a larger sheet of paper which served as our guiding mock-up seen in Figure 16.

We spent the following day translating our paper mock-up into a digital format using a platform called Miro.com. We created 17 different screens that we envisioned being used to implement the application (See Appendix D). The home screen was targeted towards layman users who would be able to easily navigate the simplified screen seen in Figure 17. The basic features included a map to show the updated location of the wildfire, and a camera in order for a user to submit their own images.

Upon the completion of the Miro mock-up screens, we assembled a powerpoint of the images. We presented our mock-up to our advisors and WPI colleagues during our status updates for the week. At this point, we were told technically we had met the expectations of an IQP. By week 3, we had accomplished all of our interviews and created the expected deliverable for our sponsor. Despite this, we were advised to continue working and attempt to think bigger.

As a result, we dreamt up the idea of bringing the Simtable technology back to Worcester. We had witnessed first-hand the awe inspiring capabilities of this technology. Users have the opportunity to sculpt terrain upon the sand. The interactive simulations allow for projections of wildfires and for users to engage with technology. We wanted all students at WPI to be able to experience a fraction of this awe.

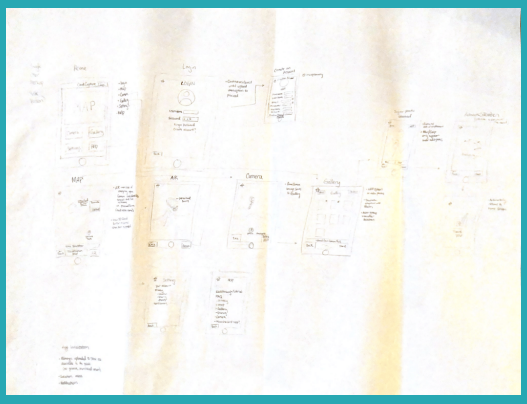
We wanted to bring the Simtable back to Worcester, but we wanted to do it in a way which made the project our own. As a result, the idea of a permanent WPI IQP installation was formed. The original vision was scribbled up consisting of 4 components seen in Figure 18.

The largest component was planned to be a map. The map would be the backdrop of the entire installation and show the city of Santa Fe. On top of the map, photographs of the October 27th fire would be pinned in their respective locations. String would be used to link the images together, depicting their distance from the prescribed burn outlining the process of triangulation.

A smaller version of the Simtable, created by us, would be placed in front of the map. The table would display a simulated model of the prescribed burn projected over the sand. Corresponding to the fires progression, a video depicting the storyline of the prescribed burn would be played. The video

FIGURE 17.

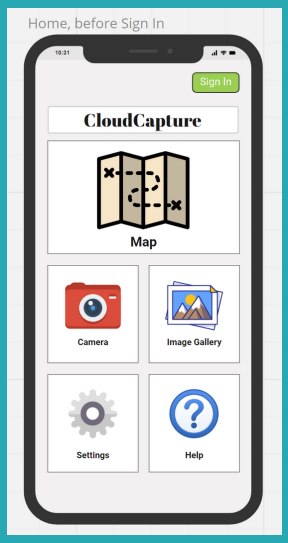
First Draft of CloudCapture



Note: Group mock-up paper first draft

FIGURE 18.

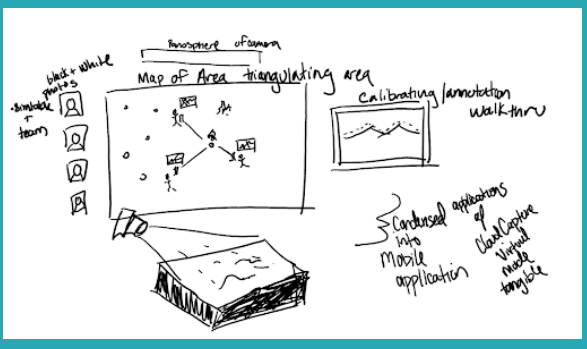
Original MIRO Homescreen



Note: Virtual homescreen of the original CloudCapture application

FIGURE 19.

WPI Installation Plan

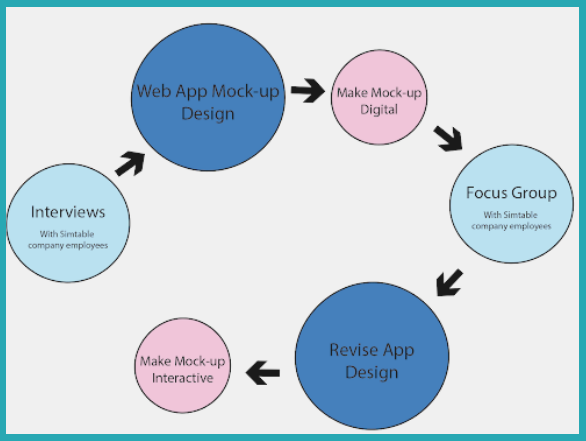


Note: IQP installation original sketch-up by Abigail Leonardi

contents would show the story of the prescribed burn and contrast it to how our application would change the public response to the fire. Finally, as an artistic component, portrait images were to be displayed along the wall next to the map. The images served a dual purpose. First, to pay tribute to the critical employees who made the Simtable technology possible. Secondly, the images serve as a reminder of collective intelligence. As the application relies on crowdsourcing imagery from the public to operate, the images were meant to humanize the foundations behind the technology.

FIGURE 20.

Design Process



Note: Iteration process for web application mock-up design

Week Four

	11/7/2021	11/8/2021	11/9/2021	11/10/2021	11/11/2021	11/12/2021
		10:30 Standup meeting	Stephen Meeting about IQP Installation	9:30 Stand-up meeting	10:00 Advisor Meeting	Make mock-up virtual
		Message Fabio and Kent about IQP installation	Assemble hook of presentation	Put together Kent logistics (budget, room, ect)	Put together cost list	10:30 Stephen Meeting
		Email Michael to get software name	Steal whiteboard	Consolidate SWOT data	Draft new mock-up	Google Earth tutorials
		Email Stephen about advisor meeting	Focus Group 2-5pm in person	Revise mockup (make mockup interactive)	Solidify Installation idea	Send email to Kent
4		Focus Group dry run	Post 5pm - Advisor + Sponsor Meeting (In-person)	1pm Fabio + Advisor Meeting		Storyboard for emergency process
		Check with Simtable about calibration software	Contact Albert Simeoni	Hook for Presentation		
		Research IQP installation logistics and interactive mock-up software		Wednesday Presentation		
		~~3:30 Advisor Meeting (Email Stephen)~~	(Revise mock-up if time)	6:00 Cohort Meeting		3:30 Show and Tell Meeting

The main purpose of week four consisted of executing our focus group, revising our mock-up and finalizing logistics for our installation.

In order to execute a proper SWOT analysis, the focus group was asked to offer their perspectives on strengths, weaknesses, opportunities and threats of the mock-up (See Appendix B). Our group ended up executing a modified SWOT analysis seen in Figure 20. We believe that the threats category was not as applicable to our application review. As a result, we changed the 'T' from threats to technical ability. Instead of asking for the threats, we asked whether our application screens were technically feasible. We wanted to receive employee feedback to determine if they would be able to execute the design and functions we envisioned.

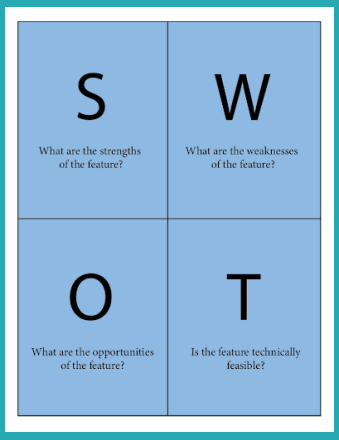
We followed a formulaic procedure in order to analyze each element of our mock-up application. We had broken up our mock-up, dividing it into 12 different features to be analyzed.

We displayed each feature on the screen and listened to the Simtable employee's deliberation. We asked them questions to articulate the strengths, weaknesses, opportunities and feasibility of the mock-up. One the application was fully discussed, we then presented the group with a poll everywhere asking them to express numerically the SWOT features using a likert scale of 1-7 (See Appendix B).

The feedback we received from the focus group was varied and helpful (See Appendix C). We found that the most common points of discussion were ideas to expand upon each of the features. The simplicity of the application was appreciated, however, each one of the employees were able to suggest an additional use case for the application. The application was determined to have many use case possibilities and our group had to make a conscious decision to focus on a singular public user. We targeted the features toward this use case, and made a list of additional possible recommendations which could be used within the app.

FIGURE 21.

Modified SWOT Analysis



Note: SWOT analysis infographic. Strength, Weaknesses, Opportunities and Technical feasibility

FIGURE 22.

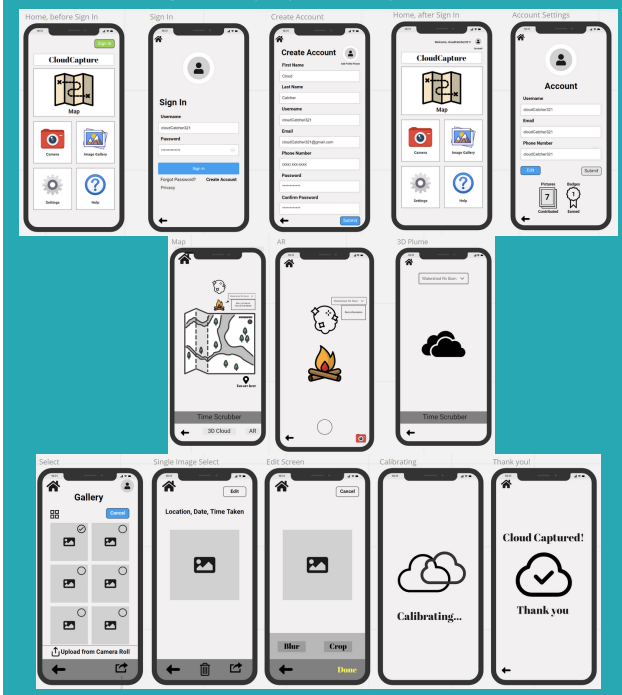
Mock-up Features

Home Screen
Sign in
Map
Augmented Reality
3D plume
Camera
Gallery
Edit
Calibration
Help
Settings
Alerts

Note: List of web application features included in the mock-up to be reviewed by focus group

FIGURE 23.

First Digital Draft of CloudCapture



Note: Web application mock-up MIRO first draft sample screens

Following the focus group, we reconvened to begin revising our mock-up. We started from scratch, allowing ourselves creative freedom to work off the feedback provided by the focus group. We analyzed the SWOT responses and weighed every piece of advice that the focus group offered. The result of our deliberation was a new paper mock-up which looked to improve the usability and visual design of the web application seen in Figure 23.

Our second mock-up draft paid special attention to details suggested by the focus group (See Appendix E). For example, the sign-in screen was expanded upon to be able to include logins from other google accounts to maximize usability. The home screen was also significantly altered seen in Figure 24. We made a decision to open up the application to a map and have other navigation features as lower elements of the screen. One of the focus group members had made a point that our web application's name of CloudCapture seemed to imply a photo centric functionality. However, if we wanted to switch focus to make the app more relevant to tracking fires we would need to change the application to become more map centric. With this change in focus, we altered the name of the application to more accurately reflect the purpose.

We completed the revisions to the mock-up and once again transferred the changes within the digital Miro mock-up. By the end of the week, we released a copy of the revised version to Simtable's employees for them to review.

Simultaneously, our group utilized this week to begin putting together logistics in order to turn our vision of an installation into a tangible result.

We began contacting various faculty members, from the Global department, to the fire protection engineering department, to the library, sharing our ideas and hoping to get support from key players at WPI. Almost every person we contacted showed interest and excitement around the idea of the installation being brought back to WPI.

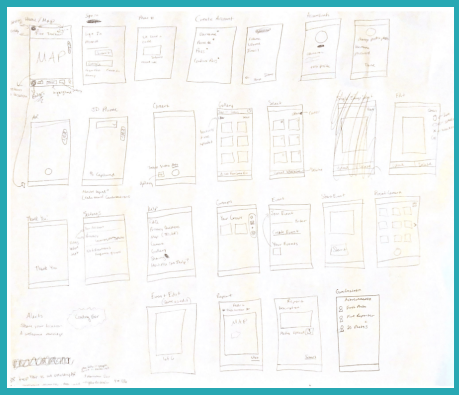
We felt that the installation had the potential to be a major success on several different levels. Our group wanted a chance to showcase the remarkable technology and company we had a chance to work with here in Santa Fe. We also wanted to raise awareness about the company's mission, drawing attention to wildfires, climate change and the technological efforts being developed to mitigate them. On WPI's side, we felt that an interactive installation would be an ideal way to introduce IQPs. Especially after COVID, the installation would present a chance to get individuals excited about global projects again. With all the different faculty members that we contacted, we also began to see that the installation could be an important point of cross-disciplinary collaboration.

We received interest from both WPI's Gordon Library and the Fire Protection Engineering department to house the exhibit. Additionally, the associate dean of the global school exhibited interest in the installation's completion, and we gathered a formal list of expenses that would be necessary to assemble it.

We began thinking through how to physically develop each element of the exhibit. We determined the approximate size of each element and the materials that would be necessary to complete it.

FIGURE 24.

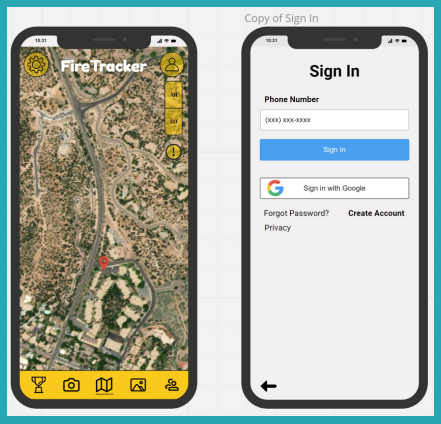
Second Draft Paper Mock-up



Note: Second draft of paper mock-up post-focus group. Produced by group collaboration

FIGURE 25.

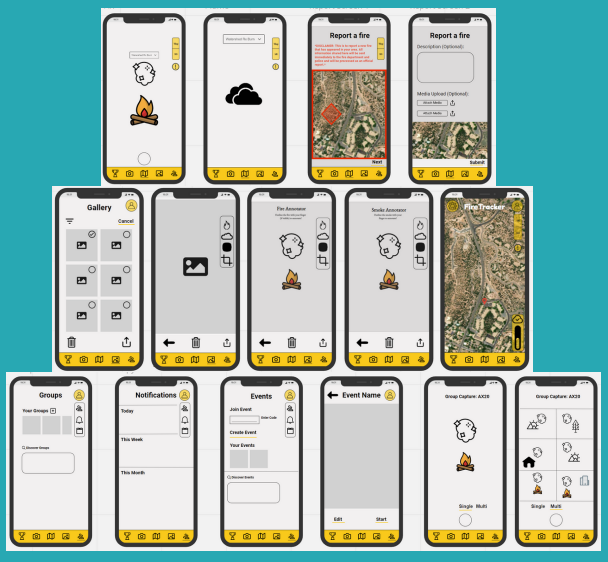
Digital FireTracker Entry Screens



Note: Second draft MIRO home screen and sign-in screen

FIGURE 26.

Digital FireTracker Mock-up



Note: Second draft MIRO sample screens. New features include: reporting a fire, annotations, uploading and groups

We determined that the construction of the Simtable could be reduced to an assembly of rope, sand, a singular phone and projector seen in Figure 26. We also started to flesh out the content intended for our video. We began to assemble a story board that would accurately depict the timeline which occurs when an unknown fire is detected. Within this story, lay the purpose of our mobile web application. The application aimed to change the current narrative of wildfires by efficiently informing the public and allowing them to become key players within the information distribution process.

We knew that coherency of the video had the potential to dramatically change the perspective of viewers observing the installation. As a result, we took great care to assemble a storyline which could hold an audience's attention and highlight the key pain points of the current process for releasing information about fires. Most importantly, we aimed to call attention to how our application would alleviate these current pain points.

FIGURE 27.

Miniature Portable Simtable Construction

Note: Miniature Simtable constructed with rope, tape and a portable projector

FIGURE 28.

Realtime Earth Focus Group

Note: Image of the Realtime Earth team conducting a modified SWOT focus group over the CloudCapture application

INSTALLATION KICK-OFF

Week Five

	11/14/2021	11/15/2021	11/16/2021	11/17/2021	11/18/2021	11/19/2021
		Storyboard map + Google earth	2pm Calibration w. Emma	9:30 Stand-up meeting	10am Sponsor Meeting	10am Kaz Meeting -RTE image fitting
		10:30 Standup meeting		Make mock-up interactive	Plan IQP paper structure - Write 4 IQP paragraphs	Editing video
5					Email Elgert and resource libraian	Plan meetings with Arthur, respond to Laureen
		11-12 Diane Portier Meeting	Script for storyboard and script for simtable video	12:30 Wedtech	Read Montessouri paper	Write for paper and send to professors
		Watch Maria Fire and story board	Create alert	2:00 Kaz Meeting	1:45 Meeting with Kaz	
		3 Sponsor Meeting	6:00 cohort meeting		Calibrate Cameras	3:30 Show and Tell Meeting

In order to get our installation idea off the ground, we decided to meet with Diane Poirier in the Fire Protection Engineering department and Arthur Carlson in order to see if our installation idea was feasible. They were very excited about our idea and told us that they could easily find a space to put our installation in either the library or the Gateway building. Once we got approval from them about our project, we decided to start storyboarding for the video that was going to be a part of our installation. We quickly realized that we wanted to highlight what happened with the prescribed burn. By showing the lack of information and then showing how it could be improved by an app like FireTracker, we can show the importance of our app concept. We also wanted to showcase some of Simtable's current software, like Realtime Earth, in the video as well.

First, we tried fitting some images that were taken of the prescribed burn into Google Earth. We were able to accomplish calibrating three images into Google Earth's landscape, but it was very difficult to use and move images around in. Noticing this, one of the Simtable employees, Kaz, suggested that we use Realtime Earth for fitting our imagery into a landscape because it would look better and be much easier to use. Using Realtime Earth, we could also annotate the photo and have the fireline be projected onto its 3D map. Kaz began to teach us how to use the software and align images. Next, we created a script for our storyboard and started putting content together for our video. For the beginning of our video, we created animated alerts and an imitation 911 call using Premiere Pro. We also recorded audio for the video, so that it could be more accessible to viewers, through the use of sound and subtitles.

Early in the week, we met with another Simtable employee, Emma. She had recently finished updating Simtable's calibration software to work more seamless, so she wanted to teach us how to calibrate the Alert Wildfire cameras. The Alert Wildfire cameras are somewhat easy to calibrate since Simtable already knows where they are located. However, with photos taken by citizens, they will need to sift through Exif data to figure out where and when a picture was taken. With their calibration

FIGURE 29.

Downtown Calibrated Prescribed Burn

Note: Photo 1 from the prescribed burn that was fitted into Google Earth.

FIGURE 30.

Fort Marcy Calibrated Prescribed Burn

Note: Photo 2 from the prescribed burn that was fitted into Google Earth.

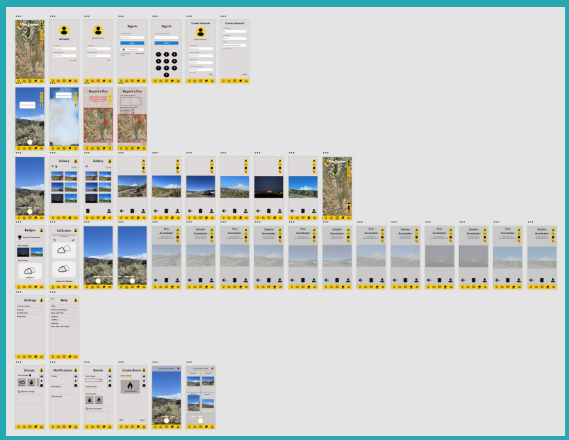
FIGURE 31.

Hyde Park Calibrated Prescribed Burn

Note: Photo 3 from the prescribed burn that was fitted into Google Earth.

FIGURE 32.

FireTracker Digital Adobe Screens



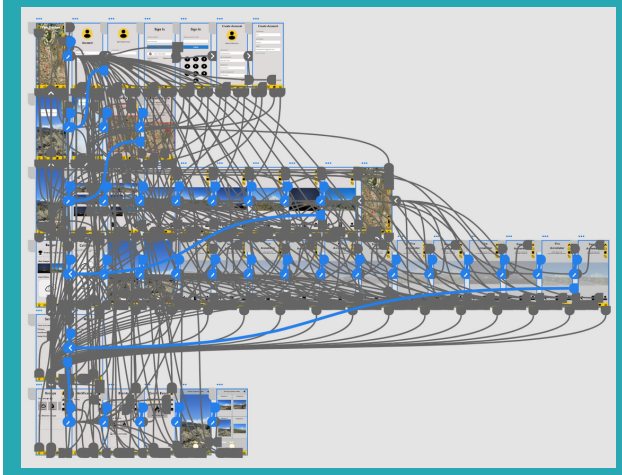
Note: The mock-up screens in Adobe XD.

software, it is possible to calibrate cameras based on the terrain that's in the photo and on the stars that are visible in the picture as well. The software works by manually selecting about ten stars in the photo and then matching them with the star that it should be calibrated with. Then the user can press the "Calibrate" button the program will start lessening the error of the terrain and star location. Once the error becomes small enough, the camera is deemed calibrated. Learning how calibration worked was valuable to our team and our project since our app will have to use this software to calibrate citizens' cameras. Without calibration software, the images from the public would not be as helpful to find the location of wildfires. Currently, their calibration system is not automated and requires manual work from humans. However, there is hope for an automated system in the future.

In the middle of the week, we decided to make the digital mock-up that we made in Miro into an interactive mock-up using Adobe XD (See Appendix F). This software was suggested to us by a Simtable employee, Cody who thought it would be interesting to use. Adobe XD software allows people to create mock-ups in which you can switch screens when certain buttons on the screen are pressed, but without any code. Although our app doesn't have any functionality, Adobe XD makes it more realistic and easy to picture how the screens flow together. In order to accomplish making our mock-up interactive, we recreated every single screen that was in Miro into Adobe XD. We even added seventeen more screens to the Adobe XD mock-up. In order to make it appear like a functioning application we created pathways. Each time a button was pressed on the mock-up, the user would be taken to the proper screen. Finally, we tested the application on our phones to make sure the pathways were successfully linked. Adobe XD helped make the vision for our application real and tangible for people to interact with, rather than having to imagine what the flow of the application would be.

FIGURE 33.

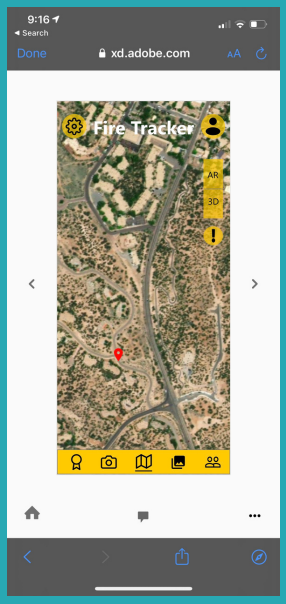
FireTracker Digital Adobe Screens Connected



Note: Adobe XD screens. The blue and grey lines represent every connection in the interactive mock-up.

FIGURE 34.

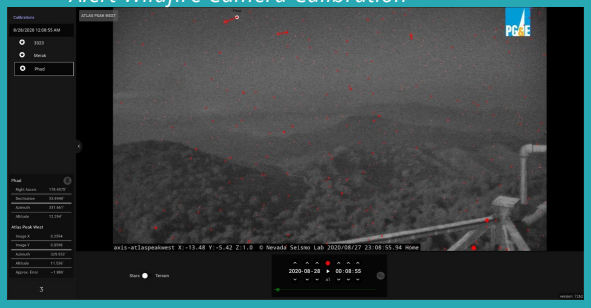
FireTracker Adobe XD Homescreen



Note: This is an example of the interactive mock-up running in a browser on a phone.

FIGURE 35.

Alert Wildfire Camera Calibration



Note: Realtime Earth's calibration software developer view

WINDING DOWN

Week Six

	11/21/2021	11/22/2021	11/23/2021	12/24/2021	12/25/2021	12/26/2021
		10:30 Stand-up	Record video footage	9:30 Stand-up meeting	Create Final Presentation	Finish up paper content
		2pm Meeting with Staci Matlock	Edit Video	Revise Paper	Write Final Paper	Finish Editing Video
		Record Video Audio		Build Mini Simtable		1st Draft of Paper due
6				Contact Research librarian		
				Record video audio		

With our deliverable completed and installation under development, our team used week six to generate an instruction guide and content for our video. After completing our interactive mock-up during week five, we wanted to create an instruction guide for Simtable (See Appendix G). This instruction guide for the mock-up will ensure that our ideas about our mock-up will not get lost or forgotten after we leave Santa Fe. We created a presentation with every screen of our mock-up. Each screen is accompanied by text, describing what the screen is used for and how the user can utilize it. Each button on every screen is explained in detail and outlines what the workflow of the user will be. Without the instruction guide, it would be very difficult for Simtable's team to understand parts of our mock-up and how we designed it to function.

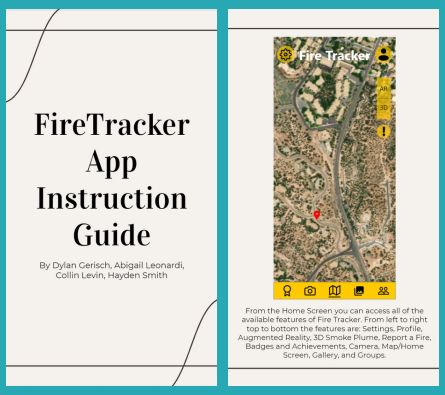
Continuing with our installation progress, we decided to focus on video production. We had a meeting with Kaz, one of the aforementioned Simtable employees, to help us record footage from Realtime Earth. He aided us in annotating the fireline onto the mountains based on the calibrated prescribed burn photos. Since he has experience in producing videos for Simtable on Youtube, he knew how to make the aesthetics of our video look pleasing. He also helped coordinate the steps of our video for what we should show to our audience. Once we edited the footage taken of Realtime Earth, we were ready to finish recording our audio for the video. Abi, Dylan, and Collin completed recording their lines and their voices were added to the video using Premier Pro. After their voices were added, the final piece of the video was connecting all of the various scenes together. In conjunction with the video, our team created a prototype for the table we hope to install at WPI. We used a rope border, walnut shell sand, a projector, a boom arm, and more provided by Simtable to make our idea of a miniature simtable come to life. Since our project has the opportunity to change the way in which people interact with wildfires, our project attracted media attention.

Our group had the chance to meet with Staci Matlock, a journalist for Northern New Mexico. As a personal friend of Stephen Guerin, she had come in to help generate a coherent narrative to explain all of the important work Simtable was doing. We had been trying to establish a similar understanding of Realtime earth's workflow through the storyboard of our video.

Our team's understanding of the general narrative was summarized within our video. The current pain

FIGURE 36.

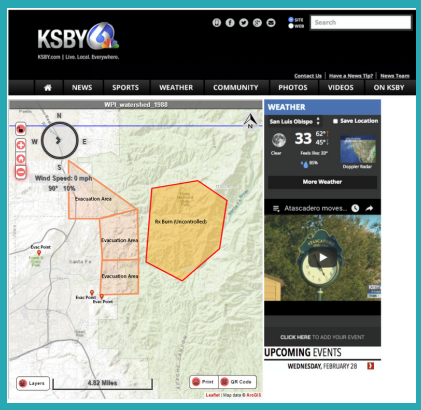
FireTracker Instruction Guide



Note: Instruction Guide title page and homescreen example

FIGURE 37.

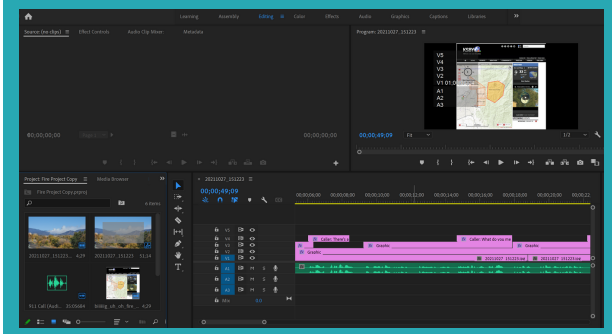
SimTables Prescribed Burn News



Note: Mock-up news source of prescribed burn

FIGURE 38.

FireTracker Impact Video



Note: Premier Pro video editing setup

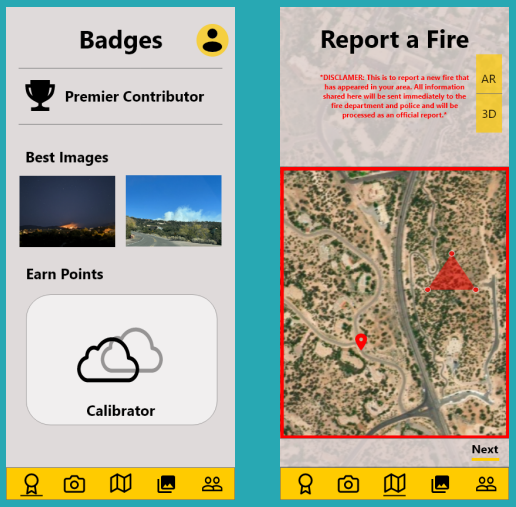
point, being addressed by our web application, was the lack of information surrounding wildfires in times of crisis. With Simtable's technology a new type of future was able to be envisioned. In this future, when a fire occurred the public would be able to take out their mobile devices and photograph the smoke. If the fire was unknown, they would have the opportunity to report the fire and submit live imagery. Otherwise their device would notify them of the nature of the fire and be able to display the wildfire's future movements to inform the user whether they were in danger. The application would work to collect imagery from the general public of the fire and hoped to "gamify" the event to get as many cameras focused on the fire as possible. Users would be rewarded for submitting imagery, calibrating photos, and inviting their friends to use the application. With all of this data collected, it would be possible for the application to establish a live updating map. The smoke plume would even be able to be viewed in 3D. The public would receive accurate information about the wildfire at a rate unmatched by current news sources.

Our meeting with Staci lasted over an hour as we explained to her the purpose of our project and showed her our interactive web application. We had a clear vision of how our application would work in unison with the Realtime Earth software. We informed her about our understanding of the purpose behind the application and how we believed it had the potential to change lives. We understood the benefit of this technology, as we had experienced first hand the delayed information about wildfires during the prescribed burn. However, we also understood the expansion of this technology.

The concepts of collective intelligence and visual modelling were building blocks to our FireTracker application, however they possessed a world of untapped potential. Using collective knowledge, emergency situations could be dramatically changed. For example, in school shooter situations, Stephen envisioned a system in place where a single camera phone could be placed in each door's window. The cameras working together would be able to instantly establish safe and unsafe zones for students navigating the situation. Even the spread of COVID-19 would be able to be handled differently. If individuals anonymously released their location data to a group network after contracting COVID-19, exposure risk of any location could be instantly determined by simply checking online. The possibilities of this combination of technology are expansive and have the potential to revolutionize the flow of information in society.

FIGURE 39.

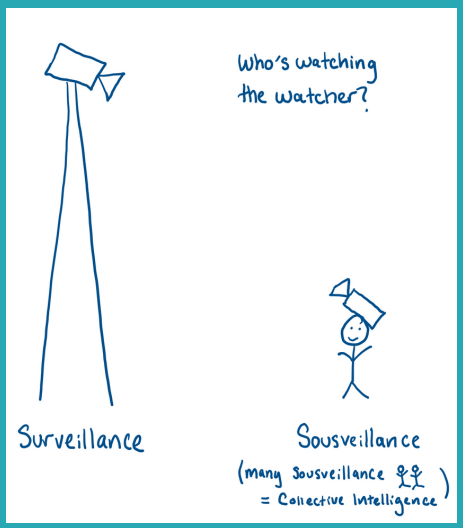
Gamification and Report Fire XD Screens



Note: The mock-up screens in Adobe XD of user contribution and reporting fire

FIGURE 40.

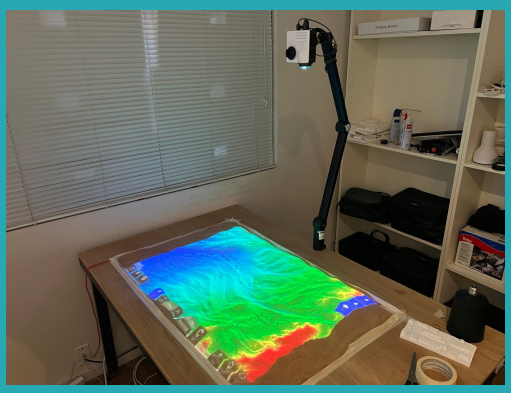
Surveillance vs Sousveillance



Note: Recreation of surveillance vs sousveillance explanation imagery

FIGURE 41.

Miniature Simtable



Note: Miniature Simtable created with rope, tap, project, and walnut shell sand

Mock-up and Instruction Guide

Our team's main deliverable to Simtable was intended to be a google slides UIUX mock-up of a CloudCapture application. This was the deliverable determined within our first week in Santa Fe. However, as our team progressed the scope of our deliverables expanded. The purpose of the CloudCapture application narrowed to target smoke plumes. Thus, the name of the application evolved to FireTracker instead of CloudCapture.

At the conclusion of our time in Santa Fe, we produced a slideshow presentation of our mock-up. However, we also created an interactive Adobe XD version of the mock-up and an instruction guide. The Adobe XD mock-up allowed for users to open up the web application on a mobile device and interact with the buttons. Our team ended up mocking up the application's functionality in addition to its appearance by using this software. Individuals were able to interact with the FireTracker application as if the software was developed. The instruction guide was also an extra component. We wanted Simtable to have a written document accompanying our mock-up so our thoughts about the application's functionality could be accurately communicated and passed along.

Ultimately, we were able to surpass our original deliverable expectations for the project. We worked to execute a high-quality product for our sponsor and took the opportunity to expand upon our original project description.

Installation

Beyond the deliverable to our sponsor, Simtable, our group created an installation for WPI. The installation is meant to provide a cross-disciplinary connection on campus and showcase the revolutionary technology created by simtable. The content within the display is in direct relation to the web application mock-up which was created for Simtable. Each element within the exhibit represents a functionality made possible by the web app. However, it is done utilizing a visual and interactive method of communicating. The visual method was accomplished by creating a video that showcased calibration, collective intelligence, and Realtime Earth. The interactive method includes a miniature Simtable that can be created using a variety of materials. The materials include rope, sand, a boom arm, a small projector, and a phone. The simtable will have a simulation of the prescribed burn that occurred during our stay in Santa Fe. During demonstrations of the exhibit, students will be able to engage with the table and move the sand around to match the projected topology.

Closing Remarks

Wildfires are unpredictable which generates fear in the public collective. However, this fear can be mitigated by unifying technology and collective intelligence. Wildfires are uncontrolled burns that threaten communities. They have the potential to happen anywhere in the world, but certain areas are more familiar with the danger wildfires pose. In Santa Fe, a company called Simtable is working to eliminate fear behind wildfires by pinpointing their location and anticipating their future movements. This forecast of wildfire movements is made possible by a concept called collective intelligence. Our group was tasked with developing a mock-up web application that could be implemented within the public to collect images and return critical fire location updates. Additionally, an installation was created for WPI to showcase Simtable's union of technology and social science to solve a global problem.

The technology employed by Simtable has the capability to revolutionize public perception of wildfire. However, it is a singular implementation not representative of all the possible applications of this technology base. The implications of a collectively intelligent society are far-reaching. Existing applications include cicada tracking and GPS systems like Waze. In order to keep track of the recent cicada emergence, the Cicada Safari app was created. This used community involvement to determine and map the range of cicadas. Waze also uses collective intelligence to warn people about traffic, crashes, and police activity. People can report when they see these occurrences and then Waze will ask other users if they also see it.

Beyond these current-day applications, collective intelligence can be used to solve newer, more significant problems, like life-threatening events. In instances of school shooters, the current situation implies complete blindness with no knowledge about whether the shooter is lurking around the corner. If every single individual in the building worked together contributing their own knowledge about where the shooter is or is not located onto a mobile device guide, people would be able to navigate the environment safely. Simtable's technology is on the cutting edge of progress and has the potential to shape a new vision for the future of society.

The technology being produced at Simtable has the capability to protect and inform society about imminent threats. We learned so much during our time with the company and felt privileged to have the opportunity to work alongside such visionaries. We are very grateful to have been able to view the future through their eyes and are looking forward to seeing this company make a difference in the world.

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Appendices

Appendix A. Interview Questions

In your own words describe the purpose of the cloud capture app.

Please walk us through the usage of this application - from opening the app, to taking the photos, what do you expect users to do?

What do you imagine people using this application for? How often do you expect them to use it?

Who are the anticipated end-users of cloud capture? (Age, demographic, etc.)

What has your role been in producing realtime earth? What do you expect your role to be in developing cloud capture?

How do you intend to ensure users' privacy with the images being collected?

Please describe any UI/UX concepts you've used in the past that might be helpful for us to use.

What software would you recommend using to do the mockup?

How would you measure the success of cloud capture? What would need to occur for you to believe the application was successful?

1.

Appendix B. Focus Group Structure

The project team conducted one focus group at which time a SWOT analysis a SWOT analysis was performed focusing on the features of the FireTracker web application. The focus groups were conducted with seven members of the Simtable staff. The purpose of this focus group was threefold, 1) to encourage communication between and among the Simtable staff, 2) to familiarize the entire staff with the FireTracker web application concept and workflow, and 3) to utilize a SWOT analysis to receive their feedback on eleven features created by the project team.

Process

- We will show the focus group a specific feature, from the application mock-up, on a projector and explain to them the functionality
- Then we will ask them open-ended modified SWOT analysis questions (below), and record their answers
- Then we will conduct a Poll Everywhere using Likert Scale questions after a group discussion takes place

We will repeat this process for all 11 features on the mock-up

Strengths
Elements of the feature which are appreciated or effective

- Likert Questions (On a scale from 1-7)
  - How effective do you think this feature is overall? (1 - not effective, 7 - very effective)
  - How helpful do you think this feature is overall? (1 - not helpful, 7 - very helpful)
  - How necessary do you think this feature is overall? (1 - not at all necessary, 7 - very necessary)
- Open-ended Questions
  - What are the strengths of this feature?

Appendix B. Focus Group Structure

Weaknesses
Elements of the feature that need to be improved immediately

- Likert Questions (On a scale from 1-7)
  - How essential do you think this feature is? (1 - not at all essential , 7 - very essential)
  - How well-designed is the feature? (1 - not very well-designed, 7 - very well-designed)
- Open-ended Questions
  - What are the shortcomings of this feature?

Opportunity
Areas of the feature that could be improved or added to in the future

- Likert Questions (On a scale from 1-7)
  - How complete is this feature? (1 - incomplete, 7 - complete)
- Open-ended Questions
  - What are some other possible changes or additions to this feature that would be beneficial?
  - How do you see this feature expanding?

Technical
The technical feasibility for the team to complete the feature

- Likert Questions (On a scale from 1-7)
  - How difficult will it be for your team to develop this feature? (1 - not at all difficult, 7 - very difficult)
  - How difficult will it be for people to use/navigate this feature? (1 - not at all difficult, 7 - very difficult)
- Open-ended Questions
  - What are the technical aspects of this feature?
  - What are potential complications about this feature?
  - What are simplifications which could be made to the feature to reduce complexity?

Appendix C. Focus Group Feedback

Feature 1: Home Screen

Strengths

- Basic Layout
- Able to view everything you need
- Map is liked
- Map, Camera, and other images from calibrations

Weaknesses

- Name doesn't indicate fire tracking
  - Fire tracking should be map-centric while the name CloudCapture indicates photo-centric data collection app
- Unclear how much the app is supposed to be interacting with the user
- Unclear the most important feature of the app
- Lacks context

Opportunity

- Open up to map and Camera, be able to swipe to other features
- Big buttons are good but only button two buttons
- Have the Inset - where are they other images in this gallery - how to get image gallery, camera and map to work as a triad
- Prefer dynamic initial view (map is live or camera is on)
- Include time within set up

Technical Feasibility

- 100% capable

Appendix C. Focus Group Feedback

Feature 2: Sign-In

Strengths

- Gamification
- Clean - basic login which is fine

Weaknesses

- Do not know what is optional
- Facebook google- sign in facebook twitter and google (what kind of user? - real or fake identity)
- Questions about what is required information? Username must be unique or required
- Get a text back after login - phone only login
- Have multiple screens to switch to separate out the create account
- Minimum and maximums on password (password criteria)
- User identification - deep issue to work through (phone number login first and QR phone as authentication) username, password as a later as an option
- Where is the person image coming from

Opportunity

- Gamefication can move from account to homescreen (badges contribution) - stars that change color, twitch user, make an avatar
- Multistep approach for sign in
- Phone log in
- A chance to connect with other existing redfish technology? Phone number system, email system.. More complex sign in - to sign into RTE account
- Let people know everything is anonymous - first go to site 1) share location with the WEB PAGE no anyone else (more willing if anonymous) 2) after login have an alert that will notify you won't have your location shared (this information will not be shared) [we are about to ask you for this permission - then give permission]

Technical Feasibility

- Doable - already done it

Appendix C. Focus Group Feedback

Feature 3: Map

Strengths
- Clean

Weakness
- Time Scrubber
- The home corner is difficult to navigate to
- Hard to reason about - make more reasonable map
- Modality - Going to 3D cloud or AR - if camera is small map is big and switch
    - Can ask Emma about her work mapping to 3D cloud (keep the same view and location - aka - 2D to 3D transitions)

Opportunity
- Opportunity to bring map and camera together - instead of imagine each different mode
- Click on you are here to get to the 3D transition

Technical
- Capable of doing it (time slider is troublesome)

Appendix C. Focus Group Feedback

Feature 4: Augmented Reality (AR)

Strength -

- Very strong feature - the essential piece

Weakness -

- No information about the report
- Camera button doesn't work without more information about what you are doing
- Need instruction - see smoke what do you do about it

Opportunity

- Visualization - (make reference to peak finder)
- Annotation
- Report with imagery - in AR - report button to capture image and associate image in report
- Highlight firepoint and smoke points with annotation (a painting) - Please highlight where you see the fire, please highlight where you see the smoke
- Finds stability using the camera Pokemon, google streetview
- AR isn't limited to camera view - augmented overlay of image not i

Technical

- Technicality - doesn't leverage machine vision
- Machine vision needed to fit it properly (Constellation software)
- A lot of technical concerns about the feature, technical metriation, 2 technically
- How do you bring AR in

Appendix C. Focus Group Feedback

Feature 5: 3D Plume

Strength

- Cool feature
- Keeping interest up
- Be able to see where the smokes with and the dynamics of the fire

Weaknesses

- Not very useful

Opportunity

- Main function of tool - see image in two pieces and come up with a 3D cloud
- Annotation - time and place - firefighters will name the fire
- Stephen - concerned about where annotation can come into play
- Change background of the cloud - background selection - color of the point picked from the photos it was taken from
- Main purpose - know where clouds are, get height and location of that cloud using the app and a treehouse camera. For example: I have two shots how to get the location and height of the cloud? User is the one doing the calculations?
- Annotation is needed - how will that be solved - how will we triangulate a singular cloud
- How to get more input from the user? - not everything is a report out to us
    - The final view is there, but how do we impact through more photography
    - Where are the holes in the cloud and what other views are needed
    - What the URL would be to create a capture event - starting public - take a simultaneous shot together
    - Start with group feature (enough to calibrate)

Technical

- Done using 3rd party software and own clouds with depth rendering and point picking, not automated, technology exists
- Get features between photos
- Visualizing smoke cloud easier than gather the data together

Appendix C. Focus Group Feedback

Feature 6: Camera

Strength

- Take picture and then do something
- Clean, simple, not having to do the report immediate (can make collection of photos)

Weakness

- The native app is better at taking photos, camera is redundant and more complicated
- Need a color highlight to select which feature you are under, arrows to show if there are more options in a different place (why you don't want to make your own photo app)
- OG camera is better - so many other features - pop into native feature and pop back into gallery view

Opportunity

- Hop into the native app - no need to reinvent the wheel - apple can handle it
- Opportunity for AR view - taking picture and getting stuff within view

Technical

- Understand the limitation - native app
- Technical - depends on the opportunities
- Integration of native - capable
    - But negative affects about AR

Appendix C. Focus Group Feedback

Feature 7: Gallery

- Strengths
  - Nice gallery, can see images, select, sort

- Weakness
  - Missing context, multiple fires at a given time
  - If an image is already uploaded have an annotation
  - Add from camera roll instead of upload (word change)

- Opportunity
  - New event or current event, what fire are you uploading to?
  - Potential for filtering - time or location based (filter feature)
  - Opportunities to get rid of the zoom in and out

- Technical
  - Been there done that

Appendix C. Focus Group Feedback

Feature 8: Edit Image

- Strengths
  - Simple
  - Crop tool in app - because then you need to have the principal point which completely changes the way you calibrate images (especially pulling intrinsics and extrinsics) - treat crop as black out

- Weakness

- Opportunity
  - Great place for annotation
  - Make an adjustable feature
  - Polygon annotation (Blur and crop together), add icons to blur and crop and show which is active
  - Select stuff you want to share instead of stuff you want to blur
  - AWF - black boxes
  - Blacked out editing is better than blurring tool

- Technical
  - 100% Capable

Appendix C. Focus Group Feedback

Feature 9: Calibration

- Strengths
  - Simple
  - Crop tool in app - because then you need to have the principal point which completely changes the way you calibrate images (especially pulling intrinsics and extrinsics) - treat crop as black out

- Weakness

- Opportunity
  - Great place for annotation
  - Make an adjustable feature
  - Polygon annotation (Blur and crop together), add icons to blur and crop and show which is active
  - Select stuff you want to share instead of stuff you want to blur
  - AWF - black boxes
  - Blacked out editing is better than blurring tool

- Technical
  - 100% Capable

Appendix C. Focus Group Feedback

Feature 10: Settings

- Strengths
  - Hitting the main points, good grouping, simple

- Weakness

- Opportunity
  - One time selection about share preferences - and can adjust in settings
  - Icons or checkboxes (instead of layered menu)
  - Line Breaks - between privacy notification
  - More information about settings - wouldn’t know what is in account

- Technical
  - Fully Capable

Appendix C. Focus Group Feedback

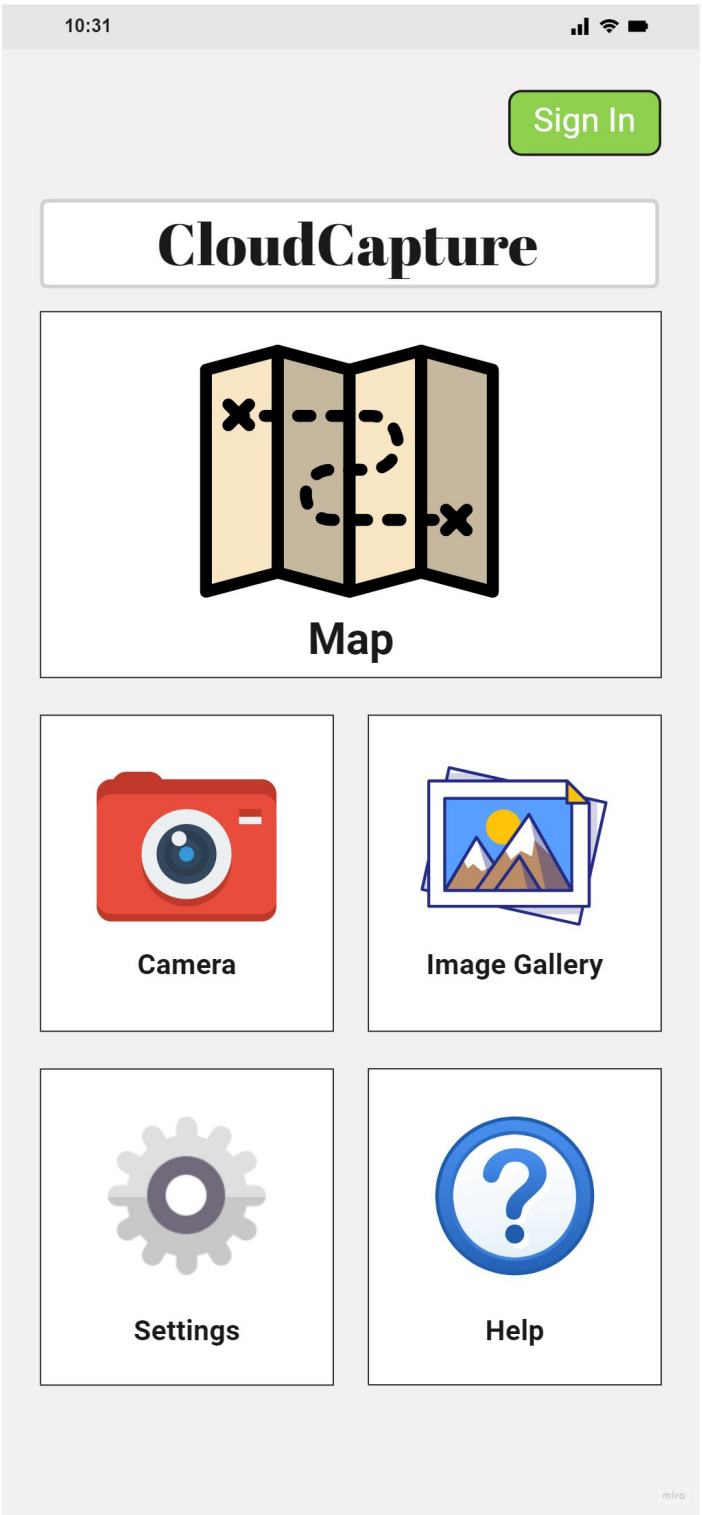
Feature 11: Help

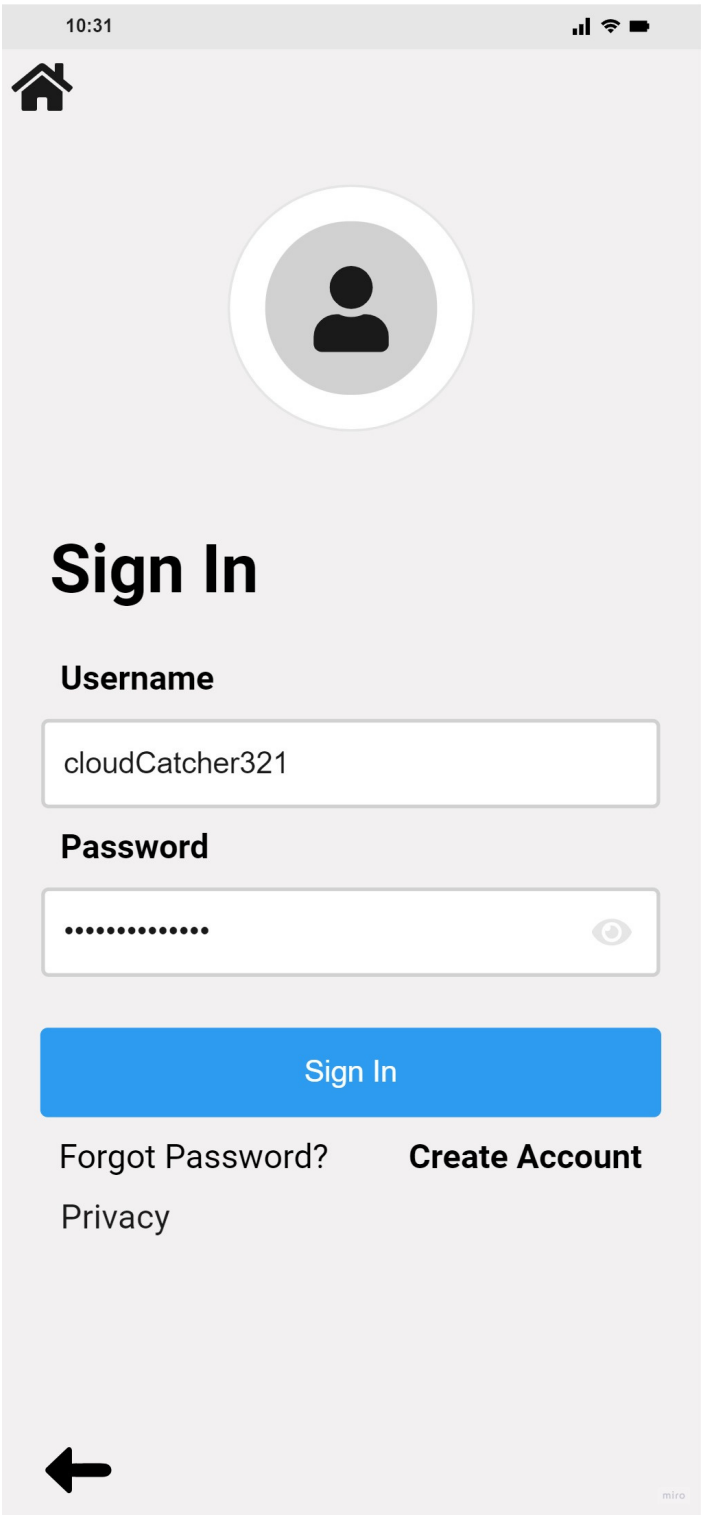
- Strengths
- Weakness
- Opportunity
  - Need user and software license
  - Get rid of question mark after share
- Technical
  - Doable

Feature 12: Alerts

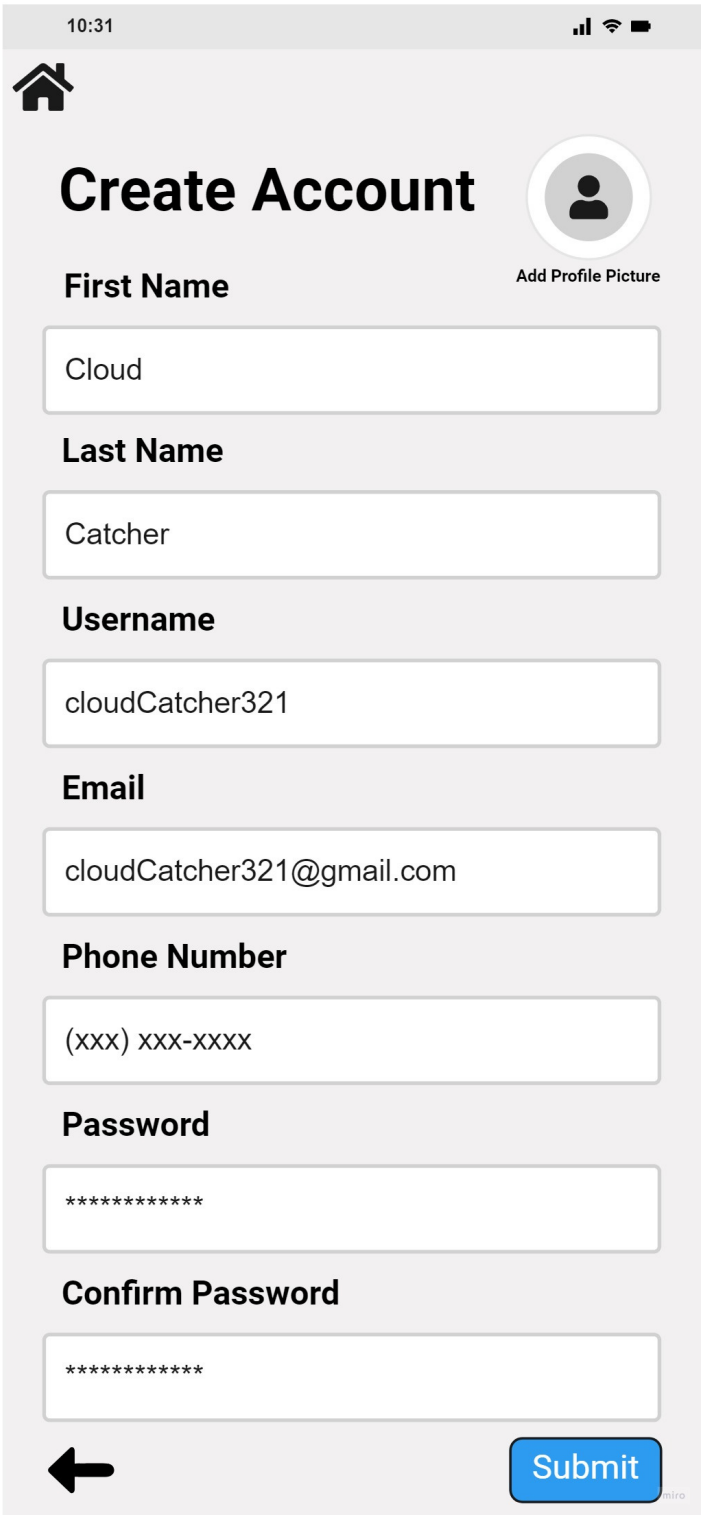
- Strengths
  -
- Weakness
  - Image rights - who is starting rights and requesting it - sharing with a group (sendings rights to other people)
- Opportunity
  - Your image is not processing
  - Update to you fire - if you activate a fire watch feature (this would be cool)
  - Memories about fire
- Technical

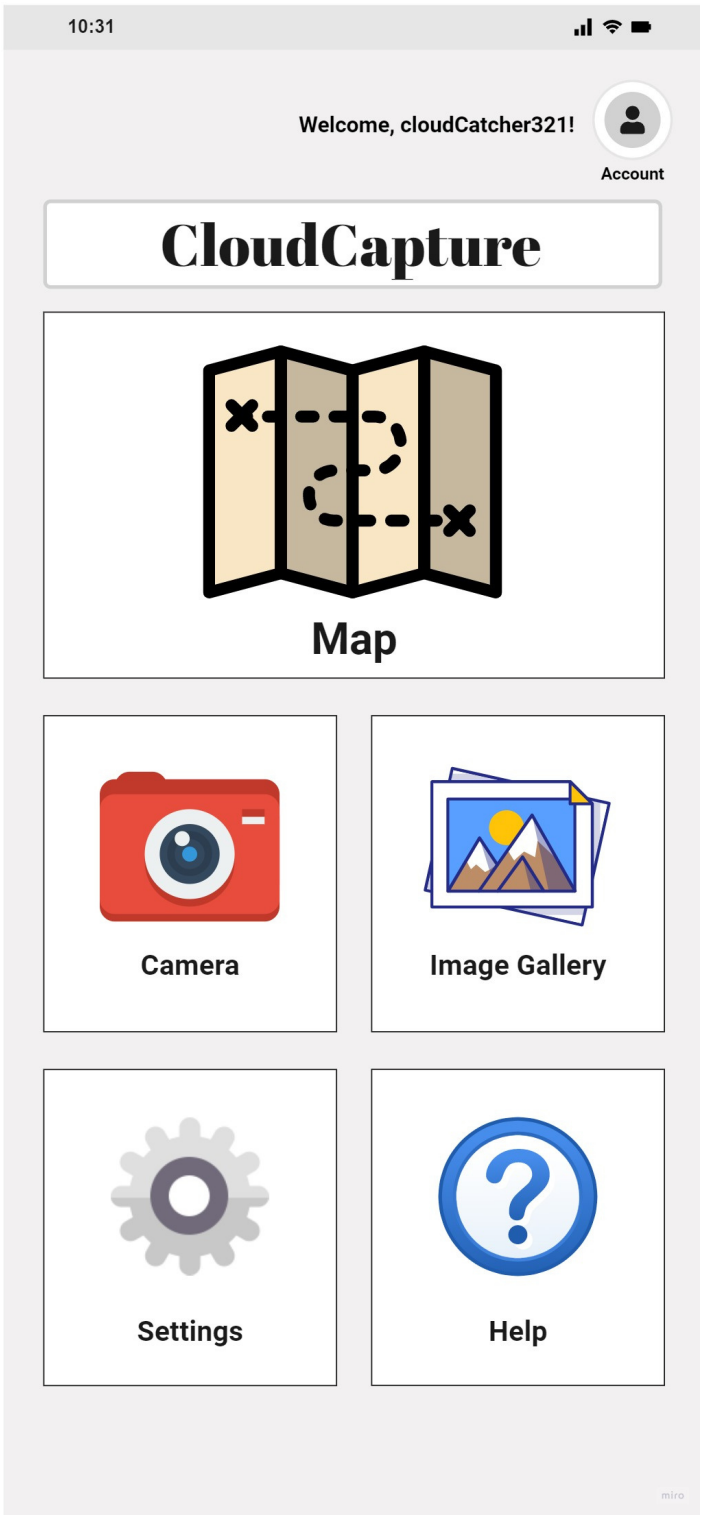
Appendix D. Original MIRO Mock-up



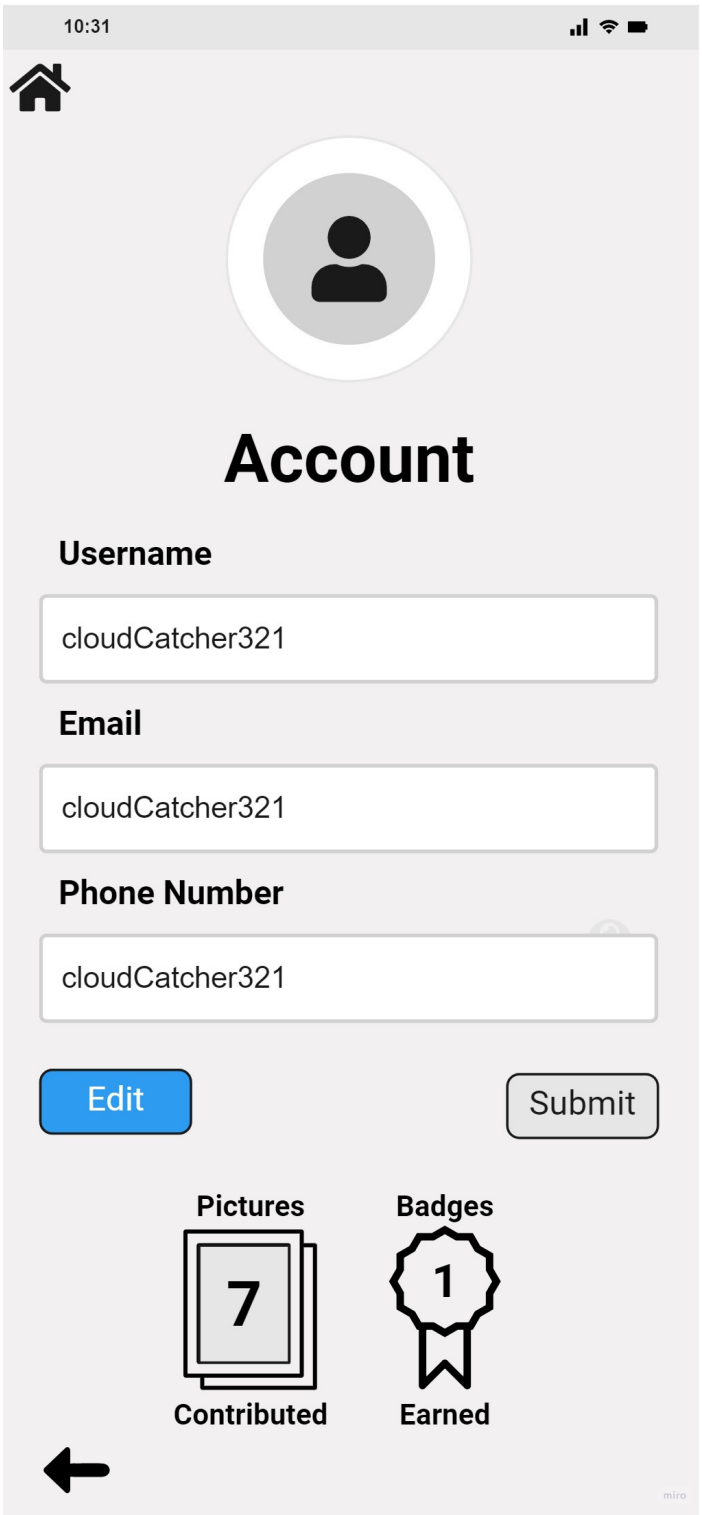


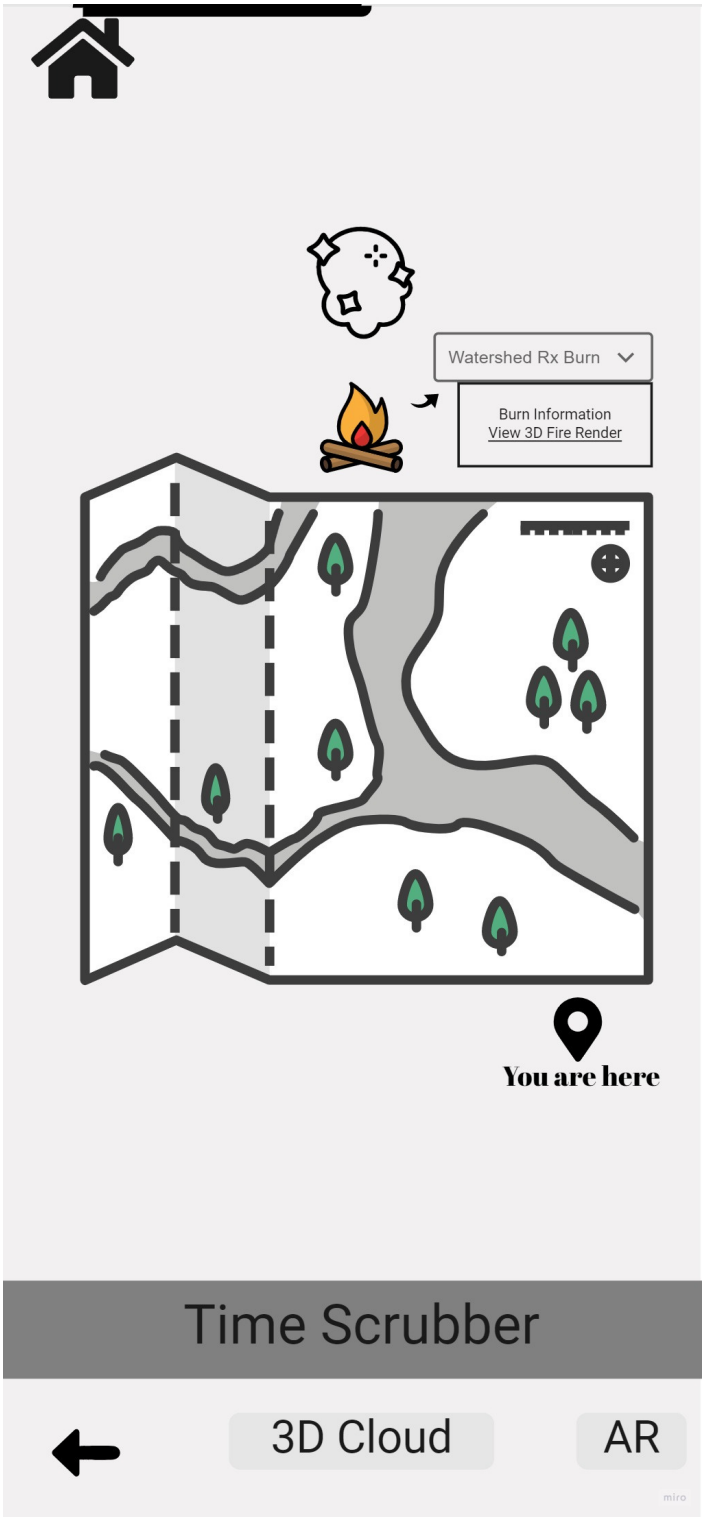
Appendix D. Original MIRO Mock-up



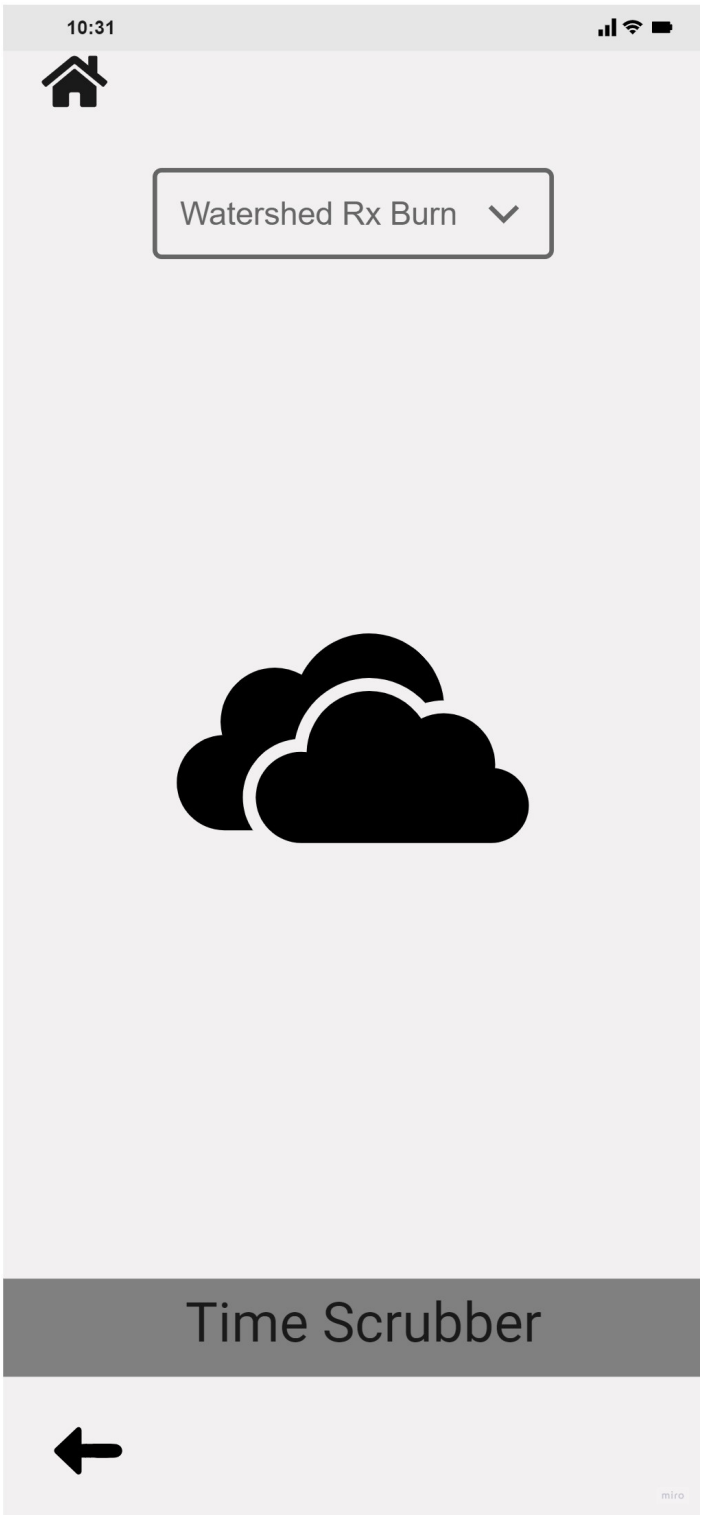


Appendix D. Original MIRO Mock-up

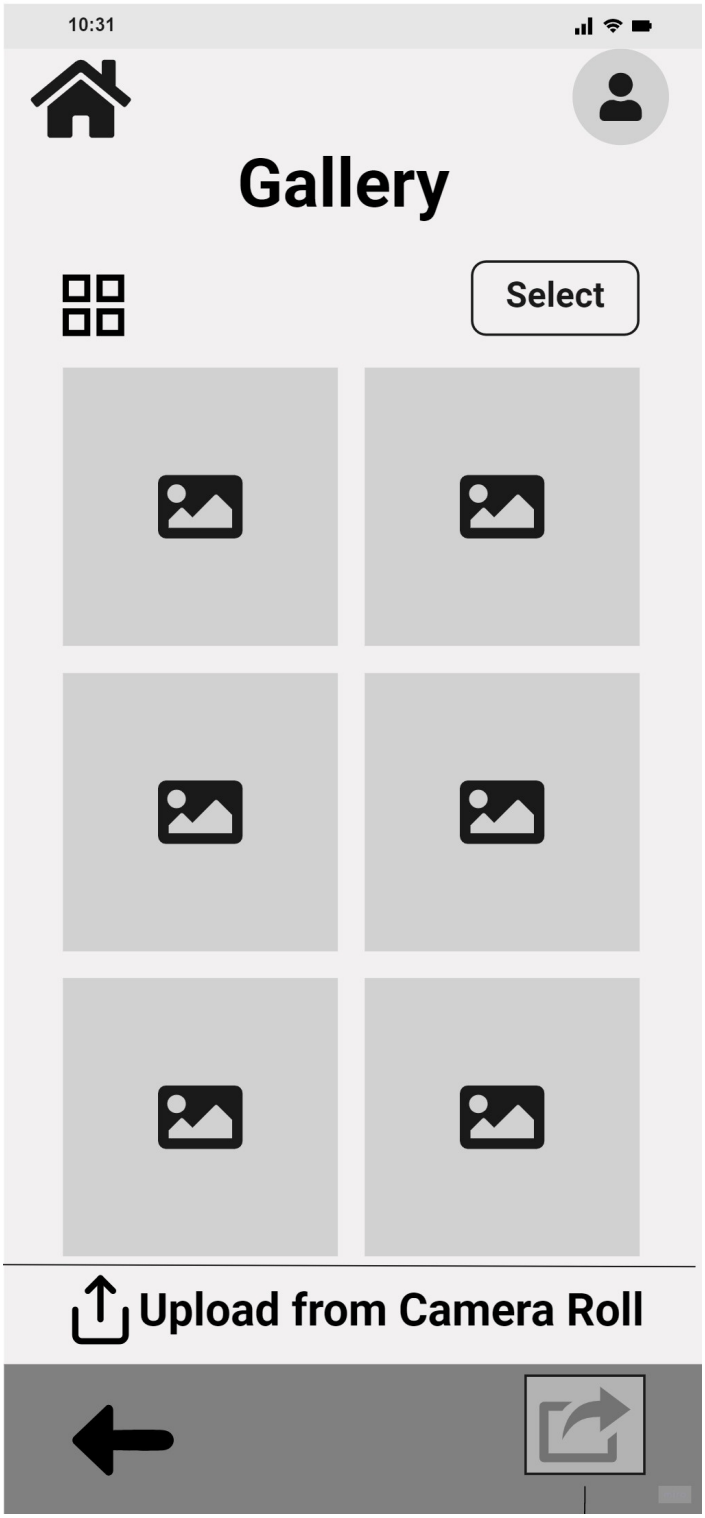




Appendix D. Original MIRO Mock-up



Appendix D. Original MIRO Mock-up



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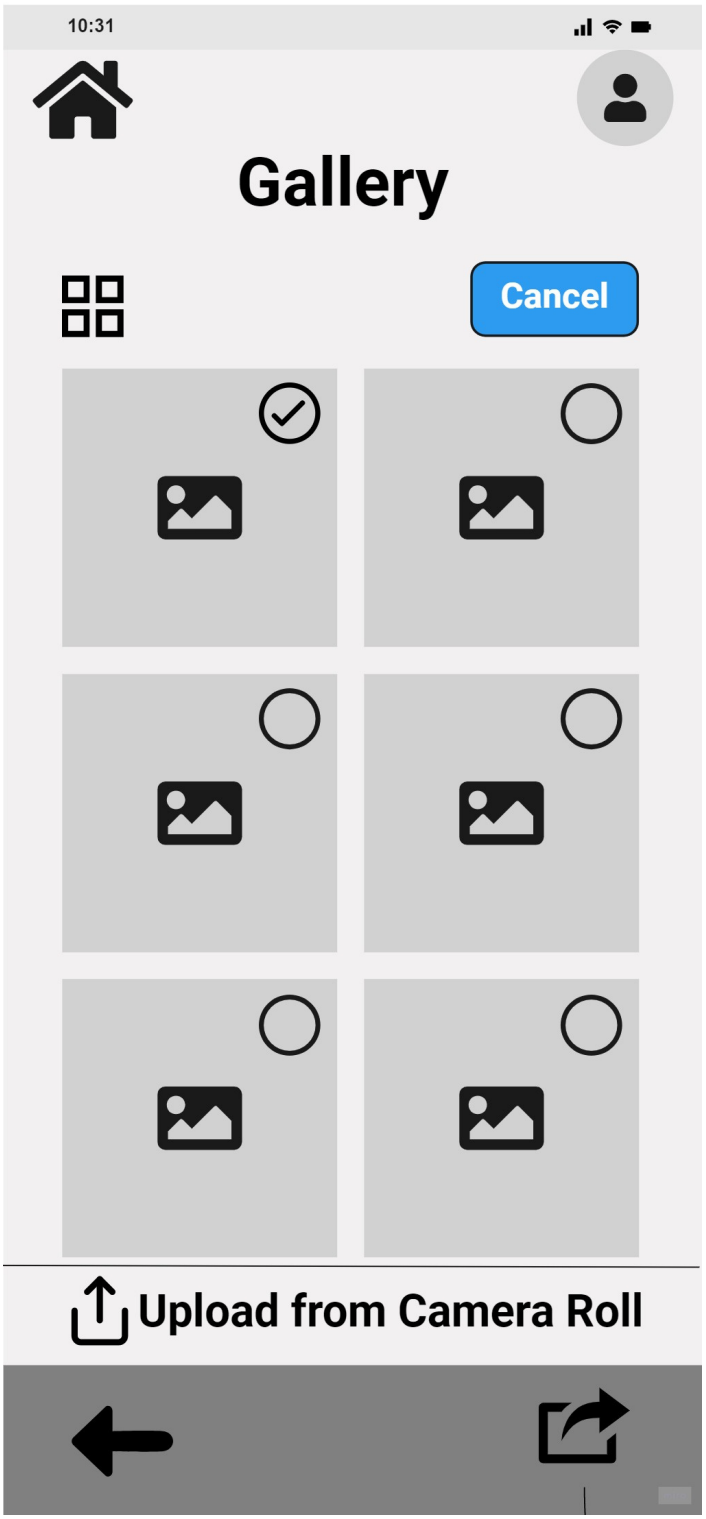
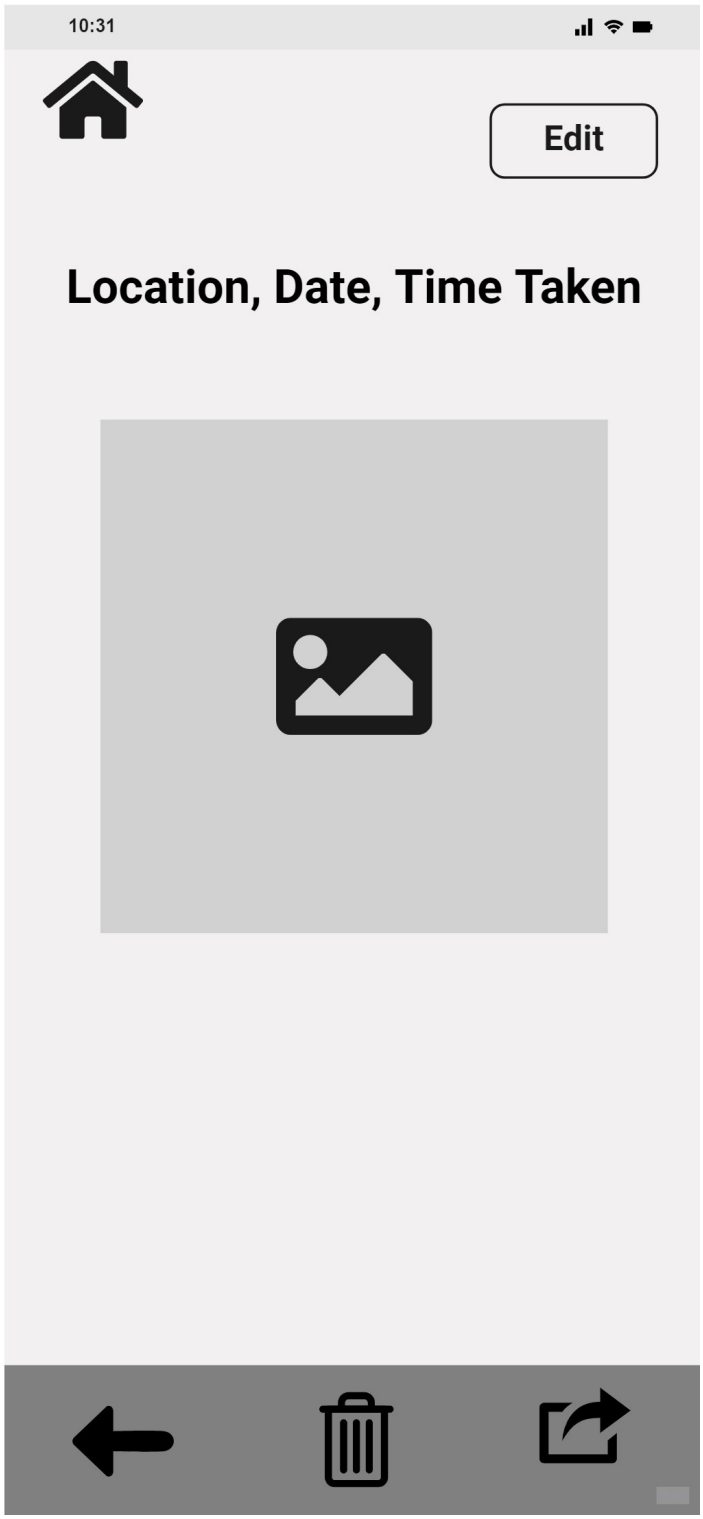
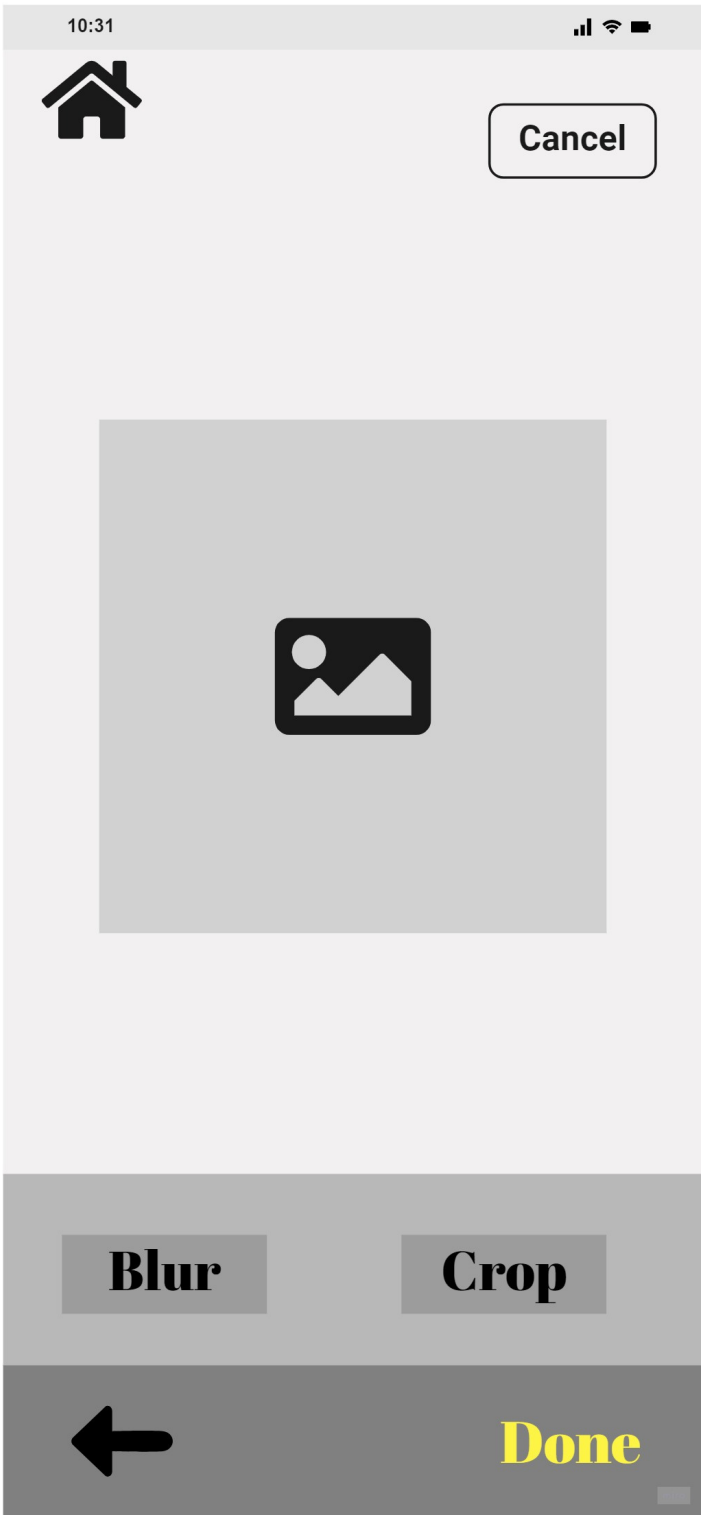




Appendix D. Original MIRO Mock-up



Appendix D. Original MIRO Mock-up

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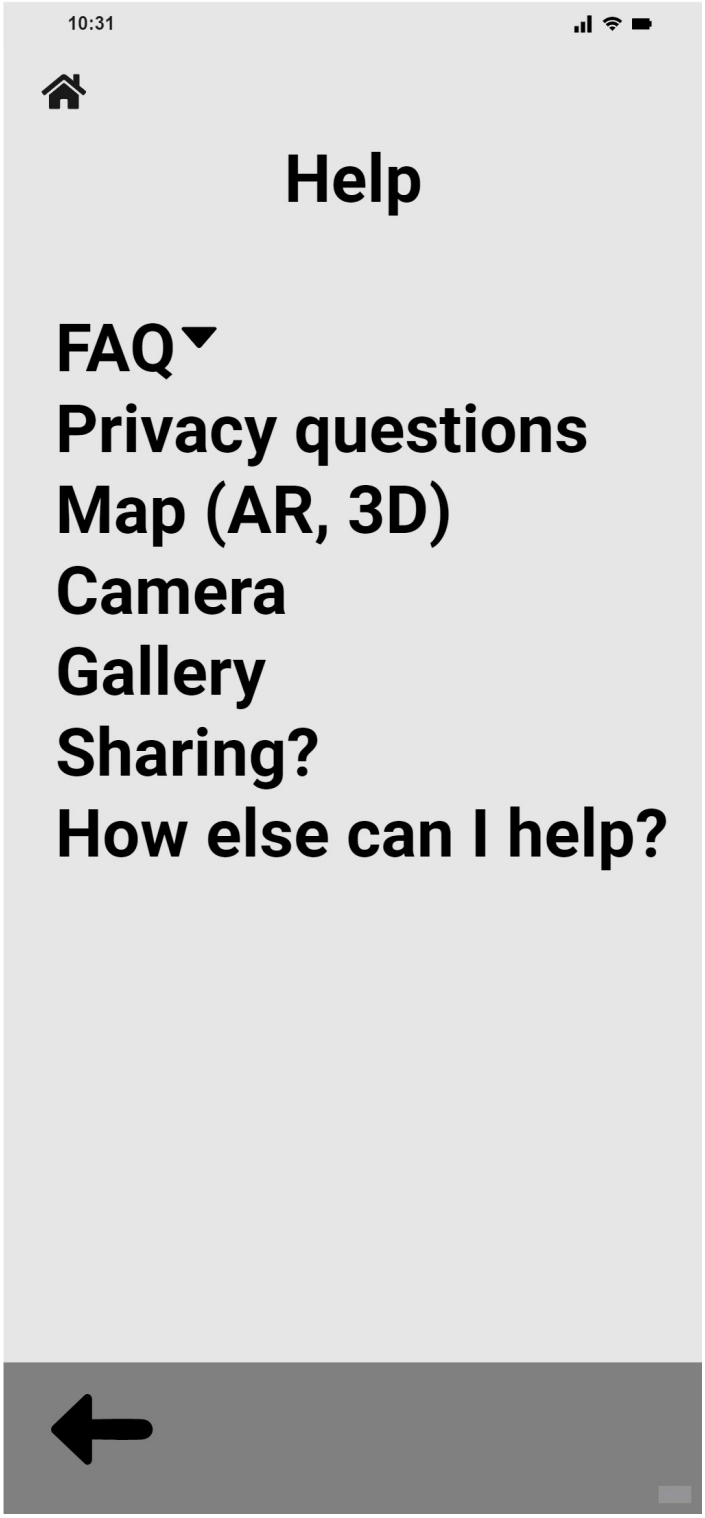


Appendix D. Original MIRO Mock-up

Additional Feature Possibilities

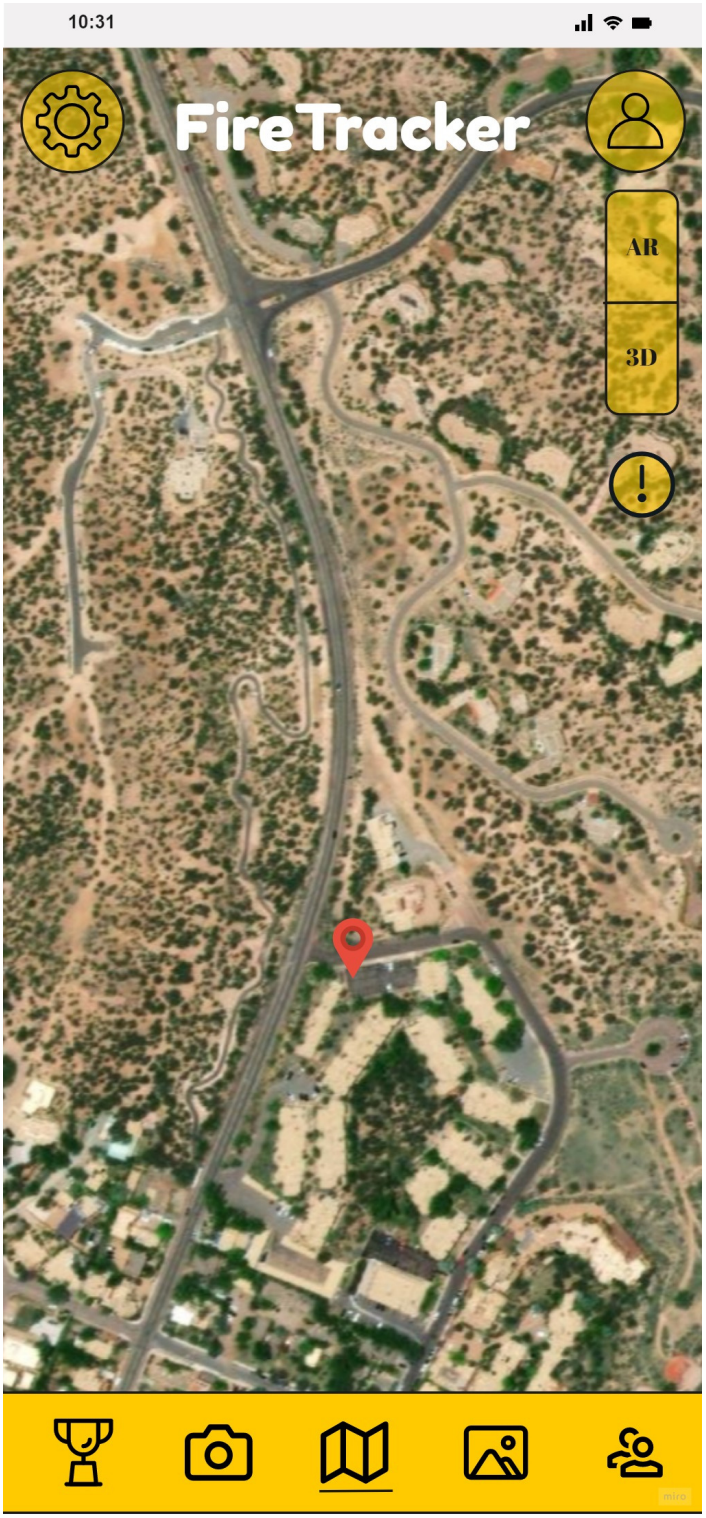
- Group/Team mode
  - Allow for families, emergency responders ect to see each other on the map feature, maybe allow groups to send notifications to each other
  - Enter in a group code or share link in order to create group
  - Enable in-sync imagery and have all cameras corresponding to same shutter time within group - photos can either all be saved to personal galleries or sent to alternate location (for ex: incident command center)
- Social Media Community
  - Enable the ability to add friends and connect with people on cloud capture to form groups, check leaderboard scores (about pixel contributions), and enable notification communication between users
  - Social media style posting of best images of the week so those who participate often get constant recognition, could offer rewards to those who are participants of the month, most calibrated images, ect. Rewards along the lines of Simtable merch.
- Incentives for setting up permanent cameras
  - Access to paid features, if they agree to set up a permanent camera they get a box sent to them with a mount and charger and maybe a shirt or something to set up the camera. They pay upfront cost for mount and charger, but once the camera is set up and functioning they get their money back. Maybe offered for the first 25 permanent cameras. They could also get a special username or something too. Something along the lines of gamification.
- Gamification incentives for manually calibrating/checking the calibration of images
  - Similar incentives to perm. Cameras. Some form of leaderboard and possibly access to paid features.

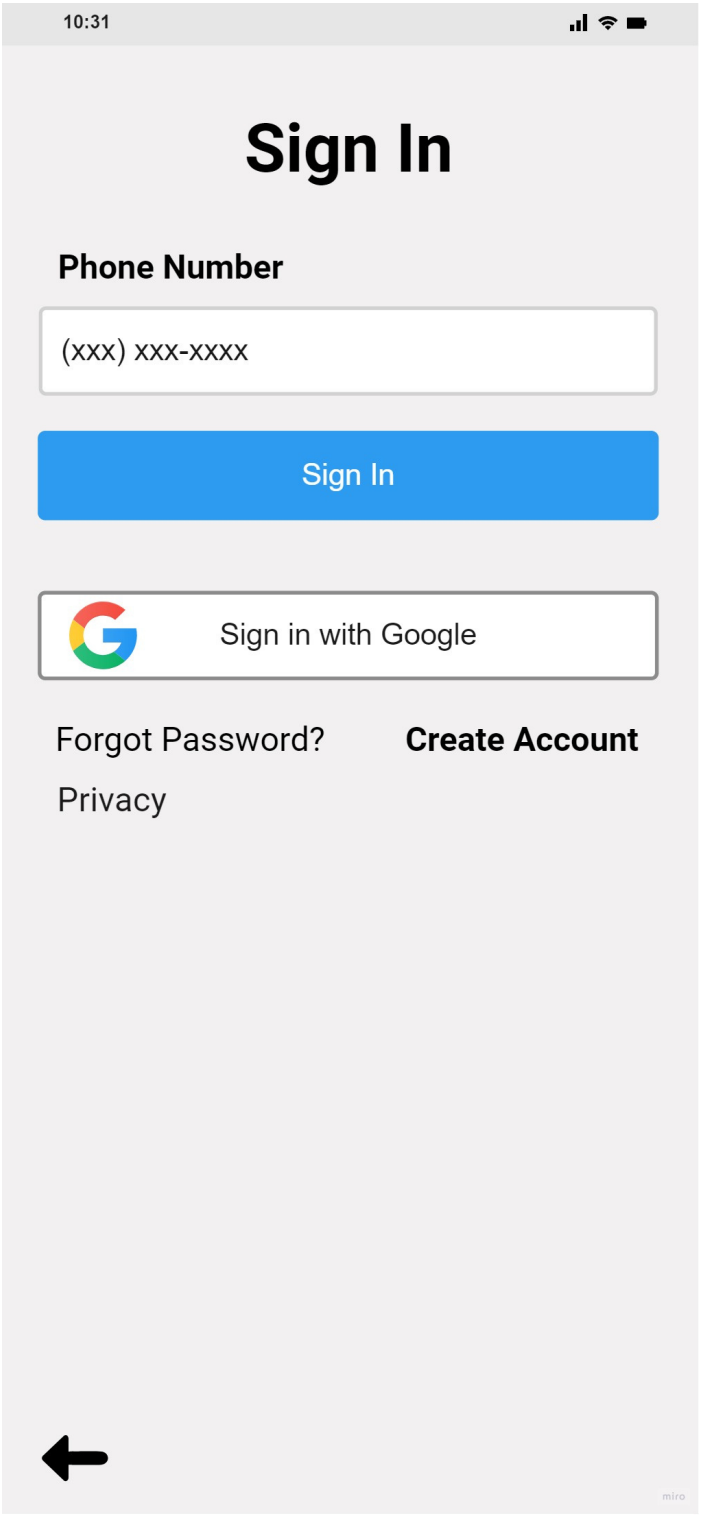
Appendix D. Original MIRO Mock-up

Additional Feature Possibilities

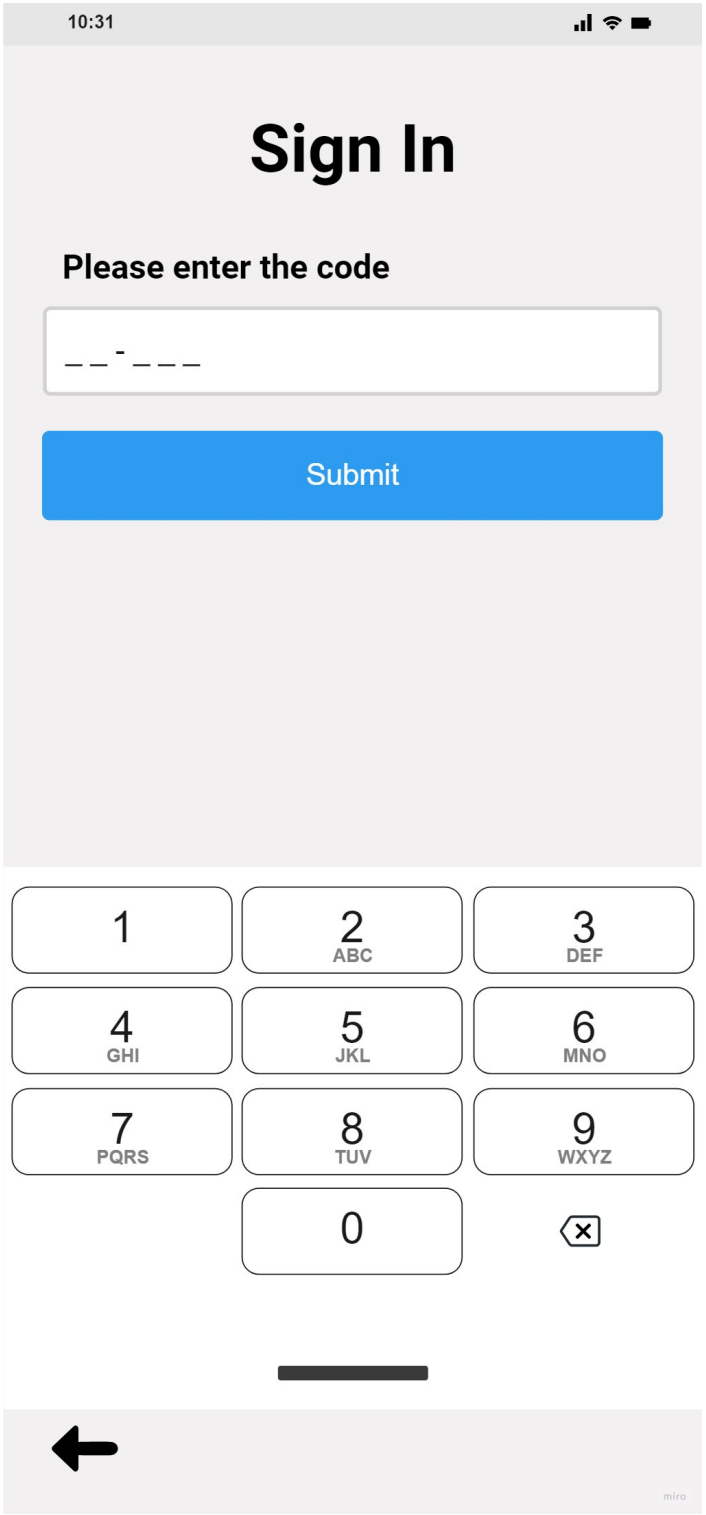
- Private usage - Monetized version of CloudCapture
  - Have the ability to view and build point clouds by using only your personal images (could include group members)
- 3D point cloud library
  - Have the ability to scroll through previous history of point clouds and look at previous data
- Map Feature - view the top ‘X’ number of fires in your area [an addition to scrolling around on map to locate the fire you are looking for]
- Additional AR features
  - Geo-tagging map features (mountains ect)
  - Cloud measurements
  - View other cameras also looking at cloud
- Gallery screen popup tutorial- forced pop up the first time you open it with skip and next options. Goes through the whole process from selecting to annotating to uploading. Help button appears in top right corner if tutorial is ever needed again.
- Uploading queue pop up on map screen

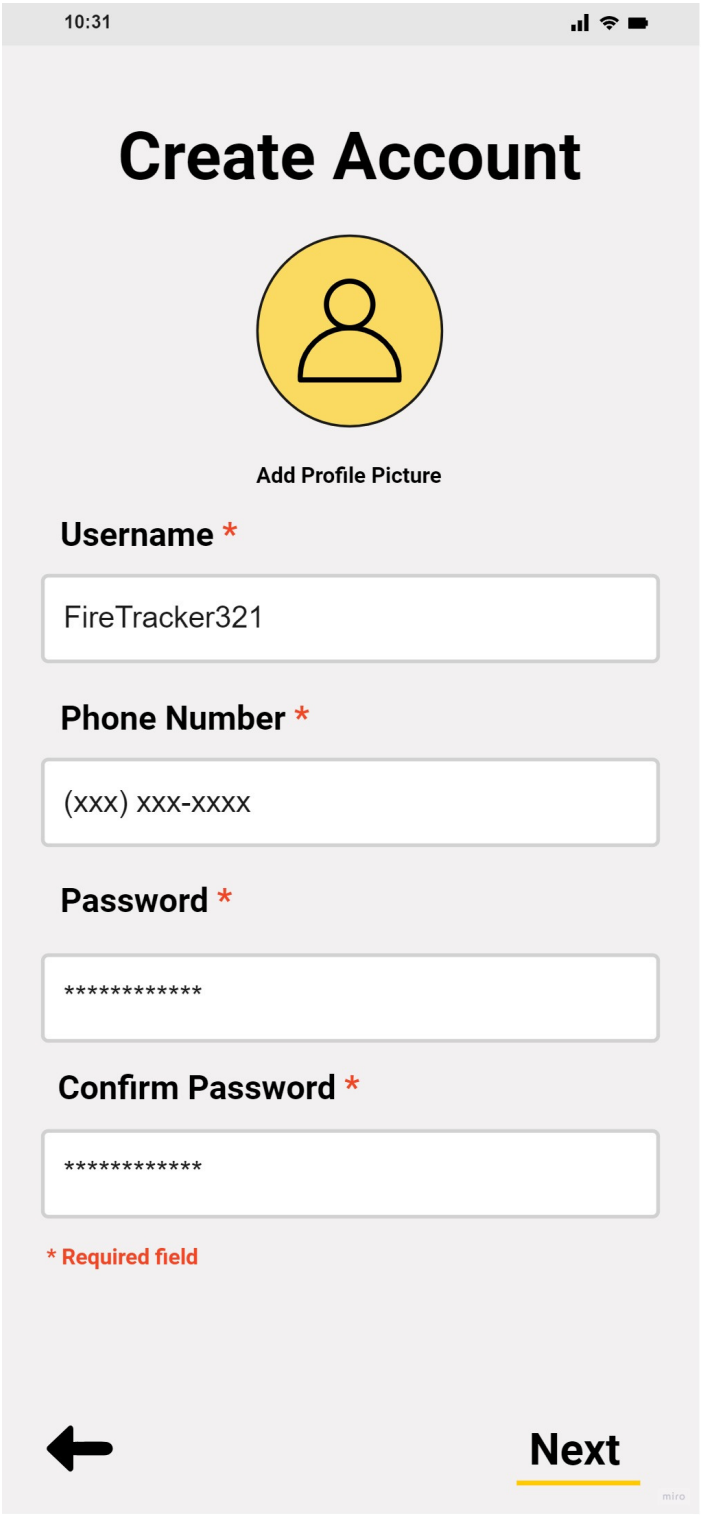
Appendix E. Final MIRO Mock-up



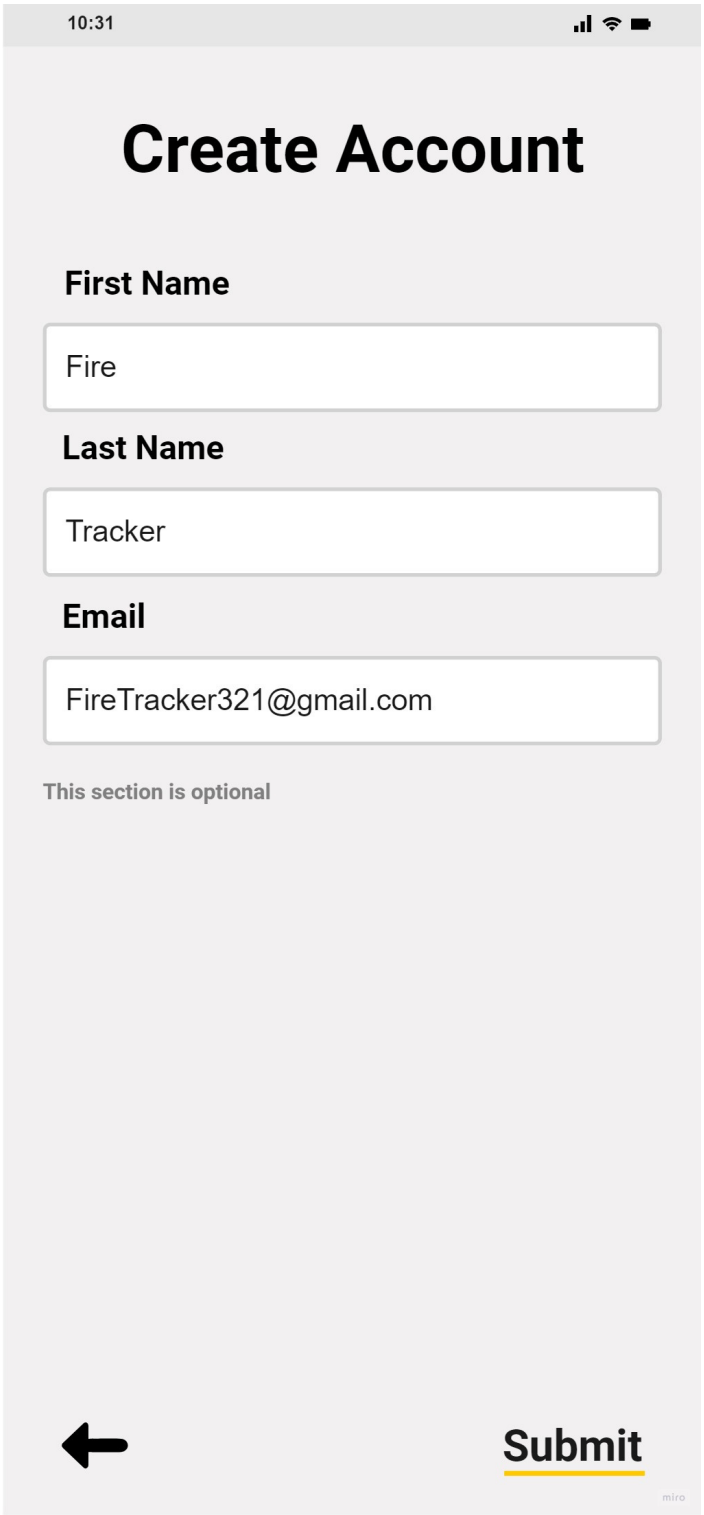


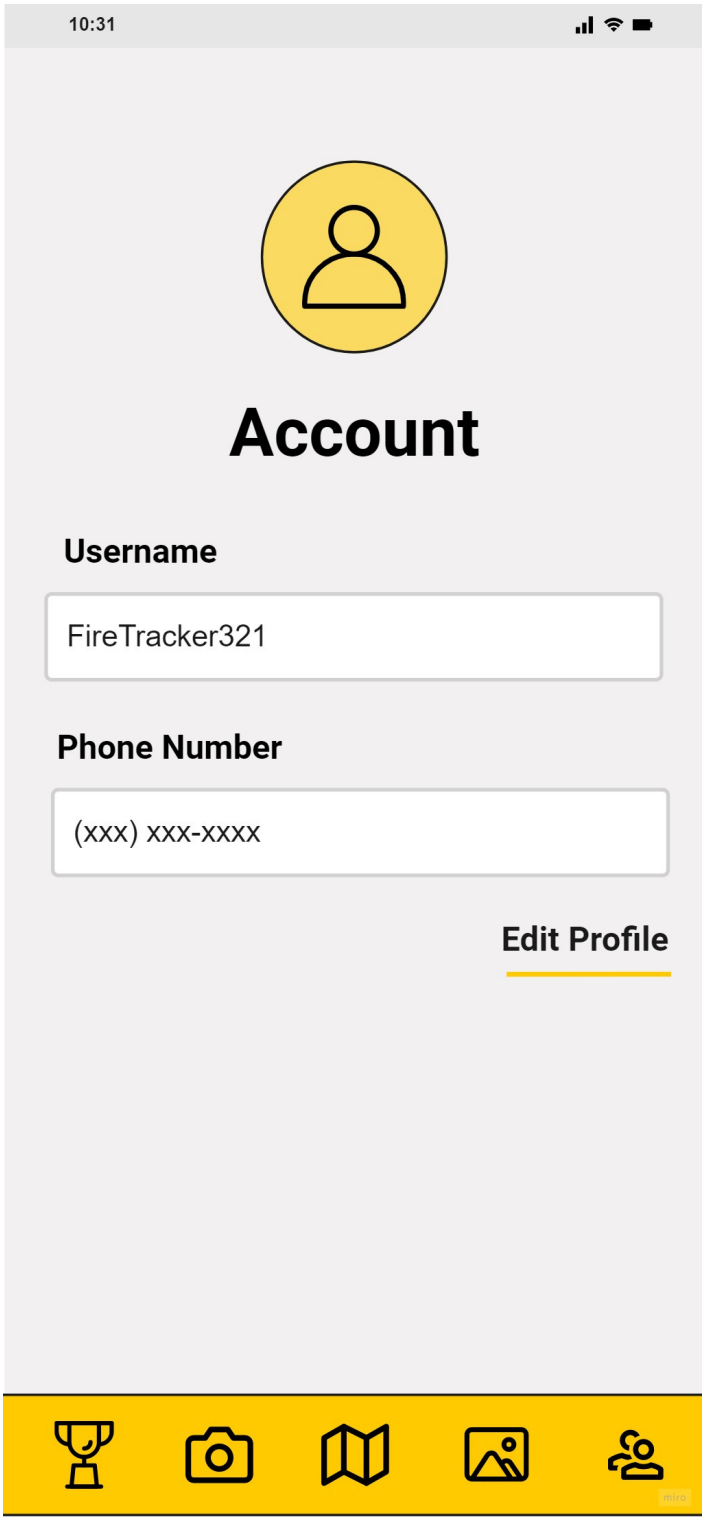
Appendix E. Final MIRO Mock-up





Appendix E. Final MIRO Mock-up





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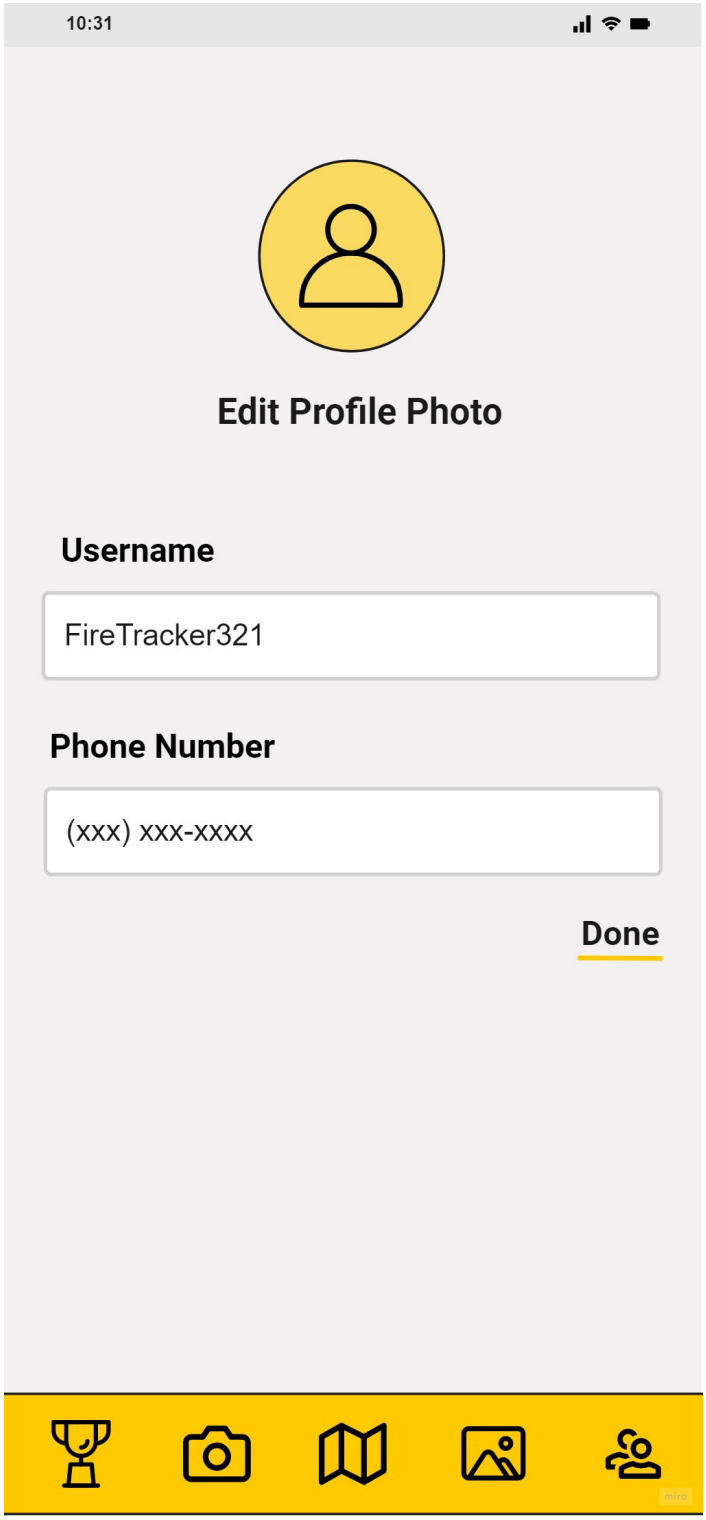

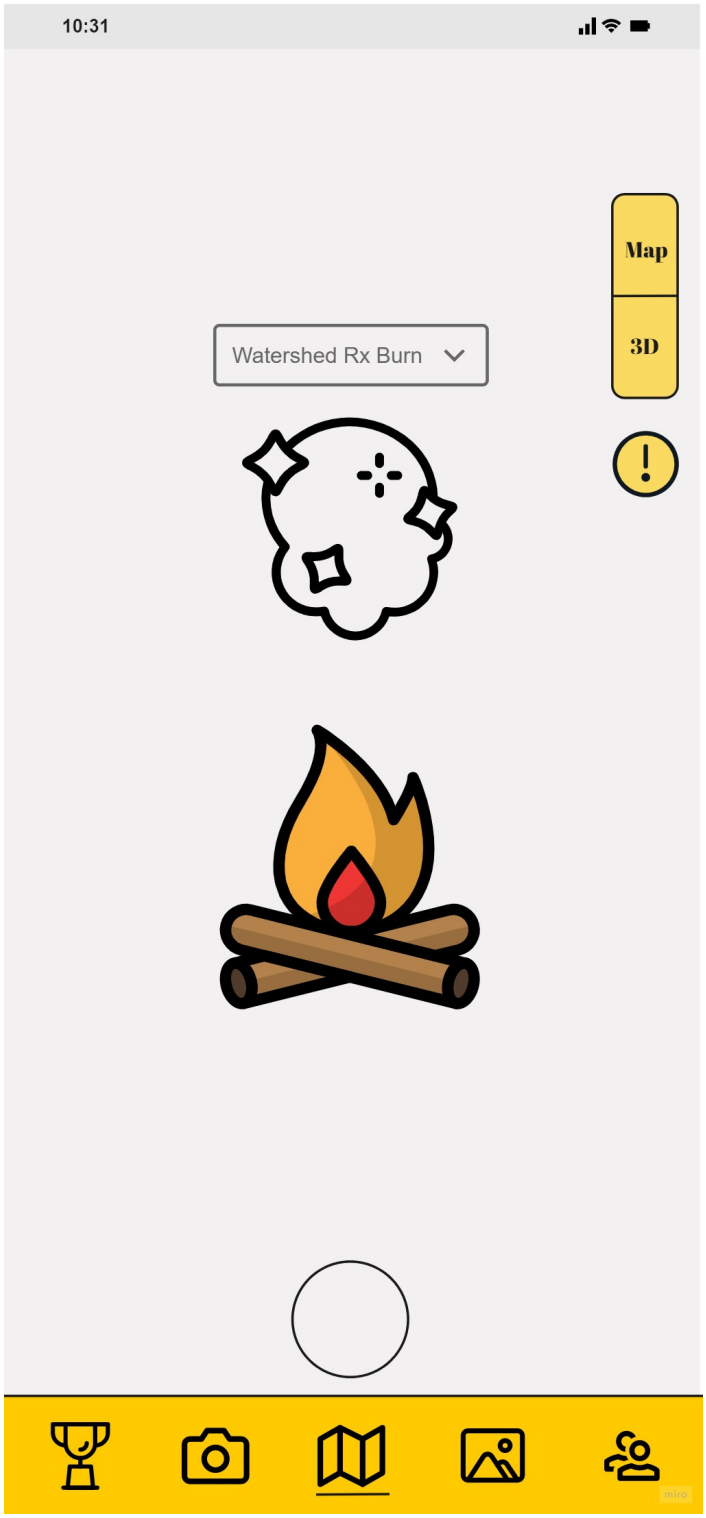

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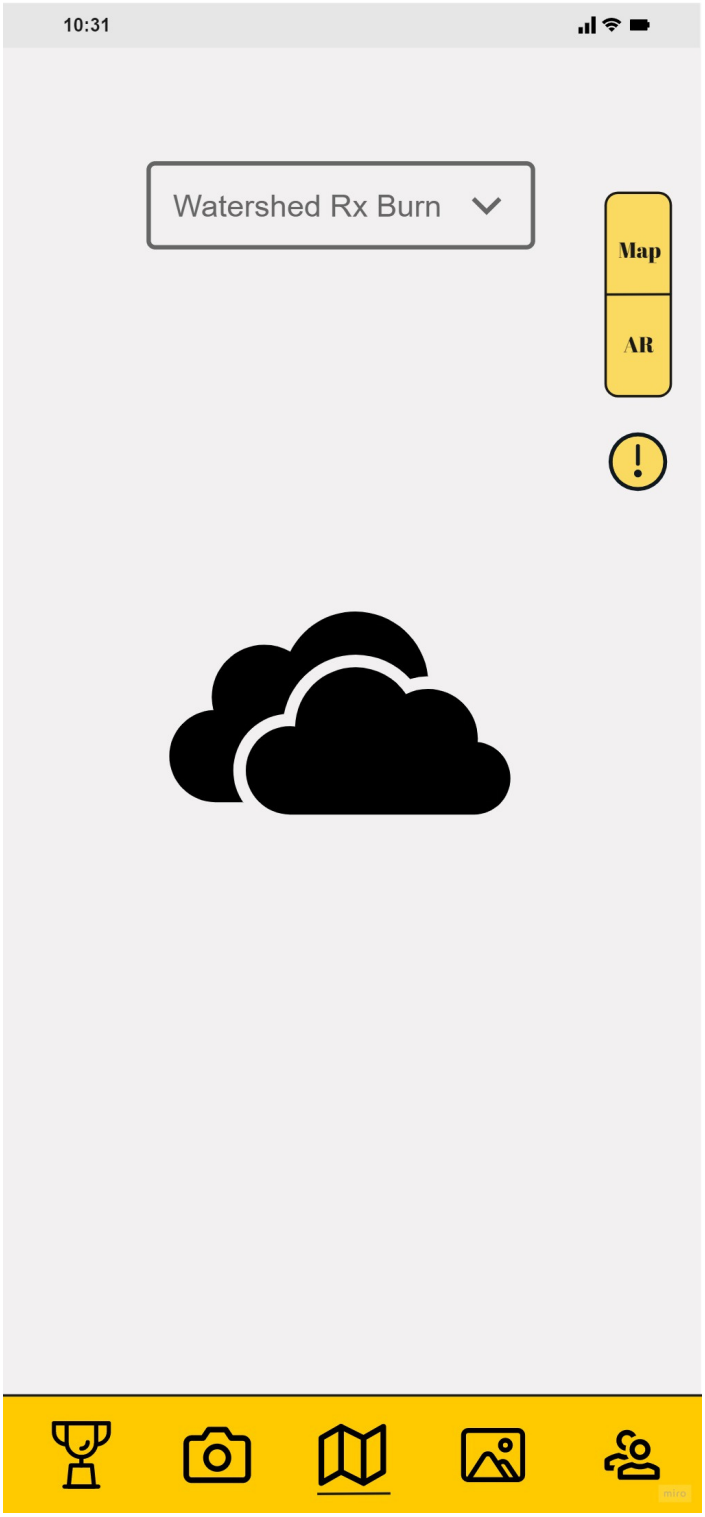

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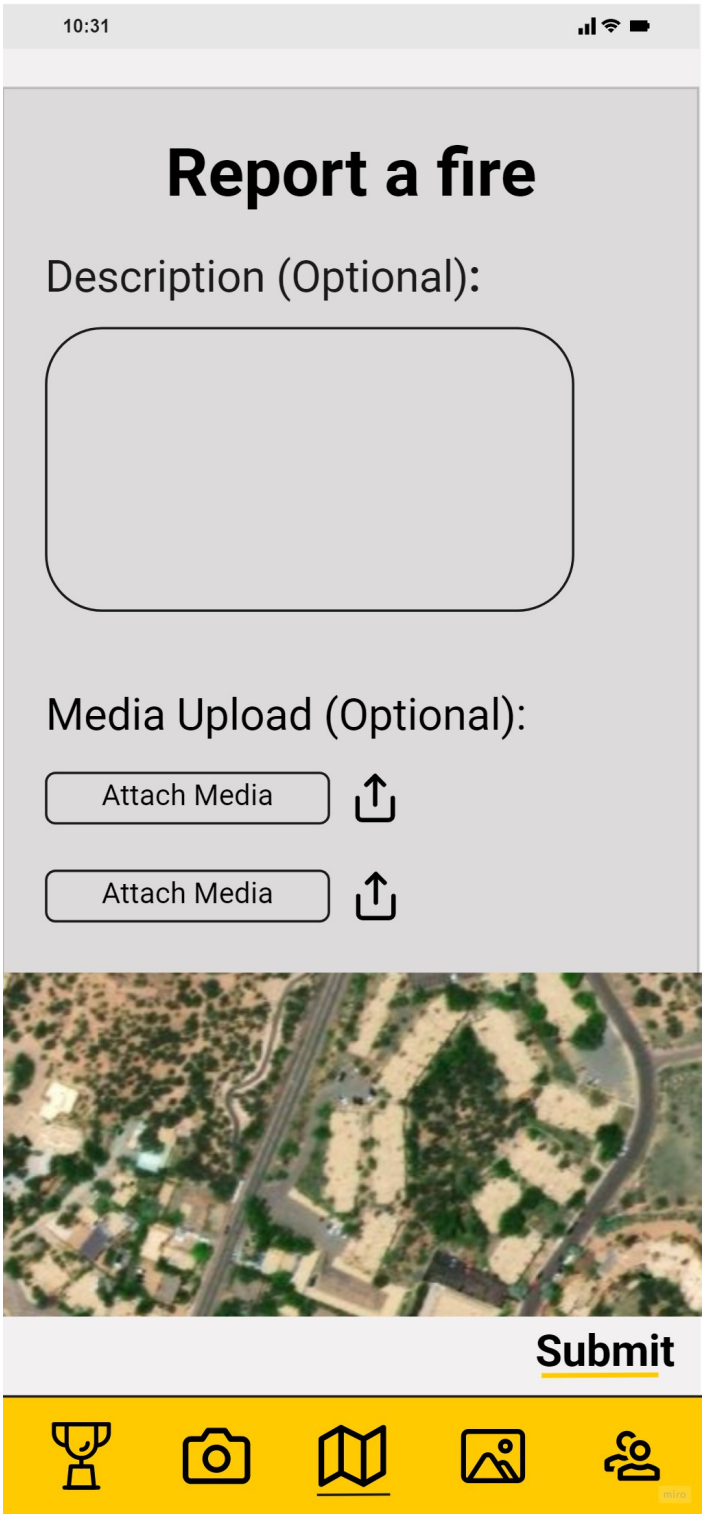

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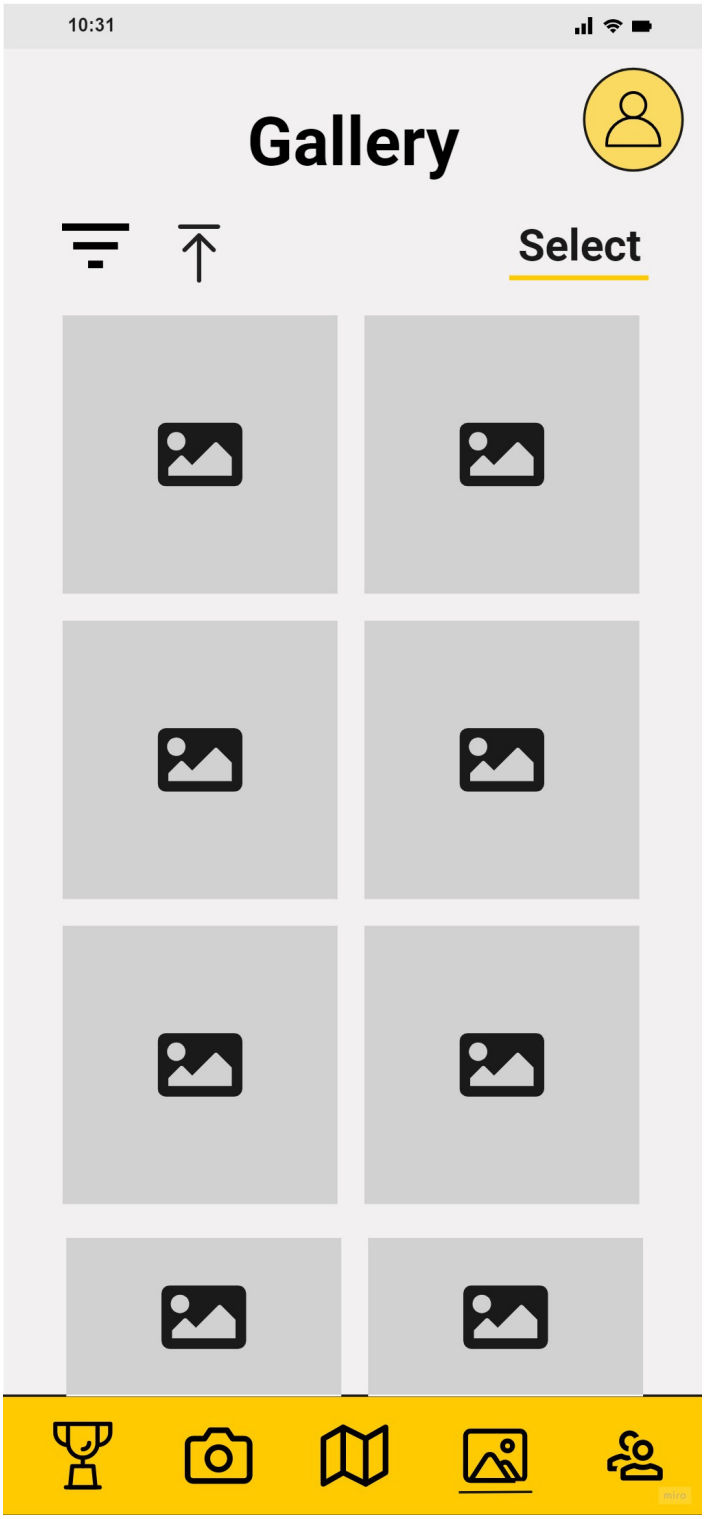

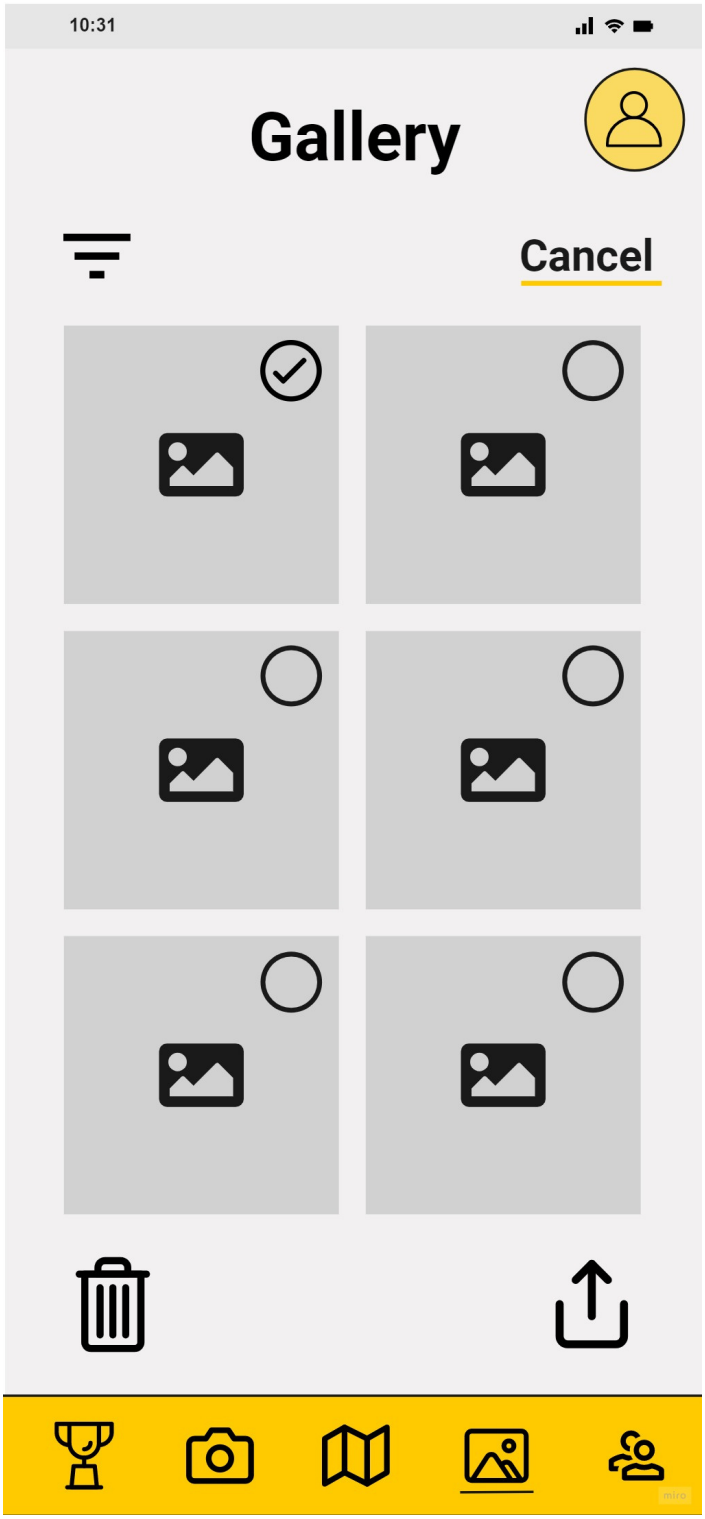

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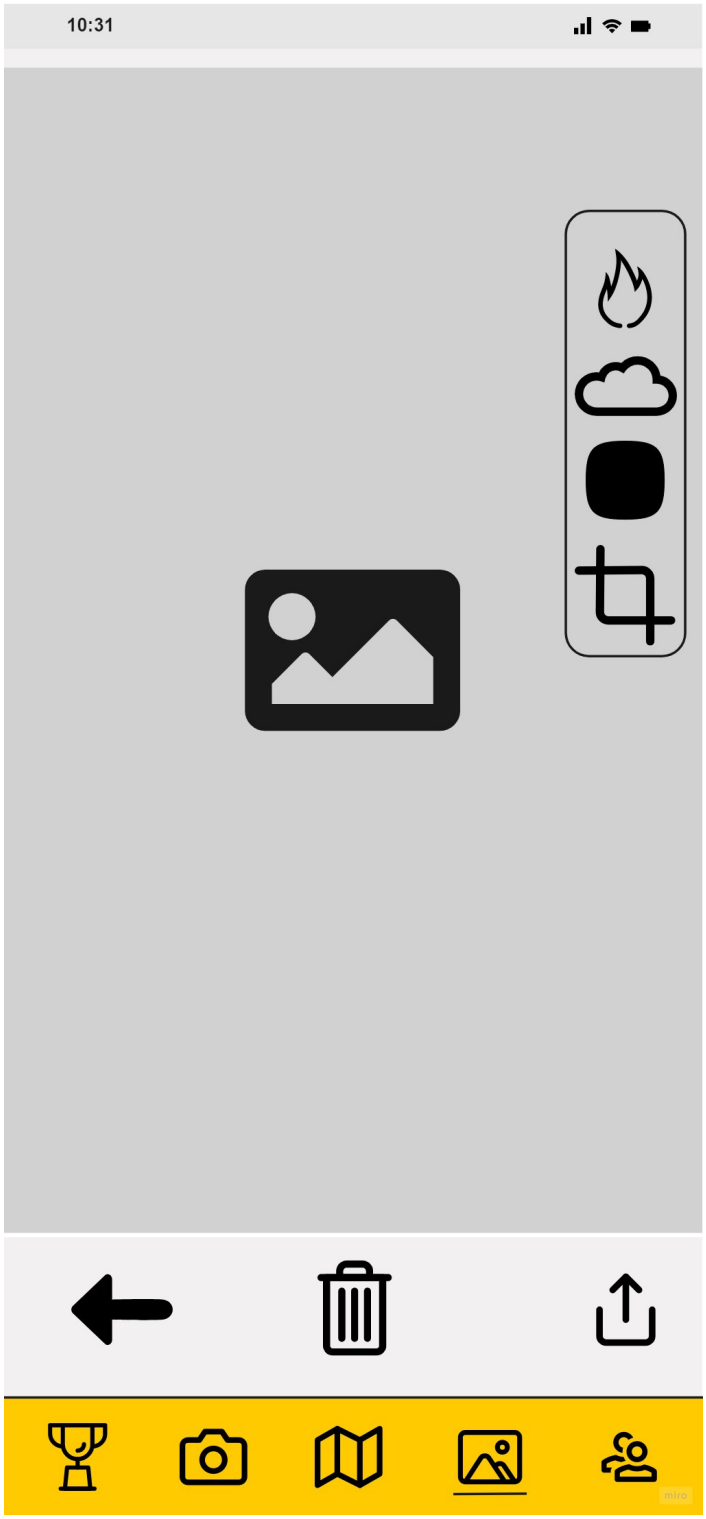

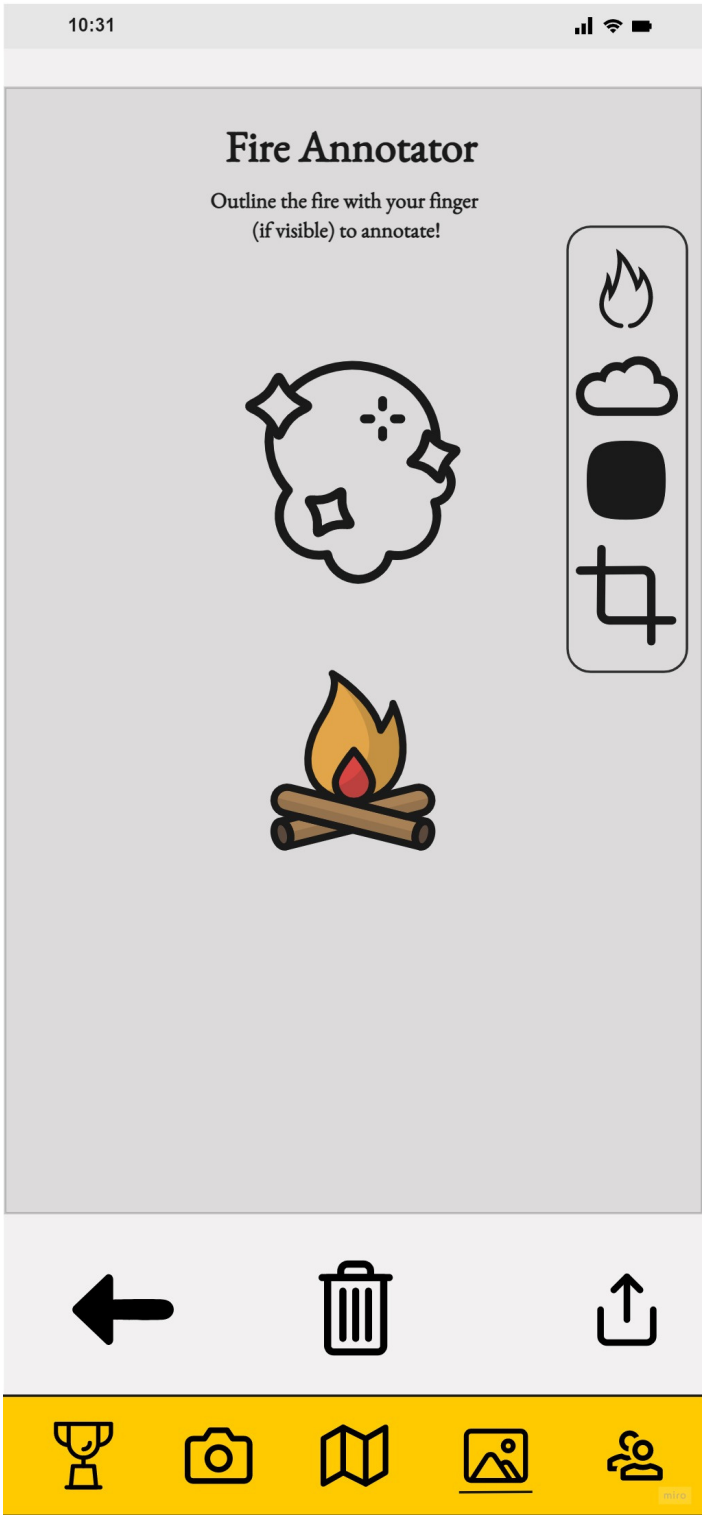

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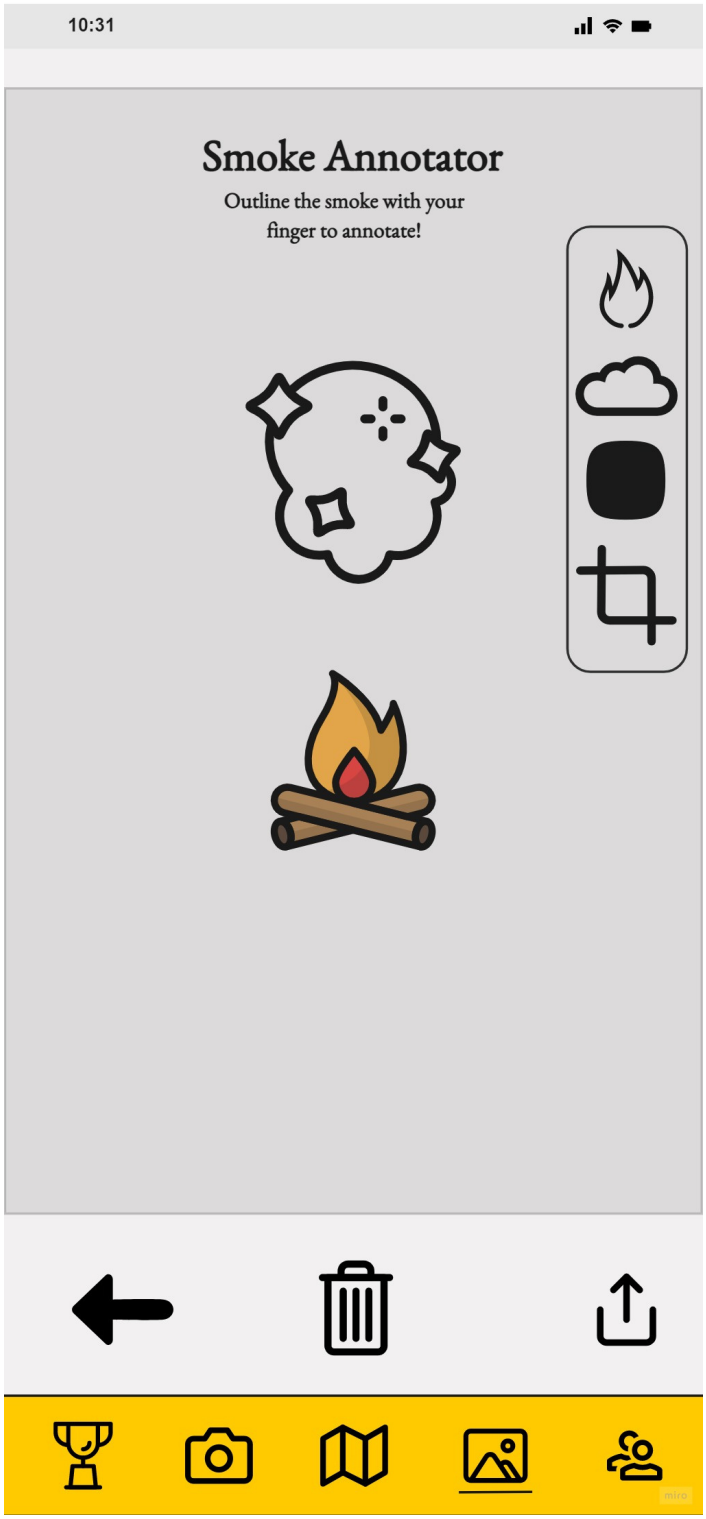

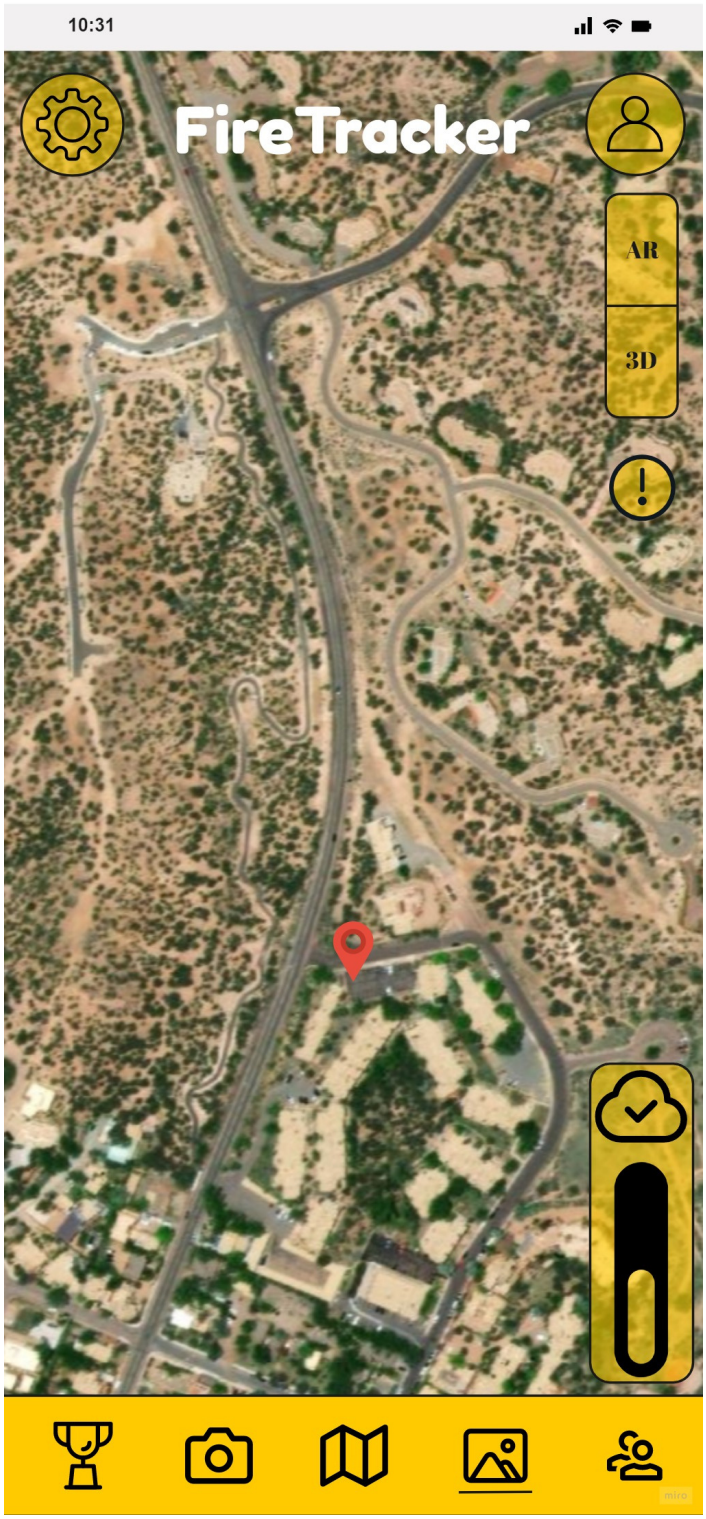

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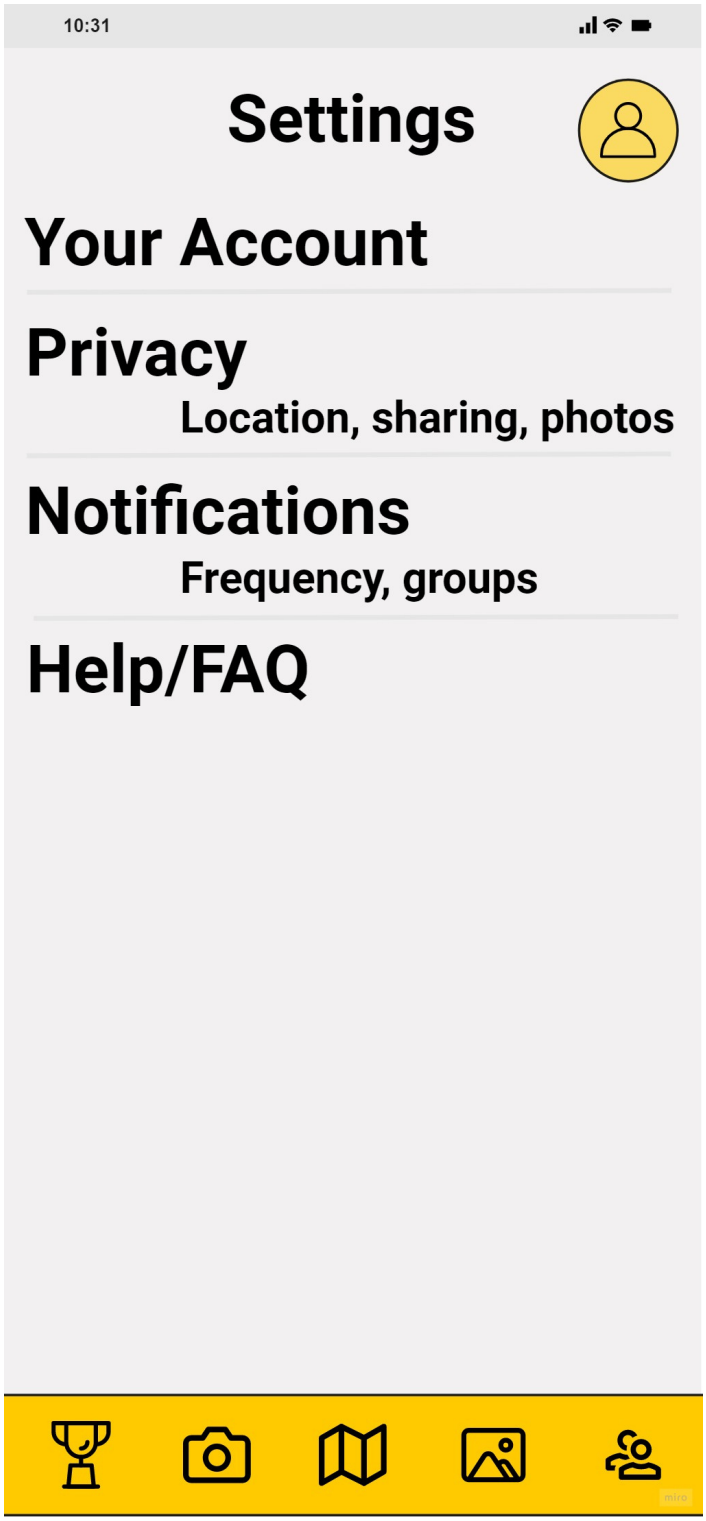

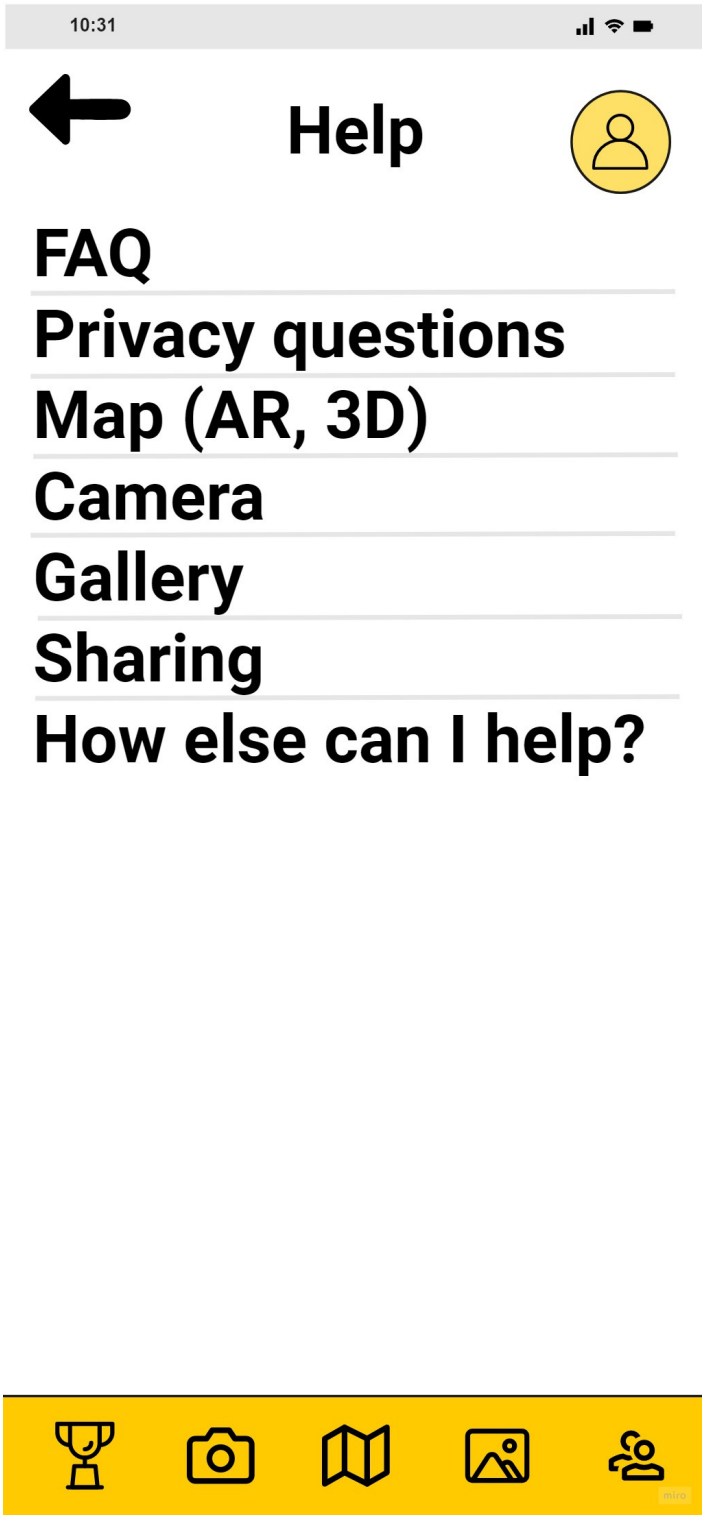

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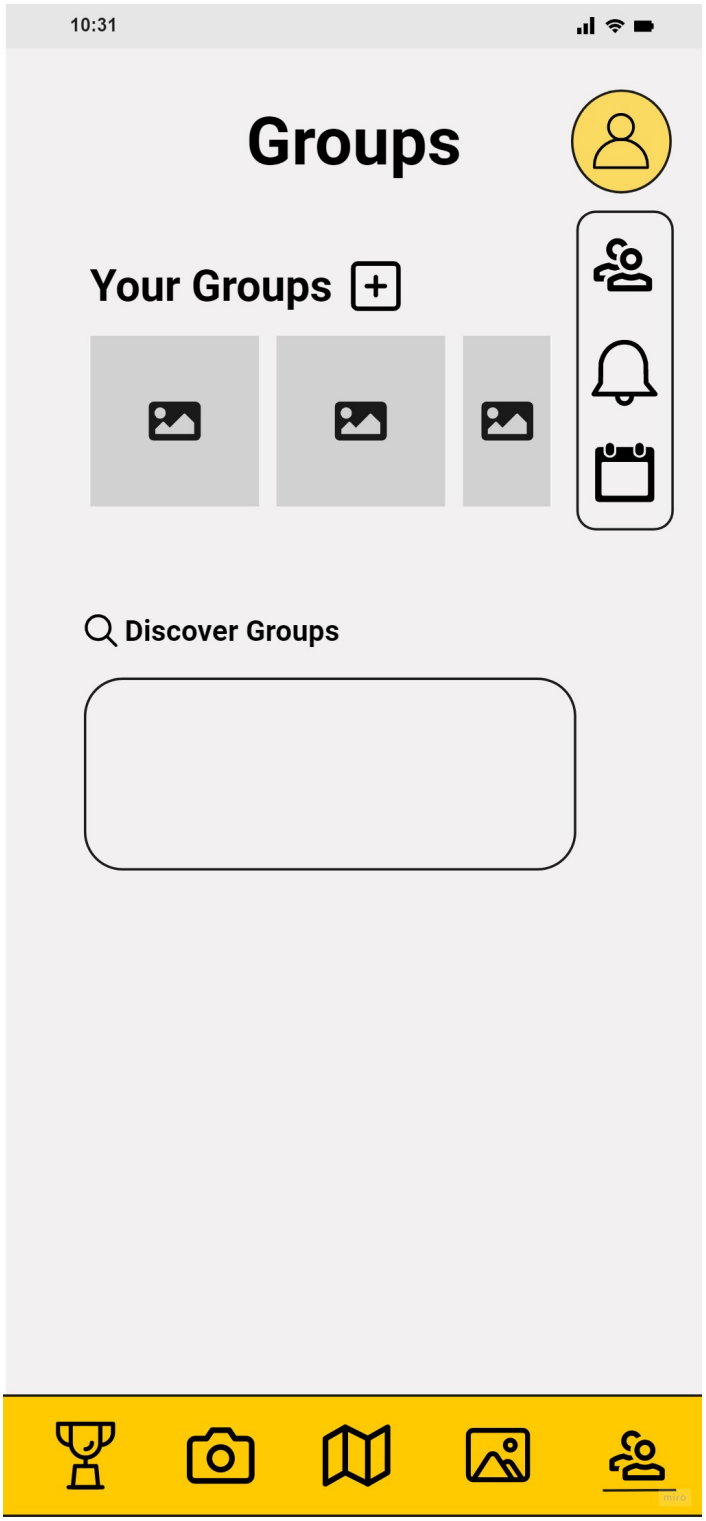

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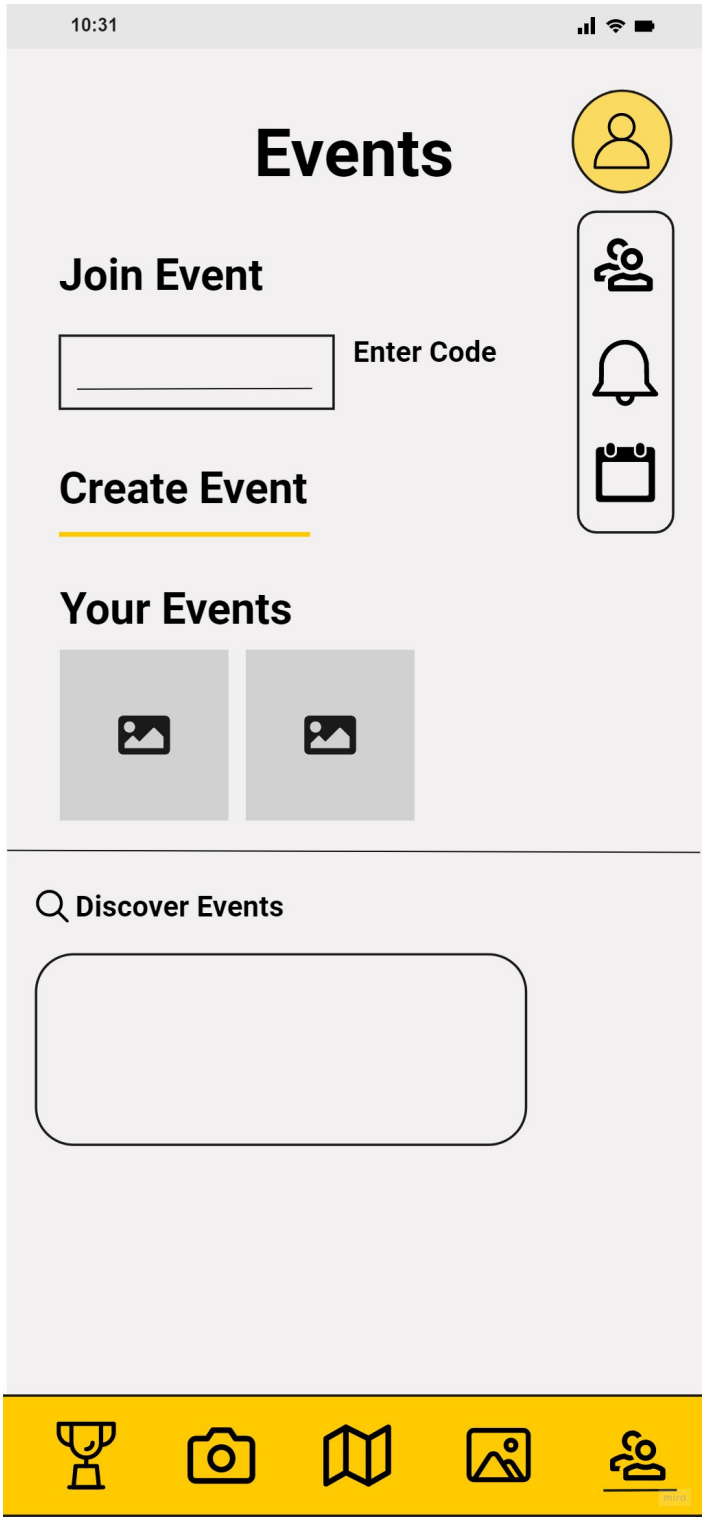

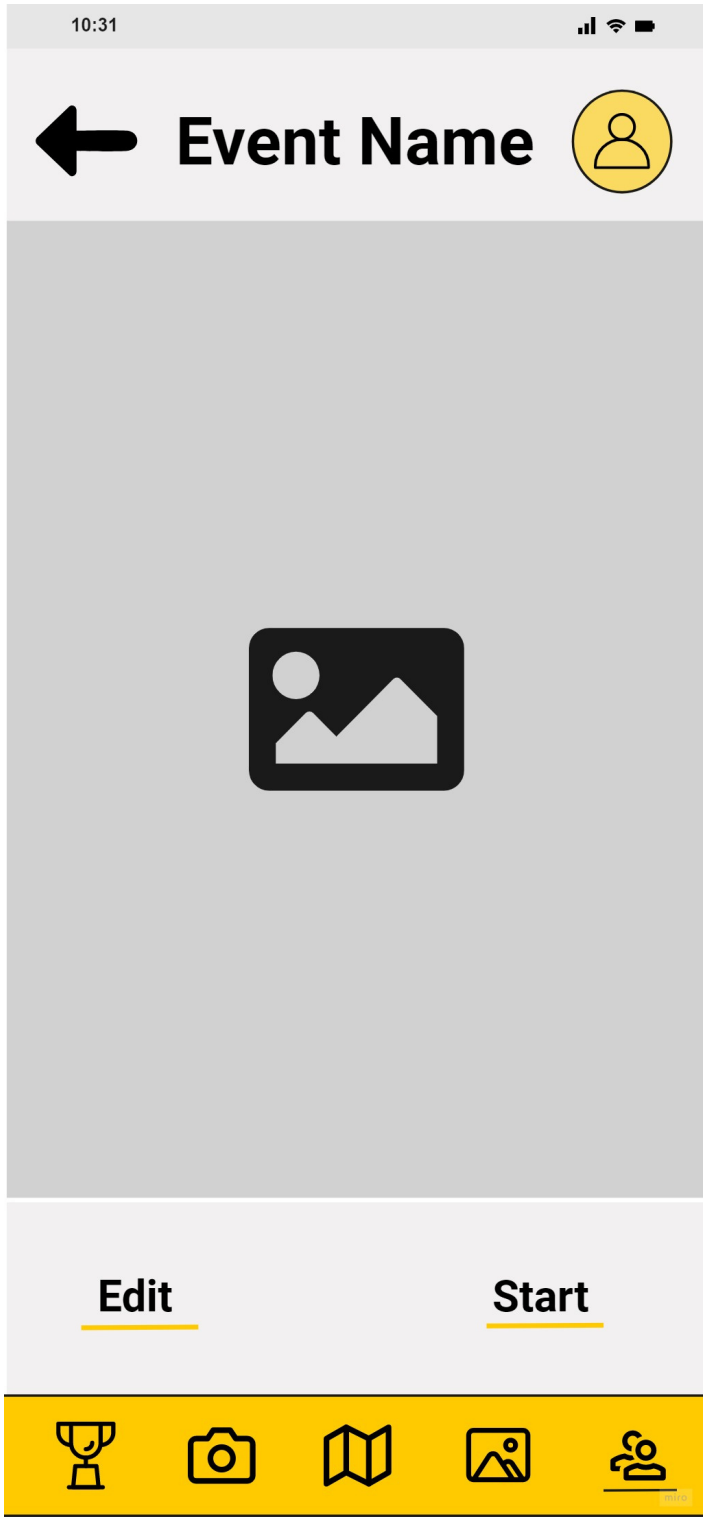

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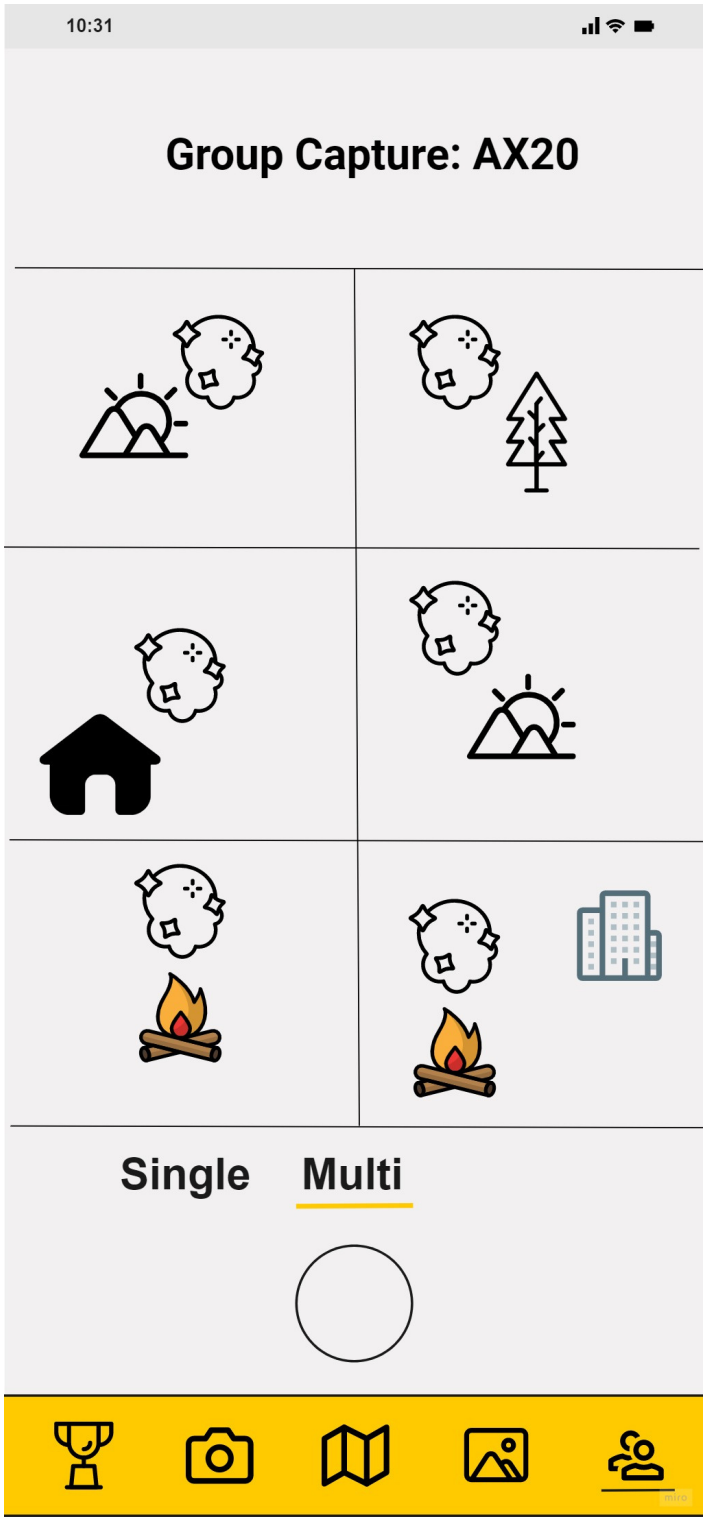
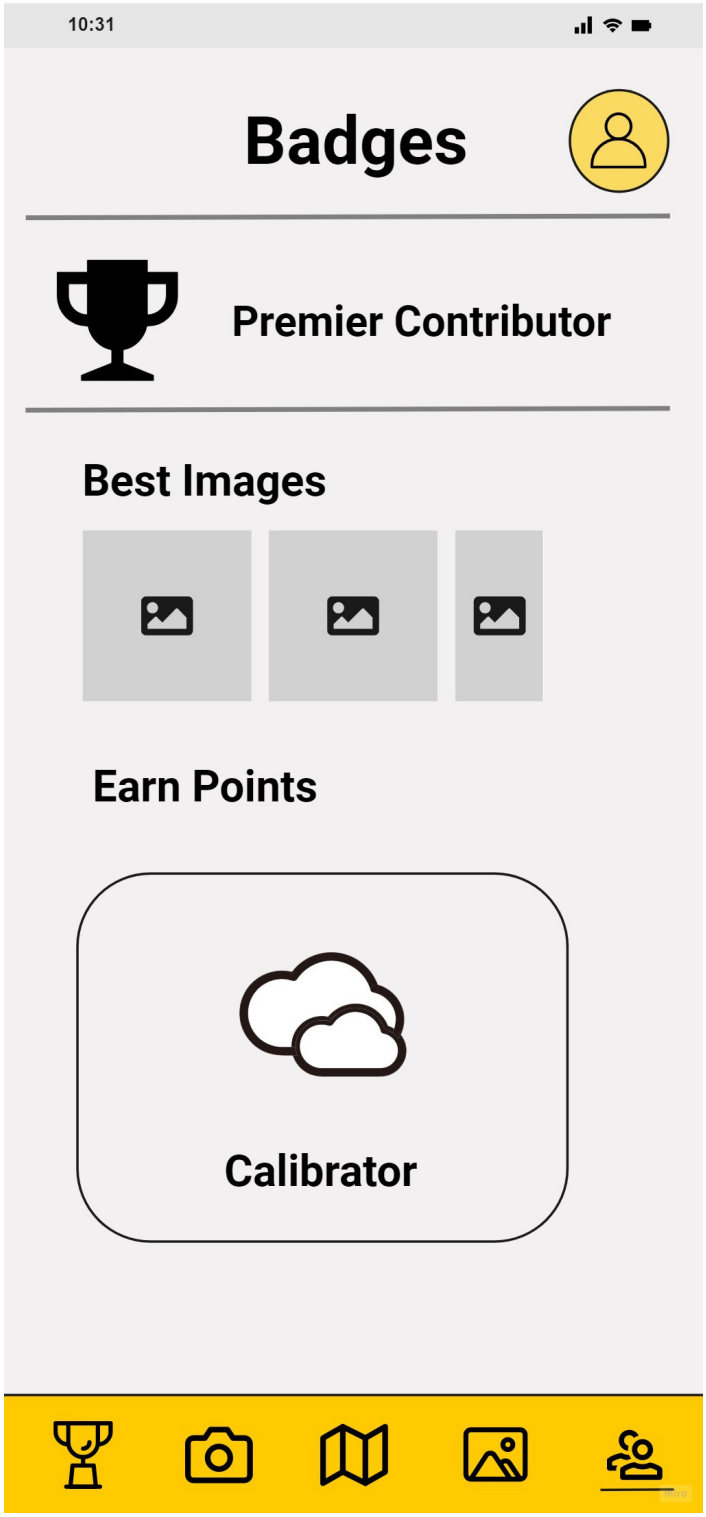


Appendix E. Final MIRO Mock-up



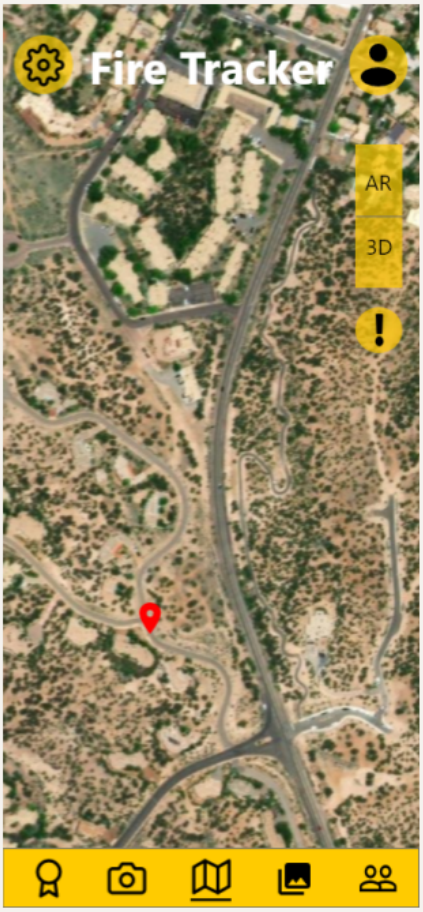
Appendix F. Interactive Mock-up

Link to view interactive Mock-up:
https://xd.adobe.com/view/bdbb2577-b8fb-43df-8970-1bed70dd3fca-e8e8/

Appendix G. Instruction Guide of Interactive Mock-up

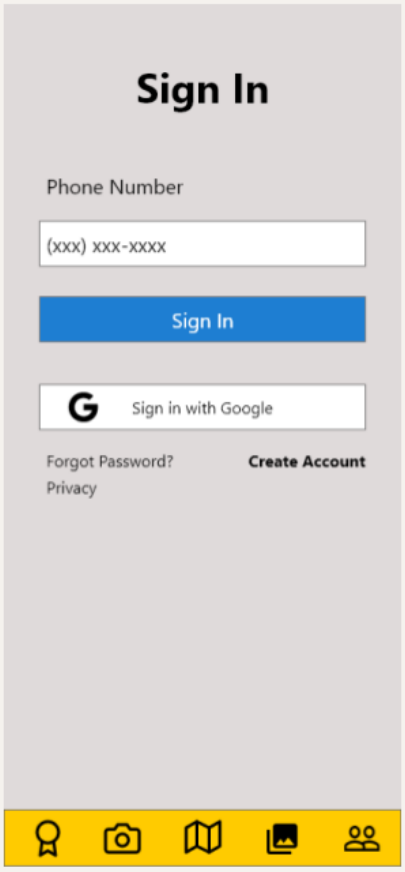
FireTracker App Instruction Guide

By Dylan Gerisch, Abigail Leonardi, Collin Levin, Hayden Smith

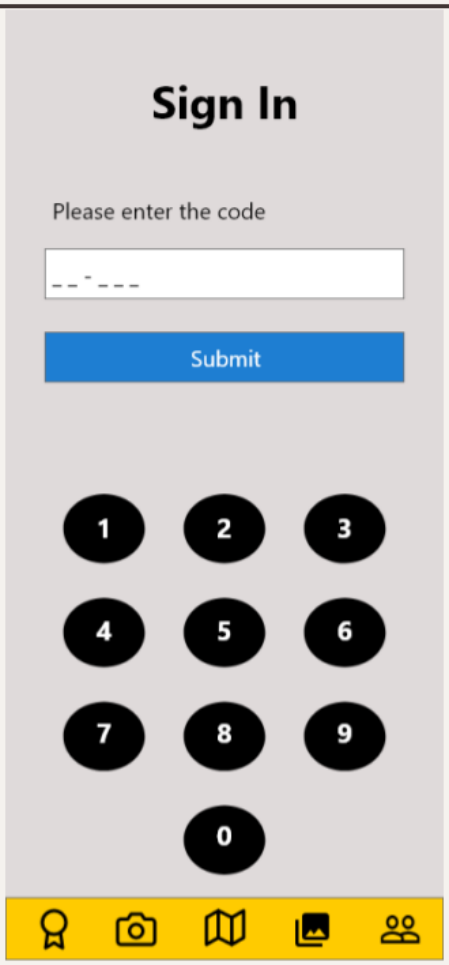


From the Home Screen you can access all of the available features of Fire Tracker. From left to right top to bottom the features are: Settings, Profile, Augmented Reality, 3D Smoke Plume, Report a Fire, Badges and Achievements, Camera, Map/Home Screen, Gallery, and Groups.

Appendix G. Instruction Guide

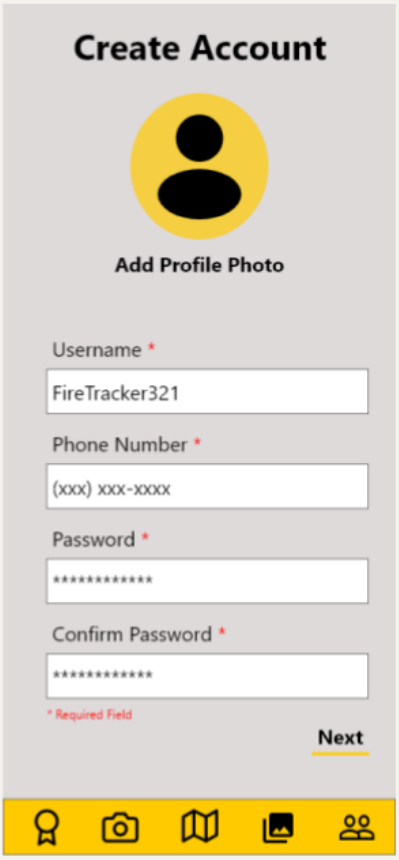


After a user creates an account they have two sign in options. The user may sign in with a one time use code sent via text, or they can sign in with a connected Google account.

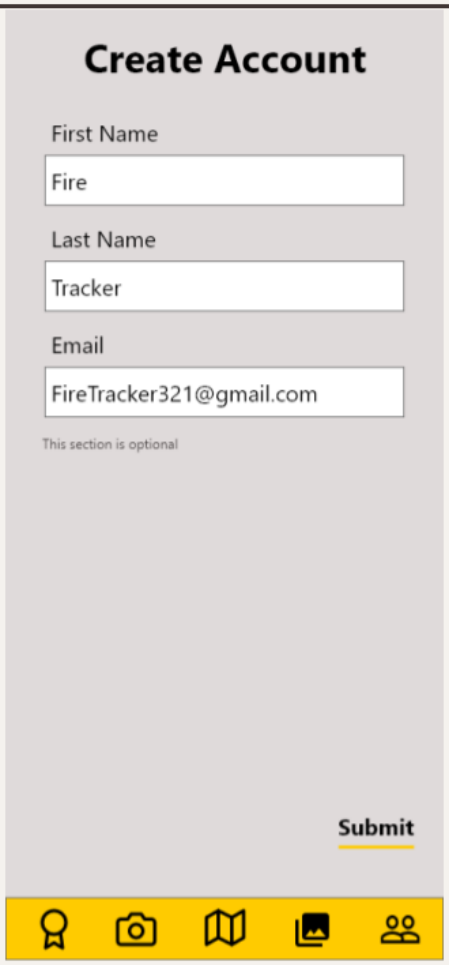


Once the user inputs their phone number on the prior screen and taps “Sign In”, they will receive their temporary sign in code to input here.

Appendix G. Instruction Guide



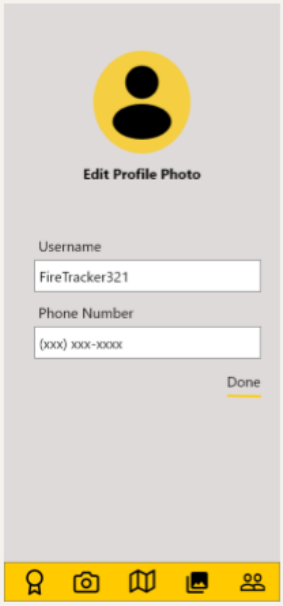
If the user does not have an account, they can tap the "Create Account" button on the sign in page. That will bring them to the Create Account page. On this screen they must create a username and password, and must provide their phone number.



Next, the user will be given the option to add their name and email. Providing this information is optional.

Appendix G. Instruction Guide

The account page is available to show a user's name and phone number. Editing is available using the edit profile button.



The edit profile page enables the user to edit their profile photo, username, and phone number. The user can tap the Done button when they're finished editing.

Here, on the Augmented Reality screen, users can point their phone at a smoke plume and have that fire identified so long as that fire has been reported. Users can also take pictures from this mode withe the annotated information and they will be saved automatically to the gallery.

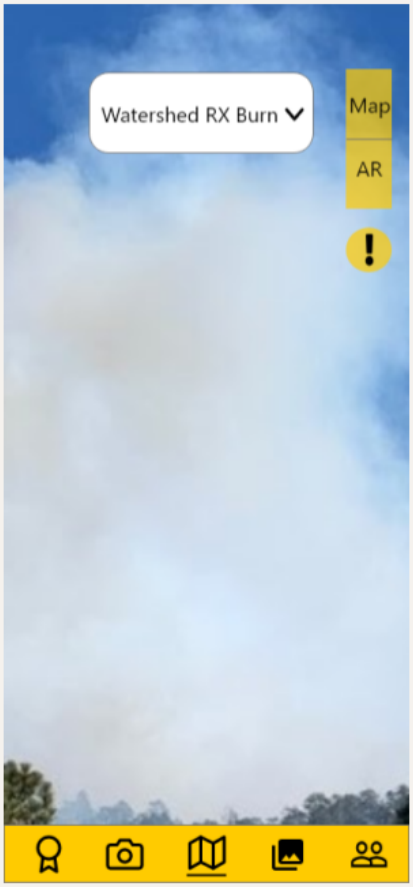
Appendix G. Instruction Guide

With the Report a Fire feature, a user can report an unidentified fire to the Police and Fire department. The user will outline the presumed area of the fire with a polygon.

On the final report screen, users can optionally add a description of the fire (location, intensity, type) and any media of the fire (photos, videos, timelapses). If the user has no extra media to submit, the presumed fire area can be submitted alone.

Appendix G. Instruction Guide

Here users will be able to view a 3D point cloud model of the selected fire's smoke plume. As imagery is provided to the model, spots where imagery is needed can be interacted with and will provide the user with a latitude, longitude, and heading. The user can then travel to that location, point in the direction of the fire, and upload that imagery to complete the model.



Our camera is not much different than one which may be found on any mobile device, but it is one of the backbones of our web app. As with a basic camera, ours can capture both still and moving images.

The Photo feature will allow the user to take a still image of a fire. This feature is best for a quick way to get the word of an active fire out to the public. To toggle between the three media options (Photo, Video, Timelapse), the user can swipe either left or right depending on which feature they would like to use.

Appendix G. Instruction Guide

The Timelapse feature will also allow the user to capture the moving progression of a fire. This feature, however, is a way of showing a fire's progression over time in a fraction of the time it took to move. When a user plays their timelapse back, it will look as though it's been sped up. This feature is best for capturing media over a long period of time. To toggle between the three media options (Photo, Video, Timelapse), the user can swipe either left or right depending on which feature they would like to use.

The Video feature will allow the user to capture the moving progression of a fire. This feature is best for capturing media over a short period of time. To toggle between the three media options (Photo, Video, Timelapse), the user can swipe either left or right depending on which feature they would like to use.

Appendix G. Instruction Guide

The gallery feature stores photos taken within the app.

The filter button enables users to filter the photos in their gallery by date, time, and if they were previously shared.

The upload button gives the ability to upload pictures from the user's camera roll on their phone.

The user has the option to tap on an individual photo to view it or they can tap the select button to share multiple images.

After hitting the Select button this screen will show up.

The user will still have the ability to filter photos while they are selecting images.

Once a user selects an image, a checkmark will show up in the circle on the top right of each photo.

The user can choose to delete the selected images by tapping the trash icon.

The user can also choose to share the selected images by tapping on the share button on the bottom right.

If the user wants to go back to the gallery, they can tap the cancel button.

Appendix G. Instruction Guide

If the user taps an image, this screen will come up with the selected image.

The user can press the back arrow to go back to the gallery.

The user can press the trash icon to delete the image.

Using the yellow vertical bar on the top right of the screen, the user can make edits to their image.

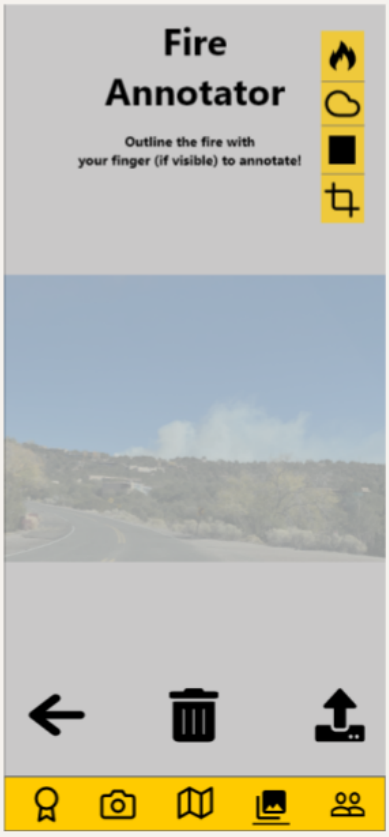
The fire icon is for the fire annotator, in which the user can annotate where fire is in the image.

The smoke icon is for the smoke annotator, which the user can annotate where smoke is in the image.

The black square is to blackout parts of the image the user doesn't want to be visible.

The crop icon is used to crop the picture.

The share button is used to share the photo after editing.



The fire annotator allows users to outline the fire in the image, if it is visible.

The user can hit the back button to go back to the original editing screen.

The user can hit the trash icon to delete the annotation.

The user can hit the share button to share their image.

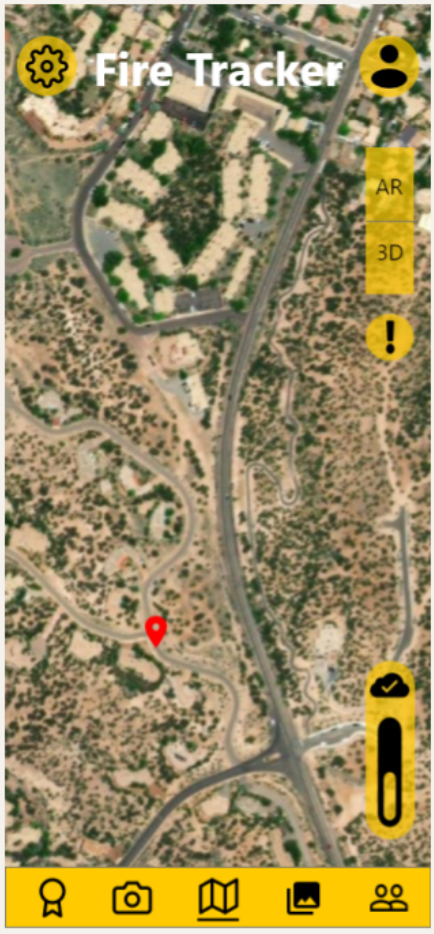
Appendix G. Instruction Guide

The smoke annotator allows users to outline where the fire plume is in the photo.

The user can hit the back button to go back to the original editing screen.

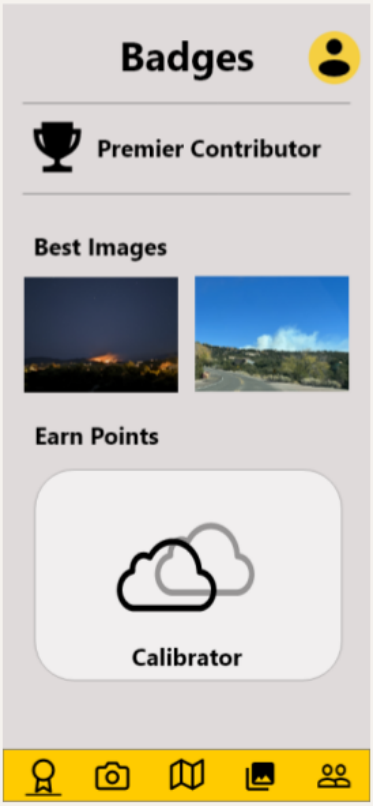
The user can hit the trash icon to delete the annotation.

The user can hit the share button to share their image.

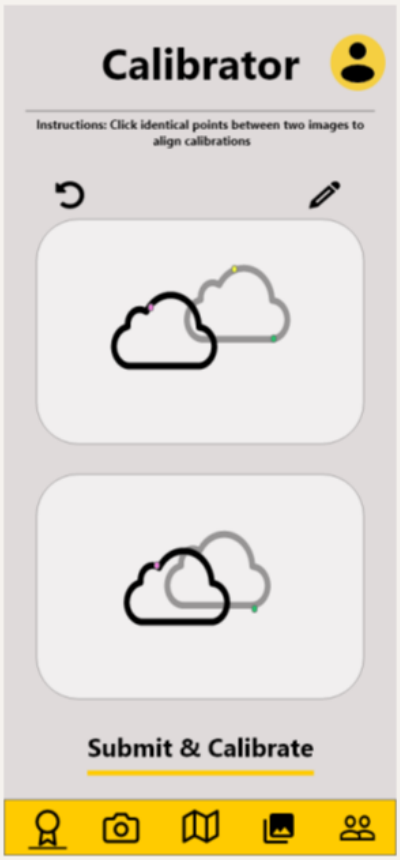


After the photo(s) are shared, a loading bar will show up on the map homepage. This will give an update to the user on the status of their photo(s) and if they have been calibrated or not.

Appendix G. Instruction Guide



One of the more exciting features of our web app is the Badges page. This page will bring a form of gamification to the UX. Badges are in-app goals for users to pursue that are tied directly to their account for the public to view. Not only will these badges provide users with public acknowledgement, but it will also give them more of an incentive to keep contributing to the web app. The more a user is compelled to contribute, the better any given fire or emergency situation can be managed. This will highly benefit public knowledge and improve public engagement while allowing the users to feel rewarded for helping their community. Finally, within the Calibrator section, a user can view the status of all of their uploaded media.



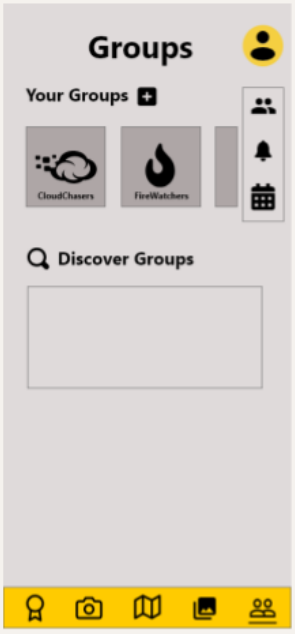
The calibrator feature is a way for users to earn points and improve their member status.

It is structured as a matching activity. The user will be presented with an image taken by a fire tracker user and either a regular landscape of the approximate location or another image of the fire.

The pencil button represents 'annotation'. The user will then be asked to place identical points of correspondence on the two images in order to calibrate them.

The back arrow button can be used to undo any unwanted annotation. After several annotation points have been identified, the user then can hit the submit and calibrate button to submit the images and earn points.

Appendix G. Instruction Guide



The groups feature of the application is meant to allow individual users to connect.

Individuals will be able to form or join a variety of groups. By participating in a group, a user will be able to coordinate imagery of fires.

On this home page of groups, denoted by the two people icon, one is able to click on any current groups they are a part of. If the user clicks the plus sign next to 'Your Groups' they will be able to create a new group. Under 'discover', the user will be able to search for new groups to join.

The sidebar contains three icons. The top indicates the group home page, the middle icon shows notifications and the last denotes events.

Notifications provide an opportunity to be updated on their groups and their fire tracking work. Users will be notified of a variety of events for example:

- The creation or invitation to a new group
- A nearby fire a group would like to start an event for
- Updates to the 3D point cloud fire that a group was capturing

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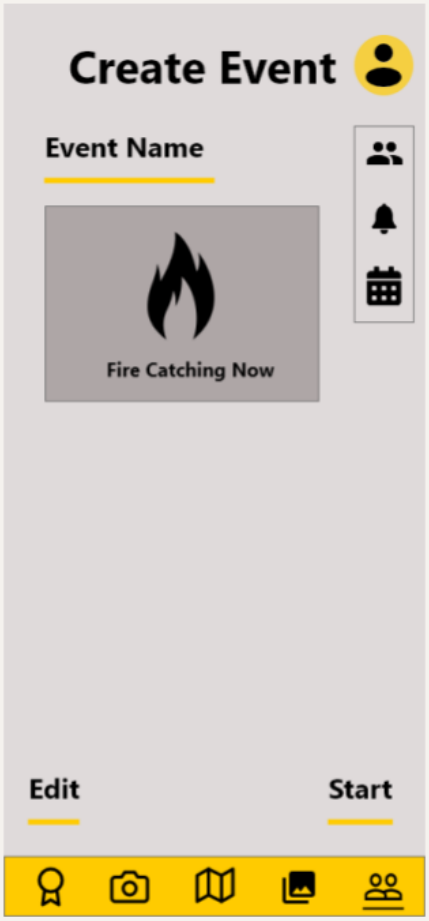
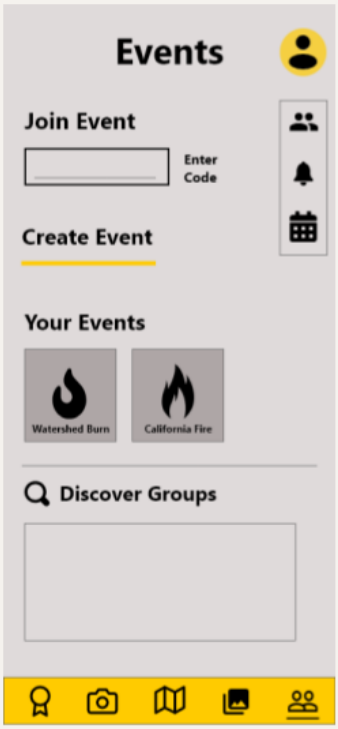
Create event provides a user to name a fire tracking event and start the group collaboration. It is possible to schedule an event in advance of it actively occurring.



Events are a way for groups to coordinate imagery. Events are meant to be started in order to collect coordinated images of a fire from many different angles.

An individual has the capability to 'Join Event' by entering a code given to them by a different user. Alternatively, a user can 'Create Event' and become the host of an event.



Upon creating an event the host will be provided with a code that they can distribute to other members. 'Your Events' will show options of current events the user is participating in.

Upon clicking on those events the user will be taken to the camera for that group. Additionally, 'Discover Events' is the opportunity for a user to search for public events to participate in.

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The user will be taken to 'single-view' for their camera upon starting or joining any event.

The feature will operate as a typical camera, however, when the shutter button is pressed all the group cameras will be triggered snapping multiple pictures at the same time.

Additionally, the user has the capability to send an invitation to invite other collaborators by clicking the send button in the upper righthand corner.

Upon taking the photo the images will all be collected and stored within the group's gallery. The groups gallery is accessible from the group page by clicking on the particular group.

'Multi view' is the alternative view for users participating in group collections. The user will be able to view all other participants' screens to see different perspectives of the fire. The shutter button is still enabled so that synchronized pictures may be taken.

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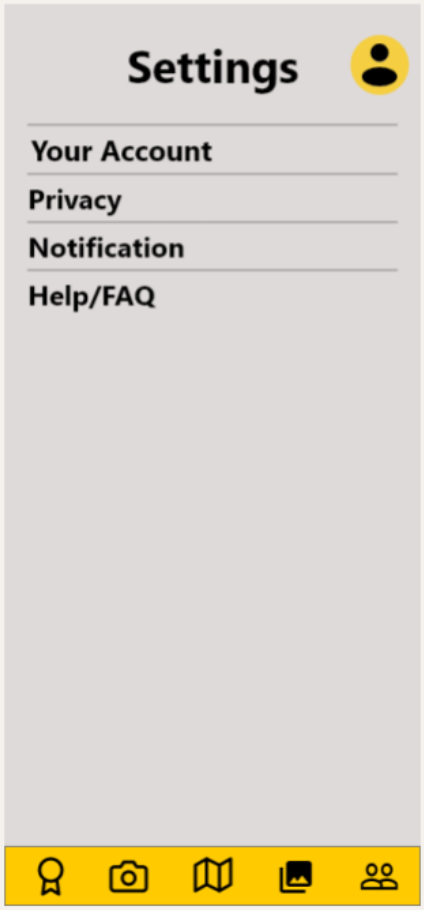
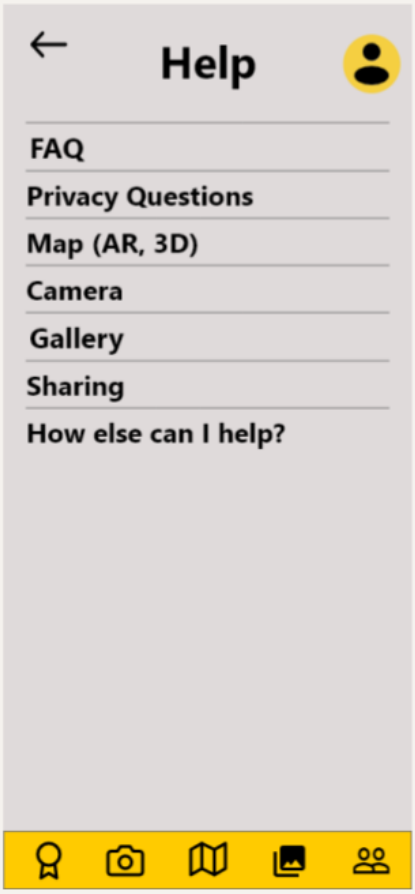


The Settings page of our web app will be one of our user's best friends. It will allow the users to not only edit their account information, but they can protect their privacy and enter the Help page for any questions they may have about the functionality of the web app. The Settings page will also allow users to control more than just their internal web app preferences. With the notifications sub-page, a user can control how often they receive notifications and what types of notifications they would like to accept.



Note: Though it may go unseen most of the time, the Help page is an important part of our UX. Our positive Help experience will help us gain user loyalty and perhaps allow them to extend recommendations to other community members.

No matter how easy to navigate we, the UI/UX developers, believe our web app to be, users may need to ask clarifying questions. The list of inquiries is as long and varied as the number of unique visitors to our web app.

Enter the Help page, a central hub where curious web app users can answer some of their more obvious queries, and where the developers can provide additional support for more complicated questions. Aside from this Frequently Asked Questions (FAQ) section, users will be able to access information on how to use each feature of the web app through the Help page. These pages will act as tutorials for even the most beginner-level users.

Finally, a "How else can I help?" section is included as a feature of our Help page. This will inform users on how they can spread the word to others about how they can contribute to the well-being of their community.