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

Project Charter
CSE 4316: Senior Design I
Fall 2022

Good Neighbors
Disaster Survey Drone

Asim Regmi
Carlos Sanchez
Danielle Pham
Faith Gutierrez
Mario Villatoro
Pratik Dhakal

Revision History

Revision	Date	Author(s)	Description
0.1	09.14.2022	PD	document creation
0.2	10.03.2022	AR, PD, DP, FG, MV, CS	complete initial draft
0.3	10.24.2022	FG	updated budget to be correct

CONTENTS

List of Figures

1 Problem Statement

In certain disaster scenarios sending a person to check on an insurance claim might be impractical or infeasible depending on the where damage is and how much damage occurred. The purpose of this project is to help State Farm develop and test the idea of creating a system that allows a State Farm Insurance Agent to validate the extent of the damage and file a claim while not having to be physically present at the insurance claim site.

2 Methodology

To solve the problem statement, we going are going to be working with a team of electrical engineers who will build a drone that can fly around the disaster site and take photos of the site. Then we, the computer science engineering team will develop a system that can use photogrammetry software to create a three-dimensional model and render that model into a virtual reality environment. Then, once in the virtual environment, the insurance agent will be able to walk around and take pictures of certain damage points as if they were at the insurance claim site in person. This will then be uploaded to a website that will automate the process of creating the insurance claim document.

3 Value Proposition

The sponsor for this project is State Farm. State Farm will benefit from this work by allowing us to develop and research for them to produce the best system we can within the given time constraints. Their choice to invest time and funding into our project will be a good investment. The value that they put in will be returned to them in a final product that follows their specifications. Having our team work on the project allows them to save resources on creating a team for this project while still allowing them to have a say in the specifications and constraints. At the end of this project, State Farm can look at the final product and result and make an educated decision to see if it is worth it to continue with this project State Farm.

4 Development Milestones

This list of core project milestones should include all major documents, demonstration of major project features, and associated deadlines. Any date that has not yet been officially scheduled at the time of preparing this document may be listed by month.

Provide a list of milestones and completion dates in the following format:

- Project Charter first draft - September 29, 2022
- System Requirements Specification - October 24, 2022
- Architectural Design Specification - November 14, 2022
- Demonstration of 3D Model - December 2022
- Demonstration of Website - January 2023
- Demonstration of walking around virtual environment - February 2023
- Demonstration of screenshots displayed on website - March 2023
- CoE Innovation Day poster presentation - April 19, 2023
- Detailed Design Specification - May 2023
- Final Project Demonstration - May 2023

5 Background

Natural Disasters occur fairly frequently around the world. They affect many people at the same time at different serveries. This project will help accelerate the process for insurance claims. The process can be very dangerous, especially after going through a natural disaster. With our system, State Farm can automate the process. They will be able to send a drone to the disaster site, calculate a 3D model, and walk around the virtual environment as if they were looking at it in person without having to leave the office. This will allow the exchange of information to be sped up.

The use of drones and photogrammetry have become more prevalent, especially in this kind of work. Many similar projects have been made where drones have done disaster surveying but have only gone as far as creating a 3D model. Our goal is to create an algorithm that creates a 3D model for any set of pictures we input. From that, we will import it into a game engine to create a virtual environment to be able to walk around with the use of a virtual reality headset. This allows the state farm agent to record what damages have been done to the property.

The development team is collaborating with the Electrical Engineering team and our sponsors. We have open communication with both teams, exchanging information and concerns about either part of the project. We also hold weekly meetings with our sponsors every Friday to voice any questions or clarifications if needed for any requirements. We also update them on our progress during these meetings.

6 Related Work

Our product will utilize drone data processing that will allow State Farm agents to interact with a virtual 3D environment of an area that has been hit by climate change. It is a vital tool for inspection, insurance, and progress updates. It will speed up the process of claims and will allow agents to do much more work in a smaller amount of time. It will save money on travels and provide an easy, cheap, fast, reliable method for agents to inspect a damaged area. "Insurance companies can assess damage quicker, safely and more efficiently with drone operations" [1].

Unless the agent is at the actual site, it would be difficult to examine a site through just photos. Drone photogrammetry will allow the agents to enter the site in a virtual space that will help the agent understand the scale of the damage and be able inspect the affected area in every angle. It will help "insurance carriers to decrease overhead, reduce turnaround times and improve data capture and accuracy" [2]. Drone land surveying will gather high quality imagery that is much more reliable than traditional photos. This will result in less time and manpower in the field, minimize overall cost, and "reduces the risk of work related personal injuries and the risk of damaging clientâs property while performing inspection operations" [3].

Drone photogrammetry is redefining conventional ways insurance companies engage with clients and claims. Drones will be dispatched to survey and gather accurate data of an affected area. The data-set is beneficial for insurance companies "to preserve or recover measurement data long after the on-scene investigation has concluded" [4]. This way, the initial state of the area and its condition will be recorded and will be available for agents to access at any time from the office. This will provide State farm indisputable documentation and reduce client fraud, providing "overall photographs from various angles and vantage points can provide valuable perspectives" [5]. Not only will it benefit State Farm by saving them time and money, but it will also create happier clients with improved customer service and decreased time in claim resolutions.

7 System Overview

The purpose of our system is to develop a virtual 3D environment of an affected area that a State Farm agent will be able to become immersed into and be able to interact with. It will ultimately save costs and increase efficiency in work and processing time of insurance claims. Additionally, it will create a safer environment for state farm agents to make claims. Our solution will include the following major components:

- Drone: The drone autonomously flies to the disaster scenario and takes images from all angles. Once finished, the images are sent to the Google Cloud bucket.
- Google Cloud: The photogrammetry process takes place on a virtual machine and the output is a 3D model of the disaster area a list of camera names and their locations. Then, the outputs are imported into the VR Environment and packaged into an executable. from a point cloud, a set of data points in space.
- React App: Once the previous process is complete, the website displays the new case. Here, the agent can download the VR Environment.
- Unreal Script: After the agent has downloaded the VR Environment, they can run the Unreal Script which launces the VR Environment.
- VR Environment: Within the VR environment, users can freely explore the disaster scenario and identify areas where an insurance claim may be necessary. When they exit the Environment, the data is sent to the react app.
- React App: After exiting the VR Environment, the React App displays the images from the claims marked in the VR Environment. Here, the agent can add text describing the damage and download the final document as a PDF which can be used in their insurance case.

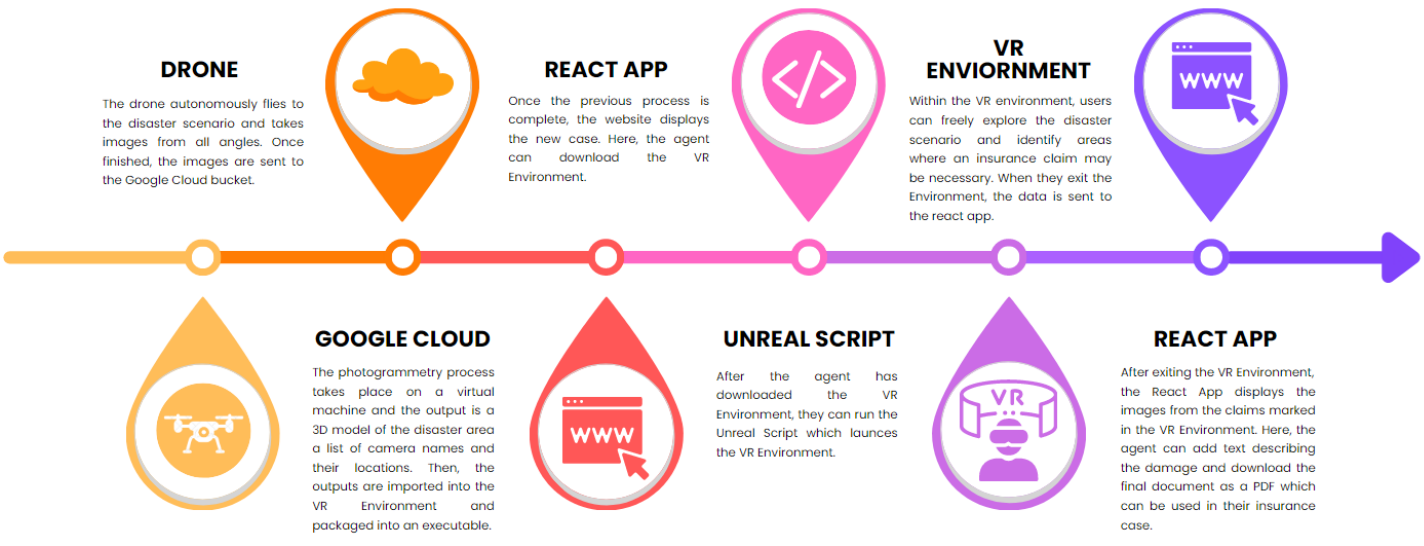

Figure 1: System Major Components Diagram

8 Roles & Responsibilities

This project is being completed as research for State Farm. Our stakeholders include State Farm, State Farm agents, Dr. McMurrough, and the CSE department. State Farm is a stakeholder because they are funding this project and are interested in determining if this technology is worth investing further resources into. If our team produces results that convince State Farm to invest resources into this technology, it could change the way insurance claims are made. Especially in disaster scenarios. State Farm agents are a stakeholder because their current workflow is subject to change depending on State Farms decision. Dr. McMurrough is a stakeholder because he is our professor and he is responsible for organizing and delegating funding for this project. He also provides our team guidance on our decisions and makes all necessary purchases for our project. The CSE department is a stakeholder because they are funding this project in addition to State Farm.

Our points of contact with State Farm are Dawsen Richins and Amy Simone. We have weekly meetings with Dawsen, Amy, and the EE team every Friday which last an hour. We also have a group chat on teams with Amy and Dawson to ask any questions we come across during the week to avoid roadblocks. Additionally, we have another teams group chat for communication between the EE team and CSE team.

Our Team consists of Mario Villatoro, Faith Gutierrez, Asim Regimi, Carlos Sanchez, Danielle Pham, and Pratik Dhakal. Mario is the product owner and team member. Faith is the scrum master and team member. Asim, Carlos, Danielle, and Pratik are all team members. The responsibilities of the product owner include being the verbal & visible face of the project, being outspoken and taking initiative when speaking with our project sponsors, providing support to the scrum master, and evaluating team progress. The responsibilities of the scrum master include developing a project plan, creating tasks, assigning priority of team goals, creating project deadlines, removing roadblocks, communicating with team members, and delegating tasks to best-fit team members when needed. The responsibilities of the team members include contributing to overall project objectives, completing individual deliverables, collaborating with other team members, and documenting their progress.

Our team plans to maintain the same product owner and scrum master for the duration of the project. However, roles are subject to change if one would like to relinquish their role or if one cannot meet their responsibilities.

9 Cost Proposal

Our project has a funding of $2300. We will be using our funding for a photogrammetry software licence, a cloud bucket for the drone photos, a GPU instance for the photogrammetry process, and drone parts. We need a photogrammetry software licence to allow us to turn the pictures taken from the drone into 3D models. Which then are used in a virtual reality environment to make insurance claims off of. While there are plenty of free photogrammetry software available, paid software often produces higher quality 3D models. We need a cloud for the drone photos so that the drone can automatically send photos once taken. This allows us to automate the process of turning the photos into 3D models because there will be no steps relying on humans involved. We need a GPU instance because our sponsors are requiring it. Lastly, we need a drone to gather a data set for testing.

9.1 Preliminary Budget

9.2 Current & Pending Support

Funding is provided by State Farm Insurance and the CSE department of University of Texas at Arlington. Initial investment from State Farm is $1,500. And initial funding provided by the CSE department is $800. This is not the final total of expected funding for this project. If needed, Dr. McMurrough may choose to allocate more resources for us.

Item	Cost
Photogrammetry Software License	$100
Cloud for Drone Photos & GPU Instance	$100
Drone Parts	$1700

Table 1: Overview of initial costs for project

10 Facilities & Equipment

For the duration of this project, we will be utilizing the shared lab space in order to collaborate with group members, hold group meetings, as well as to house all the equipments that we will be using for the project. We will be communicating to the EE team and the sponsors through Microsoft Teams.

The project is expected to utilize a cloud service in order to host the data gathered by a drone.The 3D environment for the VR interface will be developed using Unity game engine, which provides professional game development tools for students free of charge. We will be using a computer with high end graphics as well as VR headsets provided by the CSE department to perform photogrammetry and generate VR environments. Since the drone will only be completed towards the end of the project, we will be utilizing a GoPro camera provided by the university in order to gather test data for photogrammetry

11 Assumptions

The following list contains critical assumptions related to the implementation and testing of the project.

- The images provided by the EE Team will be of high quality and be from all the angles required by the photogrammetry software in order to create a 3D object
- The drone will be flight ready and be able to gather the first round of data by March of 2023
- The cost of the project, will be provided by the sponsor
- The drone will be able to take high-quality pictures of an object in 50 by 50 ft area
- The user will be able to walk around the VR environment and see the object from multiple angles
- The user will be able to zoom in on the object to get a better view of any possible damages.

12 Constraints

The following list contains key constraints related to the implementation and testing of the project.

- Final prototype demonstration must be completed by May 1st, 2023
- Photogrammetry software license must not exceed $500
- The EE Team must complete the drone and setup the camera gimble before final testing
- The drone must gather high quality images of the testing and/or disaster site for 3D meshing

- The images from the onboard storage must be transferred to Digital Ocean bucket without loss of data
- Cloud GPU instance must be set up correctly before data can be processed
- In order for our photogrammetry script to function well, we expect to have received 5 data sets from the EE team.

13 Risks

The following high-level risk census contains identified project risks with the highest exposure. Mitigation strategies will be discussed in future planning sessions.

Risk description	Probability	Loss (days)	Exposure (days)
Drone with required camera gears not delivered by EE Team	0.50	20	10
Drone unable to capture usable images from the testing area	0.20	14	2.8
Loss of images from the drone post-flight	0.30	9	2.7
Cloud GPU instance being too costly and over the budget	0.10	20	2.0
Unable to get permission to collect test data from testing area	0.15	10	1.5

Table 2: Overview of highest exposure project risks

14 Documentation & Reporting

14.1 Major Documentation Deliverables

14.1.1 Project Charter

Any major changes to the Project Charter will be updated at the end of each sprint to maintain accuracy. The initial version will be delivered October 3rd, 2022 and the final version will be delivered in May of 2023.

14.1.2 System Requirements Specification

The initial version of the System Requirements Specification will be delivered at the end of sprint 2 on October 24th, 2022. After the initial version is delivered, it will be updated at the end of each sprint if any changes are made. The final version will be delivered in May of 2023.

14.1.3 Architectural Design Specification

The initial version of the Architectural Design Specification will be delivered at the end of sprint 3 on November 14th, 2022. After the initial version is delivered, it will be updated at the end of each sprint if any changes are made. The final version will be delivered in May of 2023.

14.1.4 Detailed Design Specification

The Detailed Design Specification will be available starting at Phase II of this project. From then onward, it will be updated every sprint, until May of 2023, the final presentation of the project.

14.2 Recurring Sprint Items

14.2.1 Product Backlog

At the end of each sprint, our group and the State Farm points of contact will collaborate on deciding which items need to be prioritized. Jira Software will be used to maintain and share the product backlog tasks with team members and stakeholders.

14.2.2 Sprint Planning

Each sprint will be planned based on which items in our backlog have the highest prioritization. There will be 8 sprints total, split up into 2 phases of 4 sprints. Each sprint lasts 2 weeks with a planning period of 3 days between each sprint.

14.2.3 Sprint Goal

Team will meet before the new sprint begins to discuss the goals for next spring. The team will also meet the customer representative weekly to prioritize items that should make into the sprint backlog.

14.2.4 Sprint Backlog

Team members will meet and decide on which product item gets into the sprint backlog. Everyone will use a team Jira board to maintain and track the Sprint Backlog.

14.2.5 Task Breakdown

Team members will discuss with each other and self assign task from the Jira board. Each member will be working with at most 2 issues at a time for best efficiency. Team members will use Time Tracking feature on Jira board as well as the team communication channels to document time spend on each issues.

14.2.6 Sprint Burn Down Charts

Carlos will be in charge of creating the burndown chart for each sprint. The hours can be tracked through a Discord channel as well as the Time Tracking feature on Jira where each team member is responsible for reporting how many hours they have worked every day.

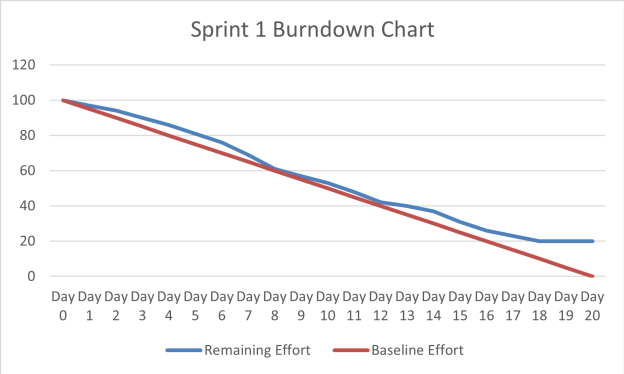

Figure 2: Example burn down chart (Sprint 1)

14.2.7 Sprint Retrospective

At the end of every sprint, the team will come together at the senior design lab to hold a sprint retrospective regarding what was done well with the sprint what what could be done better in the future. A day after the meeting, each team member will work on a retrospective regarding the sprint

14.2.8 Individual Status Reports

Any major status report will be presented to the fellow team members as soon as possible. Each team member will utilize JIRA to highlight any tasks they are currently working on, as well as any tasks that have already been completed.

14.2.9 Engineering Notebooks

Each team member will be responsible for their engineering notebook, and will be updated at minimum once every 2 weeks. Other team members will serve as witnesses to each of the engineering pages.

14.3 Closeout Materials

A presentation for State Farm representatives will be delivered upon closeout. All source code, installation tutorials, migration notes, and user manual will be uploaded to our GitHub Organization Repositories. https://github.com/disaster-drone

14.3.1 System Prototype

The entire project will be included in the final system prototype and every component of the project will be demoed to State Farm.

14.3.2 Project Poster

We will decide on the content of the poster during the second semester. Our poster is expected to be 36' x 48' but is subject to change. It will be delivered on CoE Innovation Day April 19, 2023.

14.3.3 Web Page

We will decide on the content of the project web page during the second semester. It will be accessible to the public and will be provided at the closeout of our project in May of 2023.

14.3.4 Demo Video

The demo video will include a post-flight processing of the images captured from the drone along with the website demo where agents can move around the virtual environment. The video will be between 3 and 7 minutes.

14.3.5 Source Code

The source code will be maintained using a GitHub repository. This will allow us to maintain version control and share our code with State Farm if needed. This project be open-source and the source code will be provided to State Farm after the project has been completed.

14.3.6 Source Code Documentation

Source Code will be well commented and anything left out of comments will be included in the ReadMe File of the respective repositories.

14.3.7 Hardware Schematics

The EE Team will deal with the hardware components.

14.3.8 Installation Scripts

If installation is going to be required we will provide installation scripts for the customer and steps will be provided in the ReadME on the GitHub page.

14.3.9 User Manual

Any User Manual information will be included in the ReadME on the GitHub repositories.

REFERENCES

[1] Science Direct. Photogrammetry, Published 2013. Last accessed 3 October 2022.

[2] Medium. Photogrammetry: Keeping insurance "open for business", Published 18 May 2020. Last accessed 3 October 2022.

[3] Pix4D. Using drones and photogrammetry for insurance inspections, Published 25 July 2018. Last accessed 3 October 2022.

[4] Photo Modeler Technologies. Forensic photogrammetry: A case study, Published 16 October 2017. Last accessed 3 October 2022.

[5] Unmanned Systems Technology. The importance of drones and photogrammetry for the insurance industry, Published 23 December 2021. Last accessed 3 October 2022.