DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING
THE UNIVERSITY OF TEXAS AT ARLINGTON

PROJECT CHARTER
CSE 4316: SENIOR DESIGN I
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DR-RESCUE
AERIAL RESCUE MAPPING DRONE

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Revision History

Revision	Date	Author(s)	Description
0.1	10.01.2024	JB	document creation / Front Page text / Problem Statement draft
0.2	10.04.2024	JB	Section 1, 2 and 3 rough draft
0.3	10.08.2024	DD	Section 4 and 5 rough draft
0.4	10.08.2024	OE	Section 8, 10 and 11 rough draft
0.5	10.09.2024	JB	fixed revision dates / version numbers
0.6	10.09.2024	JB	Section 12 and 13 rough draft
0.7	10.09.2024	DD	Section 14 rough draft
0.8	10.09.2024	OE	Section 9 rough draft
0.9	10.09.2024	AM	Section 6 and 7 rough draft
1.0	10.09.2024	DD	Temporary placeholder image
1.1	10.09.2024	JB	Fixed minor typo

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1 Problem Statement

The ability for a rover to be able to perform a search-and-rescue operation is based upon many factors. However, no matter what approach is used, the rover needs to be provided viable path to the rescue target. In order for the rover to accomplish this it needs some sort of aerial drone to be able to mark out the landscape, slopes, and various other obstacles. The Aerial Rescue Mapping Drones (ARMD) main task is to provide such data to guarantee a smooth travel to the target location and back.

2 Methodology

This project will focus on the design and implementation of drone that can effectively map out existing terrain, and deliver a small lightweight payload. The drone will be fully autonomous and fly to a desired location, gathering data about the height levels, objects, slopes, and other challenges that may be faced by ground travel. It will send the data it receives over to a server which will then run computations to find a viable ground path to a desired end location.

3 Value Proposition

While the end goal of this drone is to be able to perform in search and rescue operations, it does have various other practical uses that it may be more suited for. Most notably, transportation departments, wilderness rescue teams, geographical data collection, and military operations. The ability to collect such data can be crucial to creating safe, fast routes in difficult to work in areas. It will also provide a framework for researchers that are looking into geographical data collection in otherwise hard-to-reach places. The ability to create a path on-the-go for time crucial operations has various useful applications in emergency scenarios where time is everything. With hopes for the drone being fast to deploy, this versatile tool may be useful in countless operations, both time critical, and planned.

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 - October 2024
- System Requirements Specification - October 2024
- Architectural Design Specification - October 2024
- Demonstration of drone taking off - November 2024
- Detailed Design Specification - October 2024
- Demonstration of drone talking to the rover remotely - November 2024
- Demonstration of drone working to map out the location of the rescue target - November 2024
- CoE Innovation Day poster presentation - December 2024
- Final Project Demonstration - May 2025

5 BACKGROUND

Precision is essential for successful search and rescue operations, and the current methods often fall short in critical ways. Traditional search and rescue techniques can be slow, resource-intensive, and sometimes risky for the personnel involved. This project aims to harness the synergy between a drone and a rover, working together to locate and rescue a target with greater speed and accuracy. With time, this project can be tested, modified, and expanded, surpassing its initial scope. The innovative use of technology in this project could inspire further ideas, making it even more versatile and applicable in other industries. This solution isn't limited to emergencies and can be adapted for use in various sectors, demonstrating its broad utility. This project presents a unique opportunity to innovate within the field of emergency response. With the advancements in drone and rover technology, there is potential to create a highly adaptable and versatile rescue system that can be deployed in various scenarios, from natural disasters to everyday emergencies. This solution is not only beneficial for search and rescue but also has potential applications in other fields like agriculture, security, and infrastructure inspection.

6 RELATED WORK

There are several existing solutions for aerial drones used in search and rescue operations that demonstrate the technology's potential. Current research and prototypes in academic and commercial settings focus on using drones to collect real-time environmental information. Academic research has investigated the use of drones for terrain mapping and obstacle detection, typically creating 3D maps of the landscape using LiDAR and infrared sensors. These methods have proven effective at providing actionable data for ground-based rescue operations. However, many of these solutions are limited by high costs, short flight times, and small payload capacities, making them unsuitable for widespread deployment in emergency situations.

Commercially, companies such as DJI have created drones like the Mavic series, which are outfitted with cameras and sensors capable of capturing high-definition imagery and data. While these drones have proven effective in reconnaissance missions, they are not designed for real-time data transmission or the harsh conditions common in rescue missions. Other prototypes have been developed by enthusiast groups that focus on open-source solutions, but they frequently lack the robustness required for professional and emergency use cases.

Despite these advances, there is still a need in the market for a low-cost, durable drone capable of fully autonomous terrain mapping and real-time data sharing in emergency situations. Our project seeks to close this gap by combining the strengths of existing technologies while addressing limitations in flight time, data transmission, and real-time obstacle detection, particularly through collaboration with ground rovers for increased accuracy and speed.

7 SYSTEM OVERVIEW

The proposed system, named DR-Rescue, consists of an autonomous aerial drone designed to map and analyze terrain, enabling efficient rescue operations in challenging environments. The system is composed of several key components:

Drone Hardware: The drone will be equipped with a GPS module, an Inertial Measurement Unit (IMU), and a set of sensors (e.g., LiDAR and cameras) to gather real-time terrain data. The drone will fly autonomously to a specified area, scanning for obstacles, slopes, and other critical features of the terrain.

Communication Module: A reliable communication system will be implemented to enable data transmission between the drone and the ground-based rover. This module will ensure the drone can send live data regarding the terrain and any detected obstacles back to a server or the rover directly.

Rover Integration: The drone will collaborate with a ground-based rover that uses the data provided to plan and execute a rescue mission. The drone's real-time terrain mapping will allow the rover to calculate the best possible route to the rescue target.

Data Processing: A server will receive the terrain data transmitted by the drone, processing it to calculate the optimal paths for the rover. The server will analyze the data for potential hazards and adjust the path dynamically.

The user interface will be simple, providing rescue operators with real-time data and control over the drone's flight plan. The overall system will prioritize user-friendly operation, allowing for quick deployment and execution in high-pressure, time-sensitive rescue missions. Below is a high-level diagram of the system components and their interactions.

This system will be designed to handle diverse environmental conditions and will focus on robustness, data accuracy, and speed, ensuring that the drone and rover combination can be deployed in various rescue scenarios.

8 Roles & Responsibilities

Each team member will have responsibilities that they will be taking care of throughout the project. Justin has been researching about some algorithms that can be used with the drone for communication with the rover. Algorithms researched might also be used for other operations such as which direction the drone should take to reach its destination. Omar will be working on the hardware implementation of the drone such as adding any extra parts if necessary, writing any software module configurations that allows the drone to complete required tasks. David and Anaf will also be working on the hardware-focused side of the drone. Before the construction and configuration process of the drone begins, research about the functionality of the drone needs to be made. Research needs to be made about how the hardware of the drone works, how the drone can communicate with the rover so that they can complete the assigned task, and look into any other tools such as extra hardware parts that might be needed to add to the drone. Throughout the project, our team will be maintaining the product owner and scrum master to update the information written every time we make progress and complete tasks on the project. The scrum master will be used to maintain effective communication, manage impediments so that the team can get work done, and establish the scrum methodology and keep the team focused on applying scrum principles and practices.

9 Cost Proposal

For our drone, we had to discuss if we are interested in adding some extra features if necessary to make the drone perform efficiently in its task to find the location of where the rover should go to. Funding will be received from the CSE department to be used to acquire any hardware parts or software licenses if needed. An analysis of the total costs is included in the table below. Actual costs (if necessary) will be determined after we are done talking about the manufacturing process for the drone concludes.

9.1 Preliminary Budget

Include a high level budget table for components, fabrication, software licensees, development hardware, etc. This should be in a tabular format broken up into appropriate line items.

9.2 Current & Pending Support

Our team will be receiving funding from the CSE department a total of $800 to spend on any hardware parts, software licenses, and/or any other tools that are necessary to complete the project. There aren't any other funding sources that our team might need at the moment. We might be needing some additional funding, but that will be determined when we get into the actual construction and software implementation of the drone.

Drone Manufacturing Essentials	Total Budget	
Hardware Components (parts for extra features)	TBD	
Software Licenses	TBD	
Fabrication	TBD	

Table 1: Overview of total costs for drone construction tools

10 Facilities & Equipment

Three lab rooms are available for access for working on the project. ERB 203 includes tools to use for working on projects involving building rovers and internet of things (IOT) related projects. Another workstation available is ERB 208, a lab room used for working on drones and ground vehicles. Strict rules must be followed while working on the drone. Other labs and work stations available that might be needed to work on the drone are ERB 335, for working on drones and industrial related projects, and the makerspace lab. Additional parts might be needed for the construction of the drone, but very likely won't be necessary since the drone will already be fully built. A drone can be selected for use from the lab used for drones and ground vehicles. If extra parts will be necessary for use with the drone, the hardware could be available at the lab. If extra hardware not found in the labs, will likely have to purchase them which might increase the budget cap of 800 dollars.

11 Assumptions

An assumption is a belief of what you assume to be true in the future. You make assumptions based on your knowledge, experience or the information available on hand. These are anticipated events or circumstances that are expected to occur during your project's life cycle.

Assumptions are supposed to be true but do not necessarily end up being true. Sometimes they may turn out to be false, which can affect your project significantly. They add risks to the project because they may or may not be true. For example, if you are working on an outdoor unmanned vehicle, are you assuming that testing space will be available when needed? Are you relying on an external team or contractor to provide a certain subsystem on time? If you are working at a customer facility or deploying on their computing infrastructure, are you assuming you will be granted physical access or network credentials?

This section should contain a list of at least 5 of the most critical assumptions related to your project.

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

- The drone will have a GPS module and Inertial Measurement Unit implemented for location tracking, stabilization, and altitude control.
- Maintains a reliable communication link with the rover, with sufficient bandwidth for control and data transmission.
- The motors and propellers can generate sufficient thrust to lift the drone off the ground, considering the weight of the drone.
- The drone will not be flown in restricted areas such as the labs and other indoor locations.
- Drone can transmit live data to a control device in real-time.

12 Constraints

Constraints are limitations imposed on the project. All limitations provided in the following section must be achieved, unless laws, rules, regulations, funding, or schedule changes. This section is subject to change and is not an exhaustive list of all constraints the project will follow. As the project evolves, and more funding and resources are allocated to the project, the constraints outlined currently may expand to be more strict, or lenient, than what is currently listed.

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

- Final prototype demonstration must be completed by May 1st, 2025
- All outdoors test flights must occur in low level airspace's to conform to FAA regulations on airspace
- All state and local laws on drone flight must be followed when outdoor AND indoor testing
- All laws regarding how the drone may communicate with its outside components must follow all FCC or other related guidelines
- Total development costs must not exceed $800

13 Risks

The following high-level risk census contains identified project risks with the highest exposure, and/or highest financial impacts. Mitigation strategies will be addressed in future planning sessions.

Risk description	Probability	Loss (days)	Exposure (days)
Weather damage to drone	0.25	45	11.25
Drone cages occupied	0.9	7	6.3
Airspace closure (of any form ie. Inclement weather)	0.5	7	3.5
Drone battery Failure	0.25	9	2.25
Drone gets stuck in hard to reach area	0.75	1	0.75
Drone battery resulting in damage	0.01	60	0.60

Table 2: Overview of highest exposure project risks

14 Documentation & Reporting

14.1 Major Documentation Deliverables

14.1.1 Project Charter

This document will be updated every sprint. Also, will be updated when there are updates during the project. It will need to be updated as new things are added to the project and if the customer has anything to add. The initial project charter will be on October 9, 2024 and the final project charter will be done in May 2025.

14.1.2 System Requirements Specification

This document will be released on October 21, 2024 and that should not be any updates in the future. That document should be good after the initial released date.

14.1.3 Architectural Design Specification

This document will be updated often until the final version is released. The initial version will be delivered October 2024 and finally version to be released December 2024.

14.1.4 Detailed Design Specification

This document will be updated often until the final version is released. The initial version will be delivered October 2024 and finally version to be released December 2024.

14.2 Recurring Sprint Items

The following items will be documented and maintained during each individual sprint. As above, remove this paragraph from your draft, but leave the heading.

14.2.1 Product Backlog

How will items be added to the product backlog from the SRS? How will these items be prioritized? Who makes the decision (product owner, group vote, etc.)? What software will be used to maintain and share the product backlog with team members and stakeholders?

14.2.2 Sprint Planning

How will each sprint plan be planned? How many sprints will there be (you need to look at the schedules for this course and previous Senior Design II courses during the appropriate semesters to figure this out).

14.2.3 Sprint Goal

The goal is discussed within the group. The customer can have requests if needed and can discuss it with the group to see how it could work out on the project.

14.2.4 Sprint Backlog

The backlog will be managed by the whole group and be filled out as needed within the group. It will be delivered every sprint.

14.2.5 Task Breakdown

Tasks will be broken down voluntarily. No one is forcing any members to do anything. It will be handled as a team. The time spent will be documented on every sprint that occurs during the project.

14.2.6 Sprint Retrospective

The retrospective will happen immediately after every sprint. It will be discussed during the meeting to go over any changes needed to be made on the project.

14.2.7 Individual Status Reports

Status reports will be reported every time a member finishes or starts something. The items that will be reported will be on what was done to the project.

14.2.8 Engineering Notebooks

Each member of the group will have to be updating the engineering notebook constantly as we go throughout the project.

14.3 Closeout Materials

14.3.1 System Prototype

This project will need to be demostrated off site and somewhere in the open. The plans of this is still in progess and to be determined at a later time.

14.3.2 Project Poster

The poster will show the dimensions of the rover and a picture of both the drone and rover. It will show the drones circuit and some specifications of what is being used on the drone. It should be finalized December 2024.

14.3.3 Web Page

The web page will show what the drone and drover will do together. It will be released in May 2025 there will be no updates to the web page.

14.3.4 Demo Video

In the demo videos it will show the drone working to it's full completion, but beforehand there will be test videos of the progress of what the drone can do.

14.3.5 Source Code

The source code that will be used will be uploaded onto Github where everyone can access it.

14.3.6 Source Code Documentation

The final documentation will be in PDF form for everyone to access. To operate the drone though the group members will do that.

14.3.7 Hardware Schematics

At this time there are no circuit boards that have been created. This will be updated in the future.

14.3.8 Installation Scripts

The project will provide everything that will be needed to make the project run accordingly.

14.3.9 User Manual

The customer will need a video demonstration and a person who is licensed to fly a drone.

REFERENCES

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[5] “DJI Mavic 3 Drone â Specifications,” [Accessed 10-09-2024]. [Online]. Available: https://www.dji.com/mavic-3

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