THE GRAINGER COLLEGE OF ENGINEERING

PROJECT PROPOSAL

ECE 445 SPRING 2024 (PROJECT 21)

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CHAPTER 1

INTRODUCTION

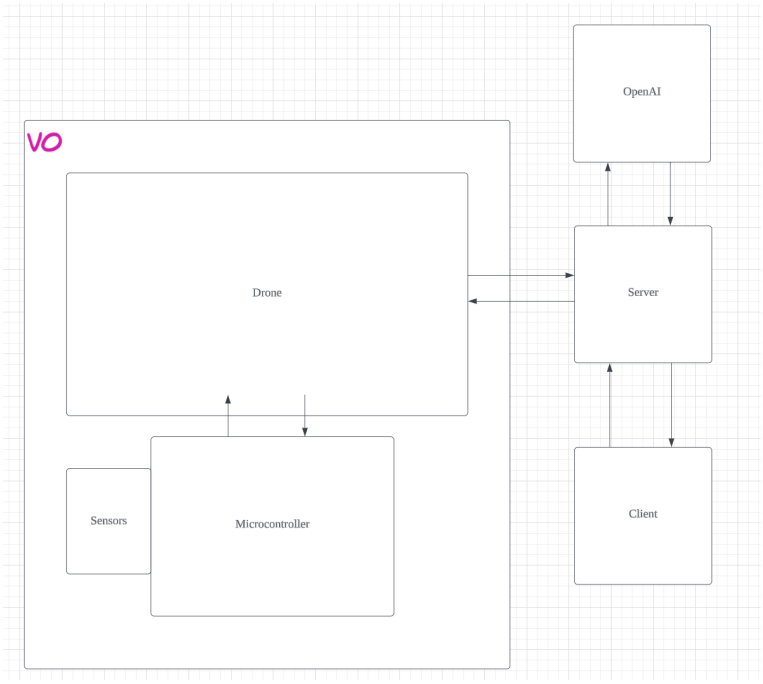
1.1 PROBLEM

Anyone entering a place for the first time, like an university, can be quite challenging. Knowing where you are, how to get to your destination, how to optimize your routes, knowing factors that will influence your routes can be complicated. Having a real-time interactive system that guides people through this process is needed. It has been possible yet not able to scale because it's not open-sourced, and its hardware isn't standardized, and is expensive. The interaction isn't versatile enough to adapt well under the ever-changing applications. A cheap and versatile solution is needed.

1.2 SOLUTION

Our solution utilizes autonomous UAV to guide our clients, sensing them and the environment, such as obstacles and drone's location with a sensor module, controlled by a control unit which orchestrate a series of tasks. Our solution is cheap, open-sourced, and versatile to meet the need of a generalized and sustainable long-term solution for our campus and many other applications.

1.3 HIGH LEVEL DIAGRAM



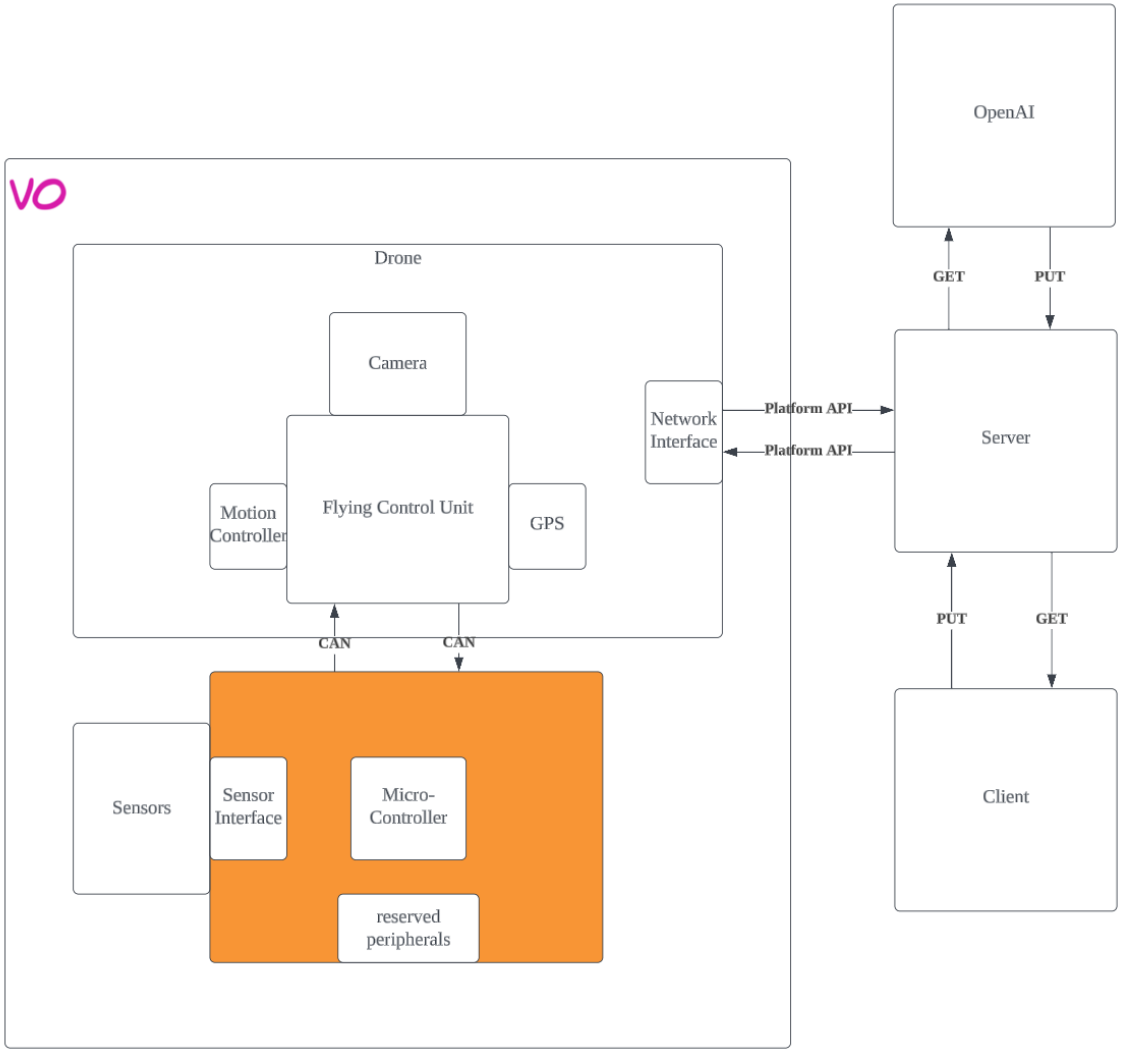
1.4 3 QUANTITATIVE REQUIREMENT

- **Guide upon commands in appointed regions.** The appointed region should be at least 300 m * 300m which should covers the core buildings of our campus. When called, the drone must be able to **react** to the visitor's command via user interface, and should be able to come to a precise location where user is (5 meters around user). I will also reach the appointed destination.
- **Interactive communication with visitors.** The visitor should be able to communicate with the assistant given the current status (location, context, etc.) and the experience should be as close as to a conversation with a normal tour guide as possible. It implies understanding user's **intent** as well as the **context** of the tour.
- **Tour safely with visitors.** The visitor should be warned appropriately. **ZJUI contains lots of infrastructures like labs** that contain safety problems if visitors are not notified promptly. The UAV itself can pose threats to people and should be carefully dealt with. **There UAV must not kill anyone.**

CHAPTER 2

DESIGN

2.1 BLOCK DIAGRAM



2.2 SUB-SYSTEM OVERVIEW

This projects consist of 4 subsystems:

- AI-powered response generation system
- User Interface
- Planning & Control system
- Sensor System

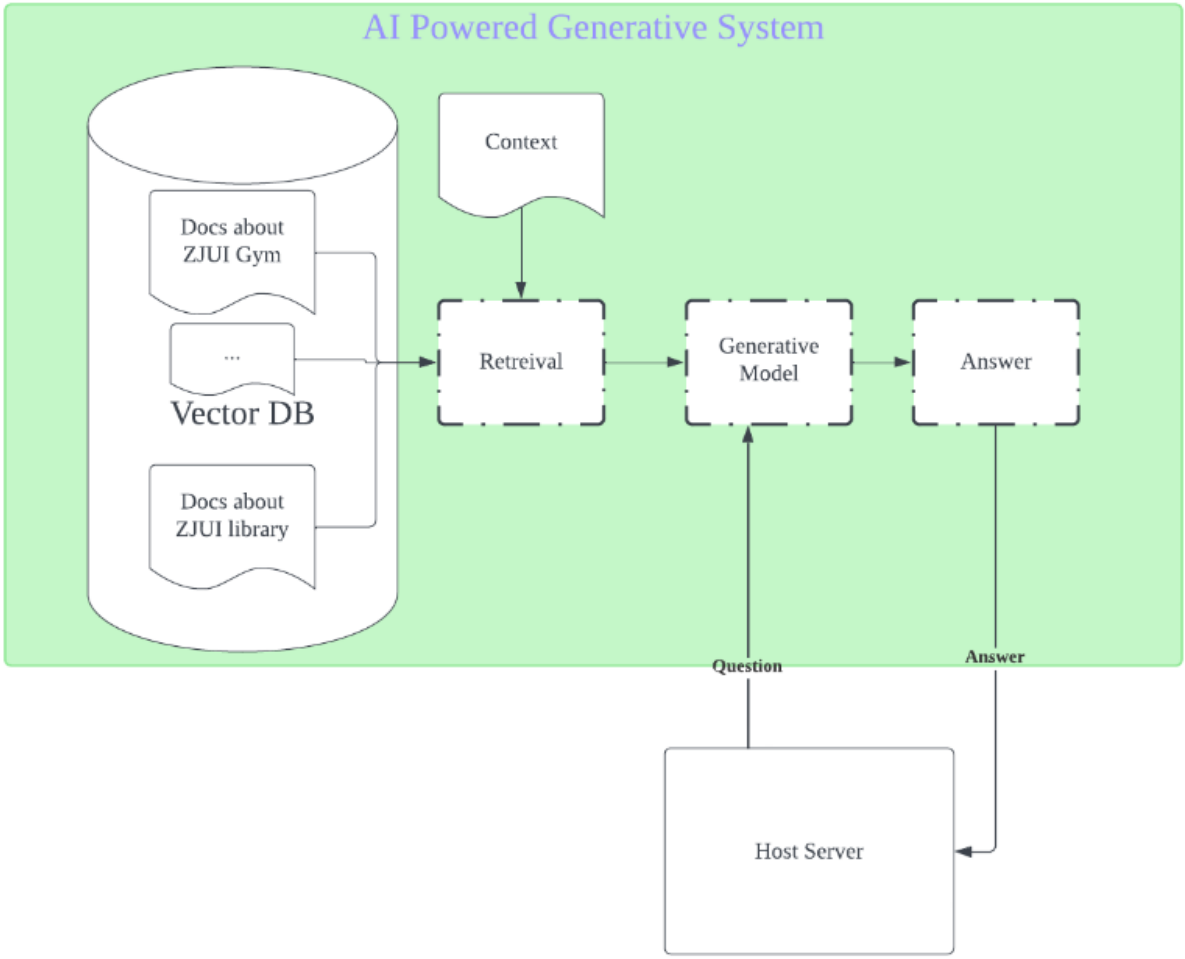
These sub-systems sense the context of the tour, planning the tour, and interact with users in a natural manner. The emphasis of the sub-systems are the integration of strong ability of Retrieval-Augment Generation into a mobile system. **These subsystems link the cloud, the PC, and the embedded mobile systems into an interactive tour guiding assistant**.

2.2.1 AI-POWERED RESPONSE GENERATION SYSTEM

This model focus on building an assistant with the core APIs exposed by oepnAI(openAI, 2023). The generation and embedding modules are powered by openAI held in their clouds. To build this system, we intend to do the following steps:

- collect related data, and tag them into vector database. (Deadline Yuntong, weiang, 2024-3-20)
- design a simple framework, given a user question + context, output an answer. (Deadline Hao, 2024-3-21)

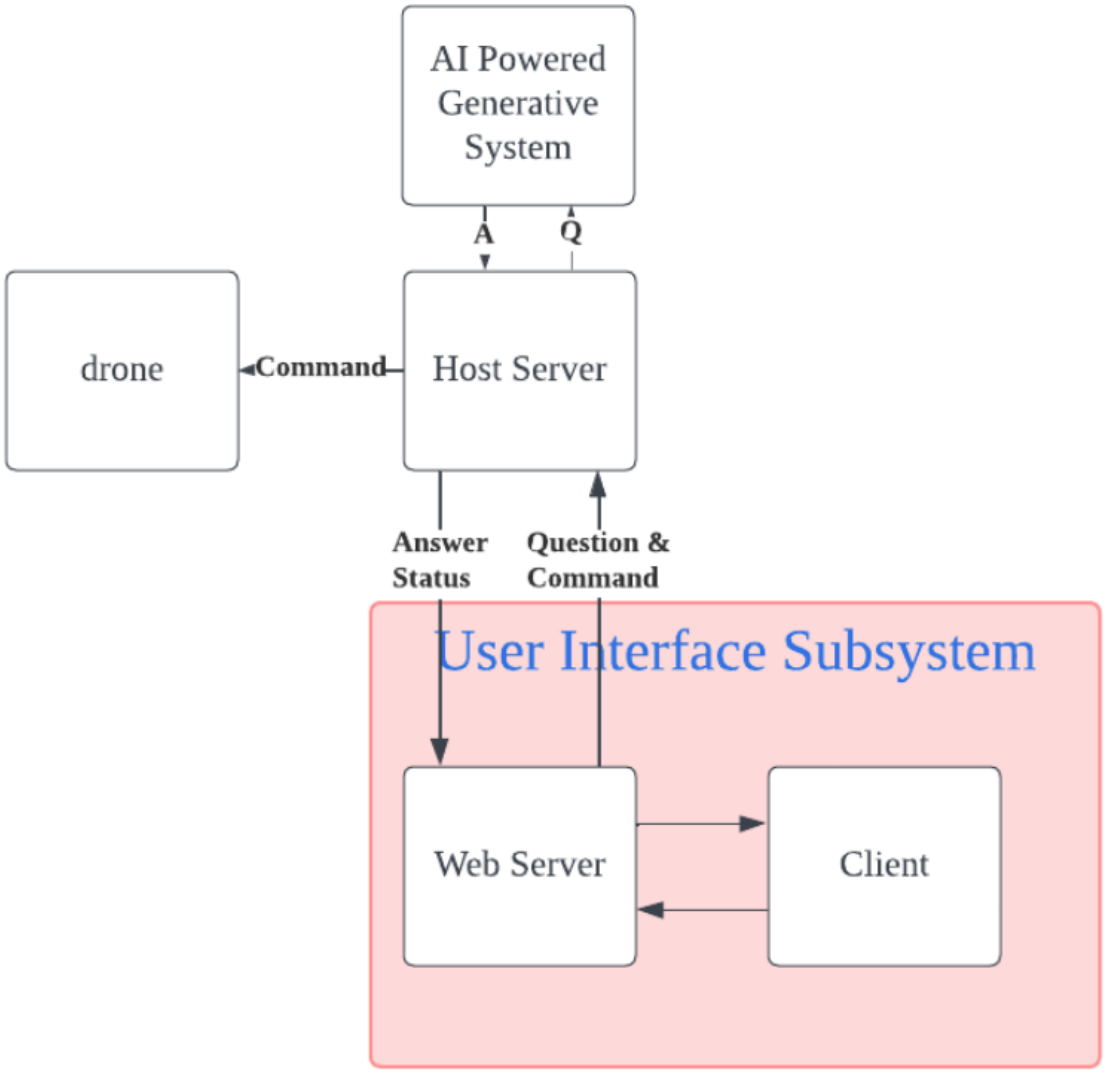
The input of the subsystem is **a string of text (Question by user) given by host server**, the output of the subsystem is **a string of text (Answer to user) to the host server**



2.2.2 USER INTERFACE

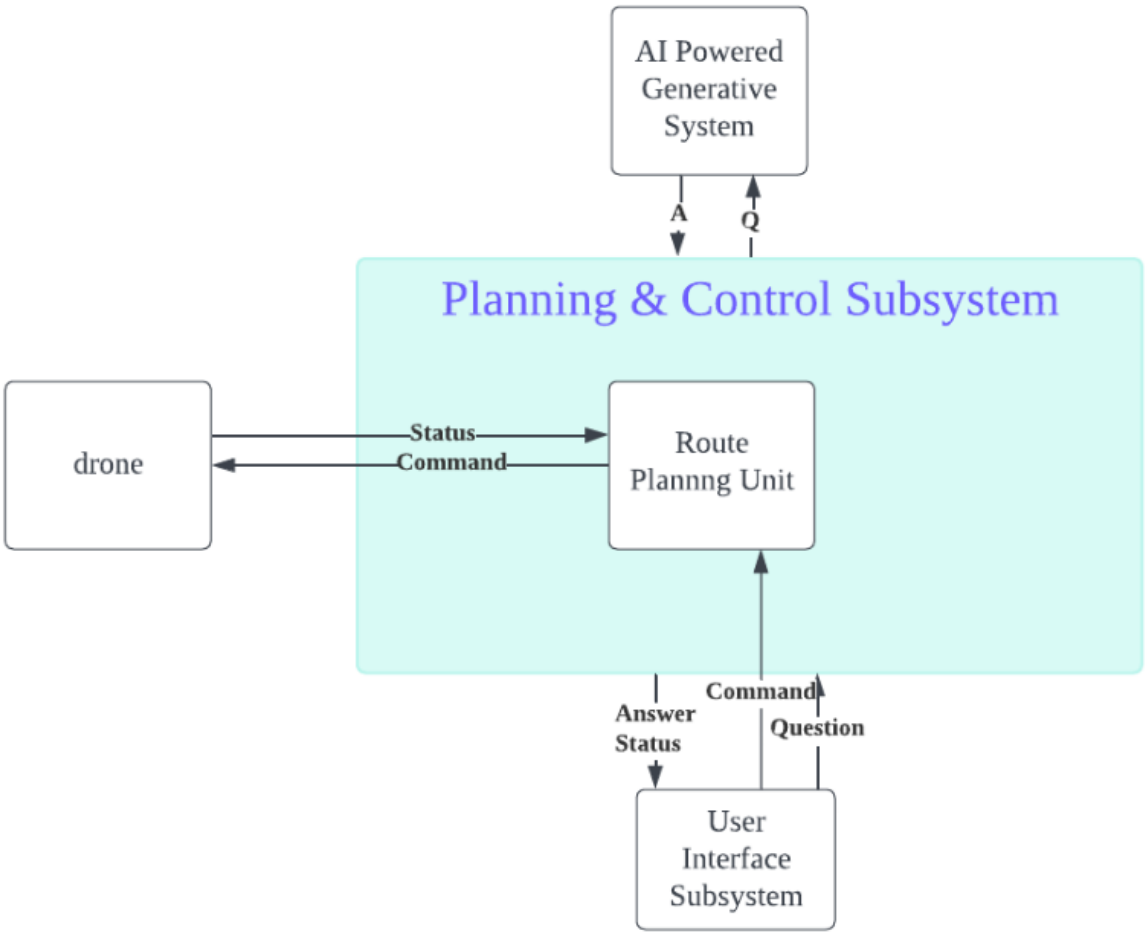
- final hosting web service (Xuanbo, 2024-3-21)
- build easy full-stack framework (Xuanbo and Hao, 2024-3-30)
- connect web server and host server (Xuanbo, 2024-3-21)

The input ot the user interface subsystem is **Answer to user's questions and status of drone**. The output of the subsystem is **Questions by user and commands to the drone.**



2.2.3 PLANNING & CONTROL SUBSYSTEM

The planning and control sub-system answers the request passed by user interface. It parses the user's comannd, and combines the status of the drone. It gives a clear command to the drone according to the drone's spec. The input to this subsystem is **the user's command and the drone's status** exposed by PX4 APIs (an open-source firmware for flying control). The output of the subsystem is the **command to the UAV**.



2.2.4 SENSOR SYSTEM

The sensor subsystem takes **the environment of the drone, and the 5V voltage supply** as input, and output a signal according to **CAN protocal**.

2.3 TOLERANCE ANALYSIS

- **Route planninng can be unstable**. The wind, obstacles, visitors, and interrupt the guiding process. Our project can tolerate these obstacles by different strategies. For wind, we will continuously correct the route by GPS. obstacles can be resolved by collecting more accurate route related data. By assigning a height > 3m, we can ignore the interference of visitors. However, this ability should be refined step by step, we will first assume a windless, obstacle-free environment and improve the tolerance step by step.

CHAPTER 3

SAFETY AND ETHICS

3.1 ETHICS AND SAFETY

In this project, We will strictly abide by the IEEE code of Ethics(IEEE, 2016), which refers to "to seek, accept, and offer honest criticism of technical work, to acknowledge and correct errors, to be honest and realistic in stating claims or estimates based on available data, and to credit properly the contributions of others "to our project integrity and fairness, while protecting the environment and ensuring safety and other basic principles, to avoid harming the personal safety of others. And do what the IEEE code says.

In the safety section, we will cover the operation of the drone, including the lifting and flying of the drone, and the interaction with the user, where the operation of the drone itself is risky. In order to ensure our safety, we have specified the operation area of the drone to avoid causing injury to pedestrians, and we have added safety ropes to the drone to avoid losing control. The whole design and operation process of the drone are in line with relevant national regulations

CHAPTER 4

REFERENCE

[1] IEEE. “IEEE Code of Ethics.” (2016), [Online]. Available: https://www.ieee.org/ about/corporate/governance/p7-8.html (visited on 03/06/2024).

[2]OpenAI. (2023). ChatGPT (Mar 14 version) [Large language model]. https://chat.openai.com/chat