INTERNSHIP REPORT

on

Design and Development of Autonomous Drone

Submitted by

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in
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Under the supervision of
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CERTIFICATE

This is to certify that the ”Internship report on Design and Development of Autonomous Drone” submitted by Roopesh O R (Register Number:20323085) at AI Aerial Dynamics is the work done by him and submitted during 2025-26 academic year, in partial fulfillment of the requirements for the award of the degree of BACHELOR OF TECHNOLOGY in ELECTRONICS AND COMMUNICATION ENGINEERING at SOE, CUSAT

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1. Overview of the Industry

The Unmanned Aerial Vehicle (UAV), or drone, industry represents a frontier of modern engineering which blends vast areas of engineering such as electronics, mehcanics and computer science. Globally, UAVs have transitioned from niche military hardware to indispensable tools across various sectors, including logistics, infrastructure inspection, precision agriculture, and disaster management. This rapid commercialization is driven by advancements in flight autonomy, sensor technology, and improved data analysis. Nowadays drone technology - which was limited hands of a few - has expanded and became accessible to wider community. Recently, in our country, huge amount of investment is going towards drone technology, partially in response to growing political tesion as well as need for self reliability.

To make students exposed to this area, various competition, hackathons and sessions are now being conducted. International competitions like the Student Unmanned Aerial Systems (SUAS) competition play a major role in bringing together talents across the world. They serve as hub for innovation, knowledge sharing and pushing the boundaries of what is possible and fostering the next generation of engineers. These events challenge teams to solve complex, real-world problems, creating a high-stakes environment where learning and development happens beyond the standard academic curriculum. This internship at AI Aerial Dynamics was an immersion into this competitive and innovative world, focusing on the practical application of engineering principles to a specific, challenging goal - representing ourself at the competition - SUAS.

2. Objective of the Internship

The primary objective of this 3-month internship at AI Aerial Dynamics was to design, develop, and deploy a highly autonomous quadcopter to compete in the Student Unmanned Aerial Systems (SUAS) 2025 competition held in Maryland, USA. The key technical objectives for the project were to engineer a UAV capable of:

1. Performing fully autonomous takeoff and landing.
2. Navigating a flight path using predefined GPS waypoints.
3. Conducting real-time aerial mapping of a designated mission area.
4. Detecting and classifying specific ground objects from aerial imagery.
5. Executing a precision payload drop mechanism at multiple target locations.

My personal objectives for this internship were:

1. To gain hands-on experience in the electronic systems integration and documentation of a complex aerial vehicle.
2. To develop practical skills in UAV software tools and programming libraries such as Mission Planner and pymavlink.
3. To understand the project lifecycle, from component selection and assembly to field testing and debugging under high-pressure competitive environments.
4. To collaborate effectively within a multidisciplinary team of engineers

3. Details about the Internship

This internship was a fast-paced, hands-on project focused on tangible outcomes. The work was structured around the SUAS 2025 competition, demanding robustness in design, execution, and teamwork under the mentorship of AI Aerial Dynamics. The space for work was provided by KSUM for a period of 2 weeks, and rest of the work was carried out at CUSAT considering the logistics of transportation and ease of work.

3.1 Project Overview and Team Structure

The project involved building a robust quadcopter from the ground up which satisfies certain constraints put forward by the competition. The basic constraints were following:

1. Total weight of drone must be under 20kg
2. Drone should be able to fly autonomously
3. Drone must have Flight Termination Failsafes

The team was divided into three core sub-teams: Electronics, Mechanics, and Software. This division was not rigid, and team members could contribute to any subteam. I was a member of the Electronics team, with some contributions to the mechanical and software aspects as well.

3.2 My Role and Responsibilities

My responsibilities spanned the full lifecycle of the drone's development, from design and documentation to integration and testing.

1. **Electronics Design, Implementation & Documentation:**

- Created list of electronic components required to meet competition criteria and prepare datasheets for them.
- Designed the electronic interconnects for the drone.
- Developed a electronic system for payload mechanism.

2. **Software Contributions:**
    - Optimized the real-time video pipeline using ffmpeg tools. Through adjusting parameters, I successfully reduced the end-to-end video latency from approximately 1000ms down to 600ms, which was almost sufficient for our purpose of object detection task.
    - Setup Mission Planner software for occassional flight tests.

3. **Mechanical and Design Contributions:**
    - Helped in the full mechanical assembly of the drone frame and contributed some concepts to the payload mechanism's physical layout.
    - Helped in designing a custom-fit protective casing for the various electronic modules.

4. System Architecture and Components

The drone was built prioritizing robustness, practical availability, future reusage and some transportation factors. Electronic components of the drone were chosen based on whether they have extensive documentation, community support as well as track record of reliability, making them a good investment for future projects. A critical, overriding factor in component selection was local availability within India, which was essential to meet our compressed project timeline as well. Our mentor also helped up picking the right components based on their previous experience with drone manufacturing.

The design of electronic interconnect was first done in Figma. An odd choice, but it was done in Figma to facilitate collaboration among other team members and iterative design. This allowed all team members to review the architecture in real-time, provide feedback and helped us keep track of the project status.

The mechanical componets were designed in Autodesk Fusion 360. The mechanical components included frame and payload mechanism. Initially we had uncertainity on which mechanism to use for payload deployment. Hence we created 4 different mechanism and tested them individually. Out of them, we choose winch mechanism. It was relatively simple and fits our purpose. In the beginning we tried desinging our own frame, but due to multiple issues (possible manufacturing delay and cost) we decided to buy a ready made frame. The payload mechanism were 3D printed on 2 different fabs for fallback.

Figure 4.1 shows a section of payload mechanism. There are 4 of such mechanism the drone. Figure 4.2 shows the detailed block diagram of the final system. Table 4.1 lists the important components used in the drone

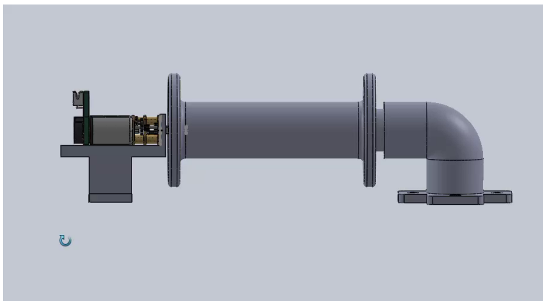

Figure 4.1: Payload mechanism

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Component	Model / Type	Purpose
Flight Controller	CubePilot Cube Orange+	Central processing unit for flight control and autonomy
Video/Data Link	SiYi HM30	Long-range video and telemetry transmission
Camera	ADTi Surveyor 24L	High-resolution aerial mapping and object detection
Manual Control/Telemetry	Skydroid T12	Telemetry and manual flight control
Power Module	Mauch Power Cube	Power distribution and battery elimination (BEC)
Propulsion System	Hobbywing X8	Provided thrust for the quadcopter
Frame	EFT E410P	Provided the structural foundation for the drone

Table 4.1: Key Components of the UAV

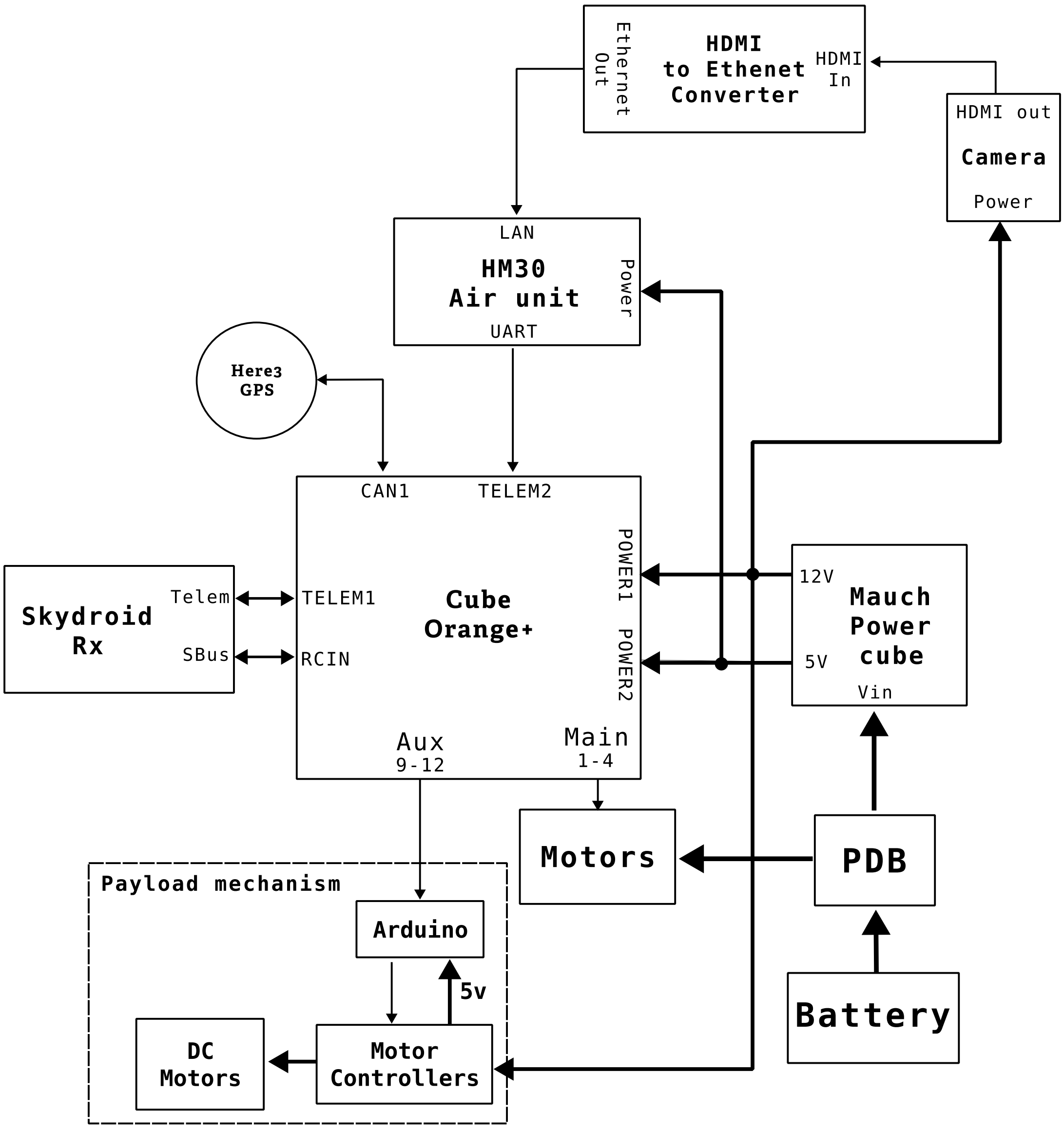

Figure 4.2: A high-level system architecture diagram of drone

5. Project Execution and Competition

5.1 Project Execution

The project's execution phase was defined by tight deadlines and the need for rapid development and debugging. Due to the late arrival of many key components, we had very limited time for full-system testing. A major constraint was the high-capacity battery capable of powering the entire 20kg drone. According to to airport security rules, the capacity of batteries being transported must not exceed 100Wh. This forced us to buy batteries from the USA and test the whole system there. Meanwhile we tested the rest of the subsystems one by one using a smaller drone offered by our mentor. The smaller drone was used to test software systems and we used top of a building to test other systems like payload mechanism and GPS.

- **Camera System Test**: The ADTi Surveyor 24L camera were not be obtained until the last week. Hence we used a small IP camera.SiYi HM30 video transmitter and IP camera were mounted on a smaller, separate drone to test their behaviour in flight, including video transmission and object detection.
- **Payload Mechanism Test**: To verify the payload drop, we tested the winch mechanism from the top of a 15-meter-tall building, satisfying the competition's minimum drop-height requirement.

This approach, while not robust enough, was necessary. This meant the fully integrated 20kg system was never flown prior to the competition.

Prior to mission demonstration, teams had to submit a Technical Design Report (TDR) detailing the overview of architecture, component and safetey systems of drone. Moreover a website showcasing the team had to be submitted. All of these developments took place in the during internal and semester exams, requiring us to prepare and adjust schedule of work.

It took us a while to get payload mechanism to work as intended. Due to slight manufacturing defects (mostly caused by low tolerance of printers), parts were not fitting together correctly. Since there was limited time to go for another round of iteration, we had to do some manual adjustments, cutoff certain pieces and then put together everything

5.2 At the competition venue

The final stage was the SUAS 2025 competition. After disassembling and transporting the drone to Maryland, USA, we reassembled it and tested the drone in the backyard of hotel we stayed. There was lot of last-moment issues with payload mechanism and related electronics and some part has to be modified. Software team also had to make changes in the software due to some changes in the rulebook of the competition. In june 24th, the competition began with orientation session where teams were remined of overview of program and provided opportunity to network with others. The next day we had to appear for safety inspection of drone, where our drone passed all technical and safety aspects and allowed to fly the next day.

On 26th june, the mission day, the drone has to be demonstrated for its mission execution capabilities. Since we were attempting four air drops of payloads the mission flow was follwing:

1. Takeoff
2. Navigate thorugh 12 Waypoint (considered a 'Lap')
3. Conduct aerial mapping
4. Conduct Air Drop during a lap, four times
5. Land

Figure 5.1: Assembled drone before safely inspection

6. Remove UAS from Runway

The software was written to drive the drone in this flow. In the competition, the drone performed a perfect autonomous takeoff and began its primary task: navigating a 12-waypoint course. However, a critical issue emerged as it finished the lap. Instead of proceeding to the next mission phase (mapping), the software system at the Ground control station (GCS) directed it to begin a second lap. Shortly after, the Mauch Power Cube's sensor incorrectly detected a low-voltage condition, triggering the battery failsafe.

To ensure the safety of the aircraft, the GCS Pilot made the decision to trigger the Return to Launch (RTL) command. The drone responded perfectly, autonomously returning to its takeoff position and landing safely. While we were unable to complete the payload drop and aerial mapping, the flight demonstrated the robustness of our core navigation and safety systems. The incident itself provided a crucial lesson in the reality of complex systems: components can fail in unexpected ways, and a deep understanding of every subsystem is critical. Post-mission log analysis pointed to a calibration issue with the power module as well as the software written.

Despite the mission's outcome, our team successfully completed the optional "Design for Transport" challenge, demonstrating modularity of mechanical design by assembling the drone from a collapsed state to flying condition under five minutes.

Figure 5.2: Drone during takeoff

6. Conclusion

This internship was an immensely rewarding and intensive learning experience. The successful construction and competitive performance of our autonomous drone stand as a testament to the team's dedication and skill.

I gained profound practical knowledge in drone technology, from the intricacies of electronic system integration and power management to the practical application of software like Mission Planner. The challenges, particularly the compressed timeline and component delays, improved my skills in learning, rapid problem-solving and debugging under pressure. The project also provided invaluable non-technical lessons, including the administrative complexities of international travel with technical equipment (visa and customs processes) and insights into effective team leadership observed from my team leads. The entire experience solidified my technical foundation and built my confidence in tackling large-scale, multidisciplinary engineering projects.

Figure 6.1: Our team at competition venue

7. Future Scope

The project has opened up several aspects for future work.

- **Indigenous Component Manufacturing**: During the travel to Mumbai for VISA process, I had a conversation with an embedded system engineer working in similar industry. He highlighted the current scenario of electronics market in India and critical need for indigenous component manufacturing for security of the nation. Inspired by this, a potential future project for me is to design and develop a domestic alternative to an imported component. I plan to focus on creating a Battery Eliminator Circuit (BEC), similar in function to the Mauch Power Cube we used. This would be a challenging as the module itself is very complex and was designed for much higher power consumption.
- **Team and Project Continuation**: The team plans to build on the success of this project. Our immediate goal is to participate in the upcoming NIDAR competition, hosted by Ministry of Electronics and Information Technology and Drone Federation India, which will allow us to further refine our platform. Furthermore, the long-term vision is to expand the team's activities, transforming it into a hub for fostering a general engineering mindset among college students, making them more confident and industry-ready. The focus will be on encouraging innovation and hands-on product development