AERO-SENTINEL
Hazard Analysis

Farhan Rouf *(rouff),* **Michael Lu** *(lum33),* **Noor Alam** *(alamn8),*
Safwan Hossain *(hossam18),* **Muhtasim Rahman** *(rahmam70)*

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1. INTRODUCTION

1.1 Background

Drones have the potential to revolutionize industries such as transportation, healthcare, agriculture, public safety and beyond, however, their impact is currently undermined by their limited battery life. Our client VanWyn Inc. has proposed a radical new method to extend the operation time of drones by wirelessly transmitting power to drones from the ground, which would extend the battery life indefinitely.

1.2 Project Description

Our capstone team, The Aero-Sentinels, was entrusted with the ambitious goal of developing a UAV platform that comprises a ground station system that can communicate with the UAV as well as track the UAV in real-time, and along with the ground station a UAV system that can transmit mission-critical data.

1.3 Scope of Project

The scope of this project involves developing a fully stabilized UAV, a camera system that can find and track the UAV, and an interface that establishes communication with the UAV and monitors essential UAV data to the user on the ground.

1.4 Project Deliverables

The project deliverables will include a prototype that highlights our design skills, an intricate and detailed report that outlines our design philosophy and the sophisticated code that makes our vision a reality, and, time permitting, a complete demonstration with a functional drone and ground system. These are the tangible deliverables that represent the culmination of our commitment to VanWyn Inc.

2. PURPOSE OF THE DOCUMENT

In pursuit of our ambitious goals, it is important to prioritize safety and risk mitigation throughout the development of our innovative UAV platform for VanWym Inc. We have chosen to employ Fault Tree Analysis (FTA) as the hazard analysis technique. FTA will allow us to systematically identify potential hazards, their root causes, and their associated consequences. This document will visually depict the complex relationships between system components and failure modes, enabling us to proactively address safety concerns and implement effective risk-mitigation strategies. The hazard analysis will extend the operational capabilities of UAVs but also adhere to the highest safety standards and the border industries we aim to transform.

3. ASSUMPTIONS

- Ignore software security hazards related to hacking or data leaks.
- Ignore human-induced hazards where humans damage the system intentionally.

4. SYSTEM BOUNDARIES

Objectives within system boundary/scope:

- **Graphical User Interface (GUI):**
  - Stable communication between two nodes
  - Intuitive and easy-to-use interface
  - Real-time data streaming
- **Camera System:**
  - Identify and classify UAVs
  - Tracking the UAV during its flight
- **UAV:**
  - Demonstration of UAV stabilisation
  - Demonstration of accurate UAV positioning (minimal drift)
  - Incorporate redundant features to perform safe flights in the event of component failure

Objectives outside system boundary/scope:

- Software security systems will not be considered in our system
- We will not be considering other visual sensors like infrared, thermal, laser, etc
- UAVs will not be capable of high-altitude flights
- The communication system will not be functional at high-altitude flights
- No additional payloads
- High-speed objects will not be identified/tracked
- The camera system will not be functional in low visible conditions
- GUI will not include accessibility features

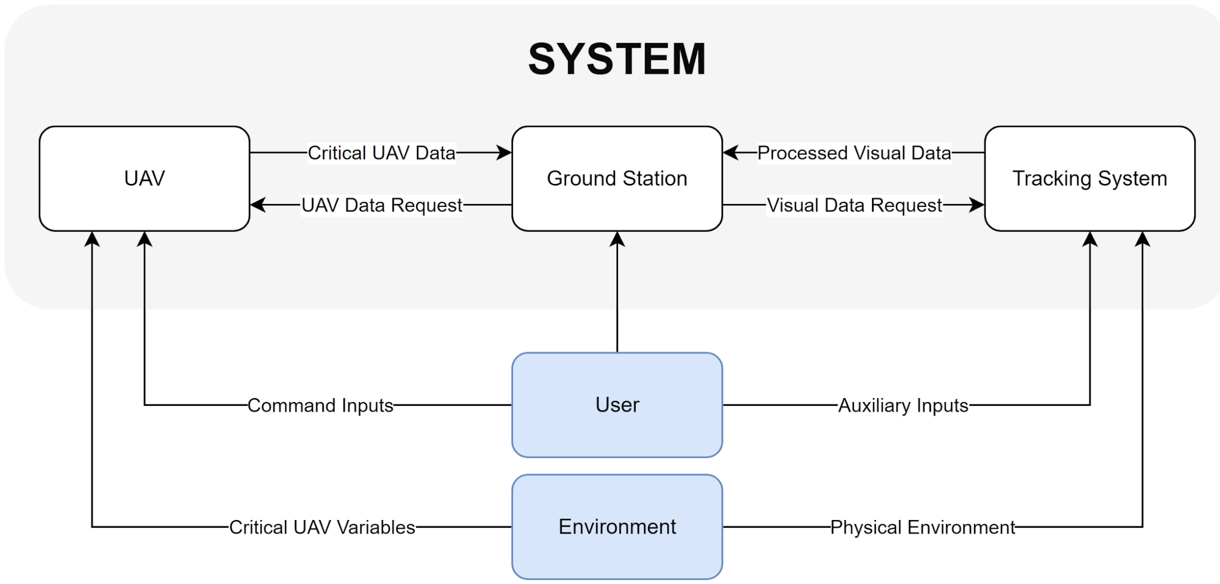

Figure 2: System Level Diagram

4.1 Scope of Hazard Analysis

Our analysis will encompass all aspects of the project, including the ground station system, UAV components, and their interactions. We will identify and evaluate various potential hazards related to the wireless power transmission system, communication systems, and mechanical and electrical hazards of the UAV in real-time.

We will thoroughly examine these elements to identify any potential failure modes, weaknesses, and their corresponding consequences. By adopting a comprehensive approach to hazard analysis, we aim to proactively address safety concerns at every stage of the project, ensuring that our innovative solution not only extends drone capabilities but also meets the highest safety standards.

What is classified as a hazard? A hazard is a potential source of harm or loss. This might include the ability to damage or cause adverse effects to people, property, the environment, or any other entity or system. Potential hazards in our system are explored in Figure 3 and Figure 4 in the form of a fault tree analysis. The potential hazards in our system are mainly split into 2 categories, physical harm and financial loss. Possible hazards are then iterated upon in the second level. Hazards under financial loss include potential drone loss and property damage. Hazards under physical harm would be drone collision and Electrical Hazards. Potential causes of such hazards are detailed further along the tree. The fault tree analysis not only helps us detail potential losses and harm but will also be used to aid risk mitigation.

5. FAULT TREE ANALYSIS

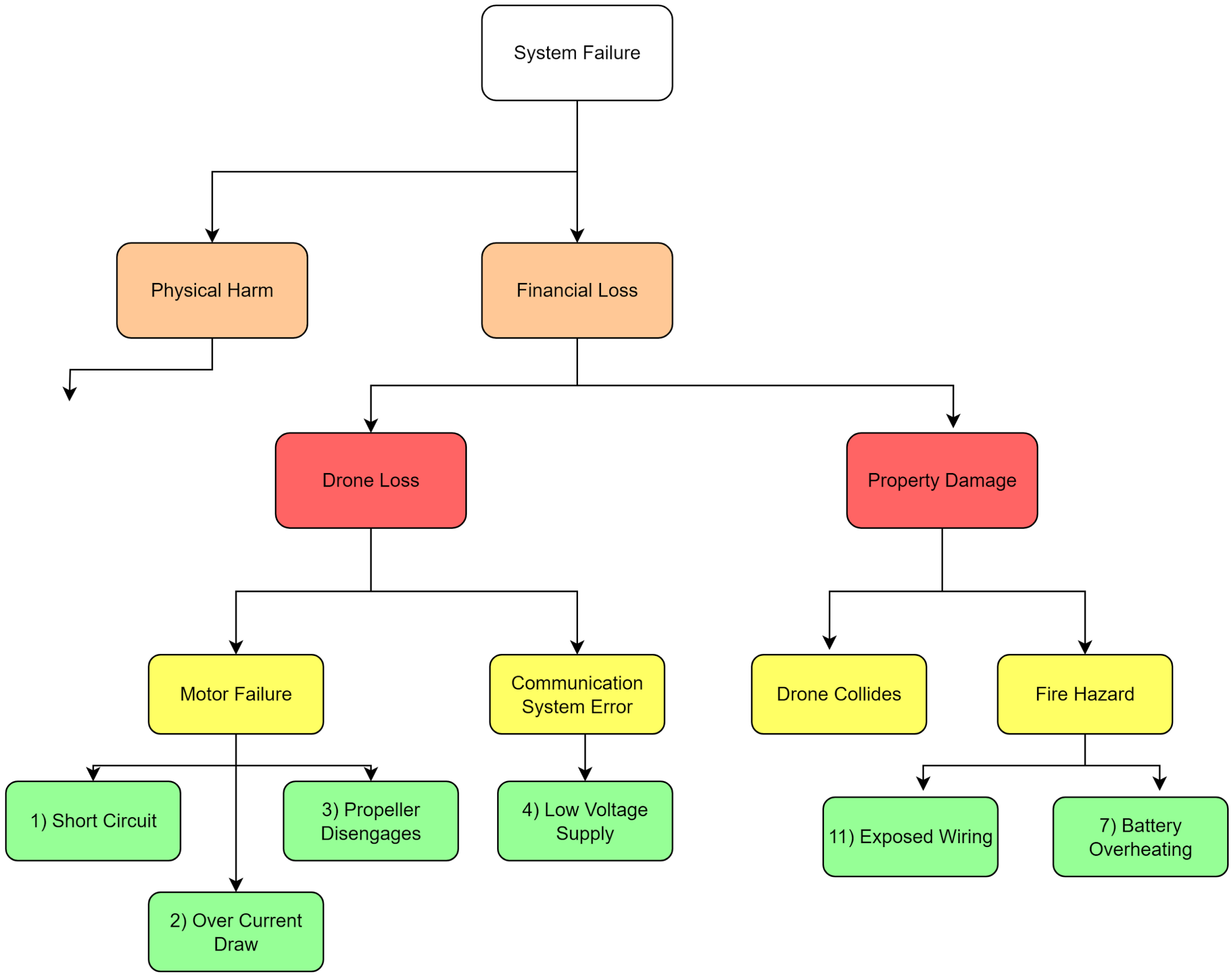

Figure 3: Fault Tree Analysis

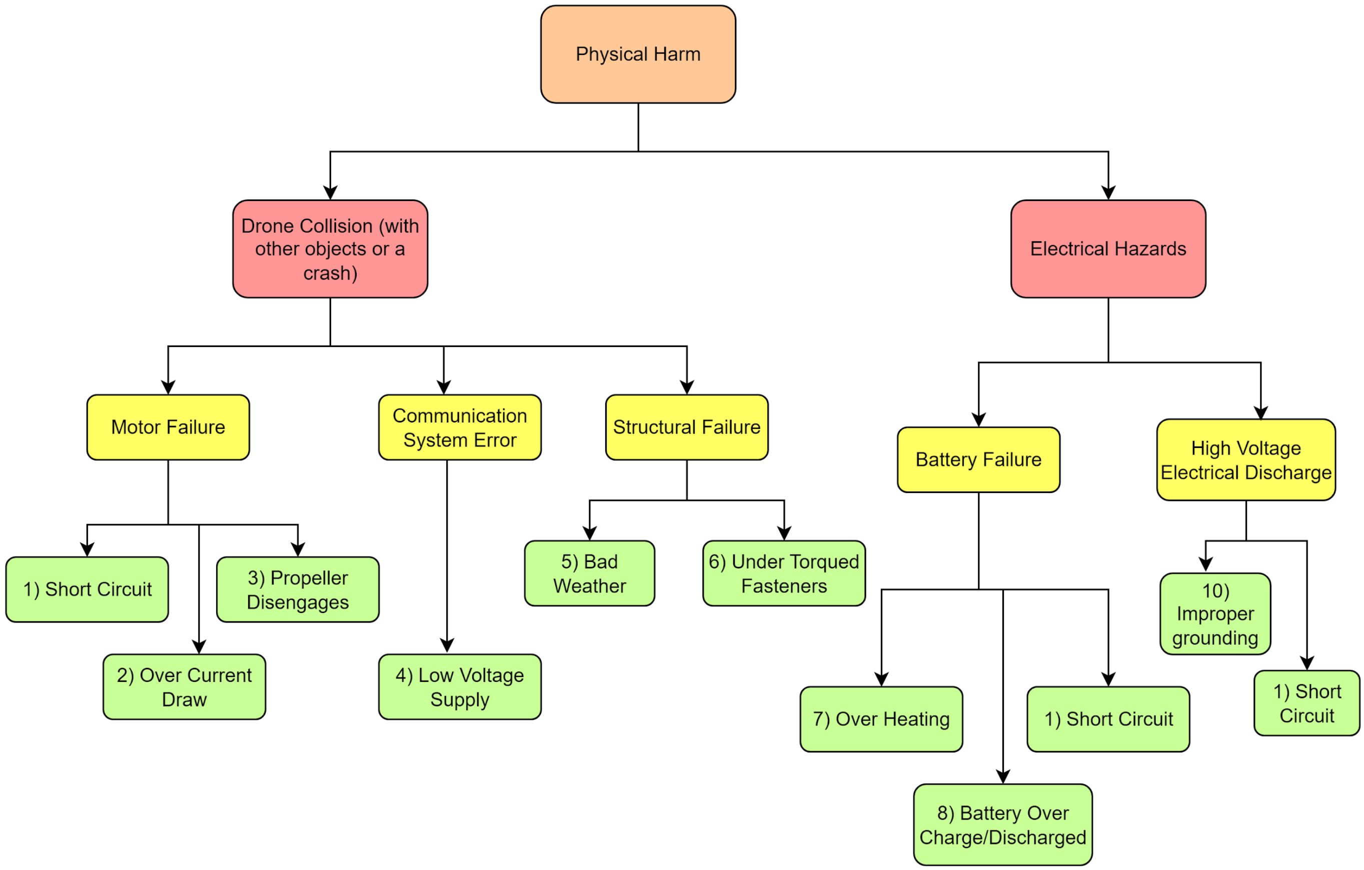

Figure 4: Expansion on Physical Harm

6. RISK MITIGATION STRATEGY

Risk ID	**Risks**	**Mitigation**
Risk 1	*Short Circuits*	Fuses and circuit breakers, and regular inspections of wiring for damage or wear
Risk 2	*Over Current Draw*	Implement current monitoring system and current limiting components in the circuit
Risk 3	*Propeller Disengagement*	Tighten propeller nut to appropriate torque specification and double check fastener connections before flight
Risk 4	*Low Voltage Supply*	Ensure the wires are connected properly and perform a test run to see desired results are monitored

Risk 5	*Bad weather*	Conduct indoor testing and avoid bad weather
Risk 6	*Under Torqued Fasteners*	Tighten torque to adequate torque specification
Risk 7	*Overheating*	Add thermal cut-off circuitry to prevent overheating
Risk 8	*Battery Over Discharge/Charge*	**Over Discharge** Implement battery management system (BMS) to monitor and prevent deep discharges, set voltage limits, and use low-voltage alarms. **Over Charge** Use quality chargers with overcharge protection and employ charging systems that automatically disconnect when batteries are fully charged.
Risk 9	*Improper Grounding*	Ensure proper grounding of electrical components and perform regular checks to maintain grounding integrity.
Risk 10	*Motor Failure*	Regularly inspect motors, employ quality control during motor assembly, and have spare motors readily available.