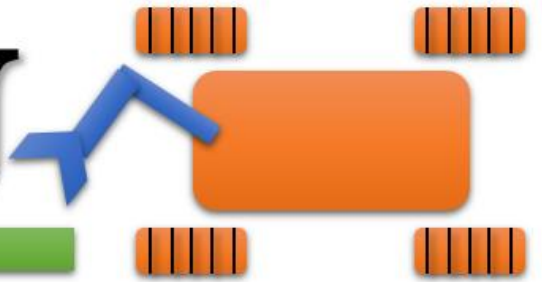


IRoC-U



ISRO Robotics Challenge - URSC

Let's build a space robot

Proposal Report

For IRoC-U 2025

by

MARVEN

Team ID: 10729

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**KIT – KALAI GNARKARUNANIDHI INSTITUTE
OF TECHNOLOGY**

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1 Description of ANAV

The **Autonomous Navigation Aerial Vehicle (ANAV)** is a specialized drone designed to operate in Mars-like conditions, optimized for the challenges of thin atmosphere conditions. Inspired by NASA's Mars mission drone, the ANAV utilizes a quad propeller system for both thrust generation and aerodynamic stability, reducing complexity while maximizing performance in low-density atmospheres

To ensure accurate navigation and safe operation, the ANAV integrates several advanced sensors.

LiDAR (Light Detection and Ranging) sensor with 360-degree scanning capability, providing **3D mapping** and **real-time obstacle detection** for precise terrain analysis. **HD cameras** are used for real-time image processing, helping the vehicle analyse its surroundings and support autonomous decision-making during flight. The ANAV is equipped with a **gyroscope**, which helps in stabilizing the vehicle by counteracting any rotational forces caused by wind disturbances, ensuring smooth and stable flight. The gyroscope provides dynamic balance during take-off, landing, and hovering, which is crucial for maintaining control in unpredictable atmospheric conditions.

The ANAV is equipped with **standing legs** integrated with **suspension systems**. This feature allows the drone to **achieve smooth landings** by absorbing shocks and **minimizing impact forces during touchdown**. Additionally, the suspension provides dynamic balance when the **drone lands on uneven or improper surfaces, irregular terrain**.

In addition in the onboard systems, the ANAV is designed to communicate with a rover operating in the same environment. The drone and rover can send and receive data, ensuring continuous communication between the two units. If any miscommunication or signal loss occurs, both systems are equipped to detect the issue. Upon identifying a connection failure or misbehaviour, the drone autonomously triggers a return-to-home function. The drone will navigate back to the rover's location or to a designated safe zone, ensuring it safely returns to its origin point without losing connection to the rover

These integrated systems allow the ANAV to perform **autonomous navigation, obstacle avoidance, smooth landing and safe landing operations in harsh, low-density atmospheres**, making it ideal for Martian exploration and environmental monitoring applications.

We'll compare potential options for aerial vehicles based on Table-1 in the rule book (Section 7.2) and justify the selected design. These are the three primary options

Table 1

Aerial Vehicle Type	Advantages	Limitations	Use Case Feasibility
Quadcopter	Easy to maneuver; stable hovering; compact design; cost-effective.	Limited payload capacity; shorter endurance.	Ideal for reconnaissance and low-weight payloads.
Fixed-Wing UAV	Long endurance; higher speed and range; energy-efficient.	Requires a launch/recovery mechanism; less maneuverability in small spaces.	Suitable for long-range mapping missions.
Hybrid VTOL	Combines hovering of multicopters and range of fixed-wing.	Complex design; higher cost and maintenance.	Optimal for diverse mission requirements.

The **quadcopter** was selected for its **versatility, cost-effectiveness, ease of development, and adaptability**. Its ability to hover and navigate tight spaces makes it ideal for tasks requiring obstacle avoidance and precision, which aligns well with the competition's goals. Additionally, it strikes a balance between performance and affordability, ensuring efficient use of resources. The availability of readily accessible components and extensive documentation simplifies development and testing processes. Furthermore, its modular design allows for the integration of various sensors and payloads, making it highly customizable for specific mission requirements.

Table 2

Aspect	Specifications and Justification
Aerial Vehicle Type	Quadcopter with a total mass of 1.97 kg, within the 2 kg limit specified by Drone Rules-2021.
Software Capabilities	Indigenously developed software for navigation, mapping, and Return-to-Home (RTH), optimized for real-time performance.
Power Source	Battery-operated system using a 14.8V 4S 5200mAh LiPo for extended flight time.
Communication	RF Communication with MAVLink/MAVROS protocols for robust telemetry.

Aspect	Specifications and Justification
Navigation	TF02-Pro LiDAR for 3D mapping and terrain analysis, coupled with a 64MP Camera and IMU for precise navigation.
Payload	Equipped with modular slots for LiDAR, HD camera, and soil sensors.
Slope Landing	Designed with a 15° slope landing capability using gyroscopic stability algorithms.
Flight Control	Powered by the Pixhawk Orange Cube+ with advanced gyroscopic stabilization.

2 System Architecture

The ANAV's system architecture integrates hardware and software subsystems to achieve autonomous navigation and aerial functionality. The design adheres to competition requirements and ensures seamless communication between various subsystems.

Key Subsystems:

1. Power Subsystem

- Powers all components, including propulsion, sensors, and the onboard computer.
- Key components: LiPo battery, Buck converter, Power Distribution Board (PDB).

2. Propulsion Subsystem

- Ensures stable flight and manoeuvrability.
- Key components: Motors, ESCs, and Propellers.

3. Flight Control Subsystem

- Maintains stability and handles navigation.
- Key components: Pixhawk Orange Cube+ Flight Controller, IMU, and gyroscopic stabilizers.

4. Navigation and Sensing Subsystem

- Provides data for autonomous flight and obstacle avoidance.
- Key components: TF02-Pro LiDAR, Arducam 64MP Camera, GPS, and IMU.

5. Processing and Communication Subsystem

- Processes data and manages communication between the ANAV and the ground station.
- Key components: Raspberry Pi 5, MAVLink/MAVROS, and RF communication modules.

6. Payload Subsystem

- Performs mission-specific tasks like imaging and analysis.
- Key components: Soil sensors and HD cameras.

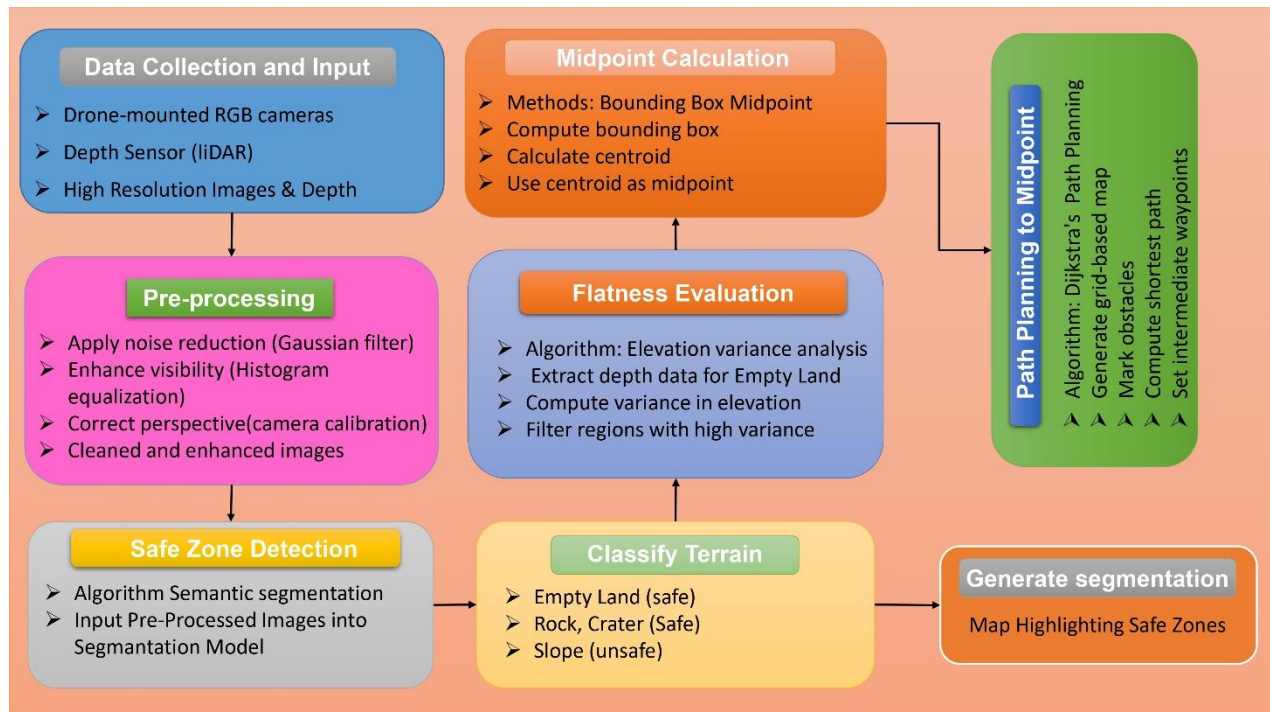


Figure 1

I. Data Collection and Input

The data acquisition process involves multiple sensors integrated into the Autonomous Navigation Aerial Vehicle (ANAV) to ensure comprehensive environmental awareness. **Drone-mounted RGB cameras capture high-resolution visual data**, while a **LiDAR sensor** collects depth information critical for accurate terrain mapping. These sensors work synchronously to provide high-resolution images, depth maps, and geospatial data, forming the foundation for subsequent processing. The input data must be timestamped for **alignment across modalities**, ensuring seamless integration during pre-processing and analysis.

II. Pre-processing

Raw sensor data is subjected to a series of enhancement techniques to prepare it for advanced computational analysis. Gaussian filters are applied to mitigate noise, ensuring smooth gradients and reducing unwanted artifacts in the image data. Histogram equalization enhances visibility by improving contrast, enabling better feature detection in varying light conditions. Perspective distortions are corrected using camera calibration parameters, ensuring spatial accuracy of the captured data. This stage outputs cleaned, high-quality data optimized for safe zone detection and other downstream processes.

III. Safe Zone Detection

This module employs advanced semantic segmentation algorithms to classify the terrain into safe and unsafe zones. Pre-processed images and depth data are fed into a segmentation model trained to identify and label areas suitable for landing. The model outputs a pixel-wise map that highlights safe zones, unsafe terrain, and obstacles, ensuring precise delineation of navigable areas. The accuracy of this module is critical for the safety and reliability of the ANAV's operations.

IV. Midpoint Calculation

Once safe zones are detected, the midpoint of the largest or most suitable safe zone is computed to determine the optimal landing location. This involves calculating the centroid of the bounding box encapsulating the safe region. The process ensures that the selected point is equidistant from the edges of the identified zone, reducing the risk of encroaching on unsafe areas. The calculated midpoint serves as the primary reference for navigation and path planning.

V. Flatness Evaluation

Flatness evaluation is essential to assess the terrain's suitability for operations. Elevation data extracted from the depth map is analyzed for variance, ensuring the selected zone exhibits minimal elevation changes. High-variance regions, indicative of slopes or uneven terrain, are excluded from the candidate safe zones. The algorithm's precision in detecting flat areas ensures the stability and safety of landing and operational activities.

VI. Classify Terrain

This module categorizes the detected zones based on their characteristics, providing an additional

layer of validation for safe navigation. Terrain is classified into categories such as empty land, rock, craters (considered safe), and slopes (deemed unsafe). Classification is achieved through a combination of elevation variance analysis and surface texture evaluation, enabling robust and accurate terrain assessment.

VII. Path Planning to Midpoint

Path planning involves generating the most efficient and obstacle-free route to the calculated midpoint. A grid-based map is created using depth and segmentation data, marking obstacles and delineating traversable areas. Algorithms such as Dijkstra's or A* are utilized to compute the shortest path, incorporating intermediate waypoints for smooth navigation. This module ensures precise and efficient navigation, critical for the ANAV's autonomous operations.

VIII. Generate Segmentation

The final output of the system is a comprehensive map highlighting safe zones and navigation paths. This map integrates data from all previous modules, providing a visual representation of the safe zones, unsafe areas, and the computed path to the designated midpoint. It serves as a crucial tool for operator verification and mission planning, ensuring the success of the ANAV's deployment.

3 Identification of components with their specifications

I. Holybro S500 V2 Frame Kit

Weight: 900g

Description: The Holybro S500 V2 is a robust and lightweight frame designed for quadcopters. It features high-strength arms with vibration dampening, making it suitable for stable flight. Its modular design supports easy assembly and maintenance.

Comparison: Compared to plastic frames, the carbon fiber build of this frame ensures better durability and resistance to stress during crashes.

Justification: Selected for its compatibility with the quadcopter design and ability to handle additional payloads efficiently.



Figure 2

II. DYS D2836-9 880KV Outrunner Brushless Drone Motor (4 Units)

Weight (per unit): 100g

Description: High-performance brushless motors with 880KV rating suitable for stable thrust generation. Known for efficiency, low noise, and heat dissipation during operation.

Comparison: Tested against higher KV motors, which were found less efficient for payload-heavy drones.

Justification: Ideal for balancing power efficiency and thrust for stable flight in medium-sized drones.



Figure 3

III. Speedy Bee 50A 4in1 ESC

Weight: 90g

Description: A compact electronic speed controller (ESC) capable of handling 50A current per motor. Includes integrated power management for seamless communication with the flight controller.

Comparison: Chosen over separate ESCs to reduce weight and simplify wiring.

Justification: Ensures efficient power delivery and reduces hardware complexity.

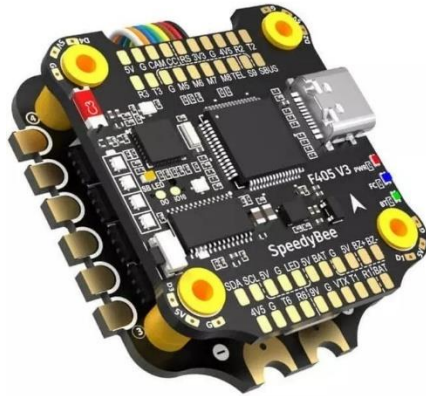


Figure 4

IV. Orange HD Propellers 1050 (10X5.0) ABS Black (2 Pairs)

Weight (per pair): 60g

Description: Durable ABS propellers optimized for stable thrust generation with a 10x5.0 pitch ratio.

Comparison: Tested against carbon fiber props but preferred for affordability and adequate performance.

Justification: Chosen for their balance of performance, durability, and cost-effectiveness.



Figure 5

V. GenX 14.8V 4S 5200mAh 40C/80C LiPo Battery

Weight: 420g

Description: A high-capacity lithium polymer battery capable of delivering stable power output. The 40C/80C discharge rating ensures ample current for the motors and electronics.

Comparison: Outperformed lower capacity batteries in flight endurance tests.

Justification: Selected for its high energy density, balancing weight and flight duration.



Figure 6

VI. Pixhawk Orange Cube+

Weight: 100

Description: A robust flight controller with advanced processing capabilities for autonomous navigation and precise control. Compatible with ArduPilot and PX4 firmware.

Comparison: Chosen over older Pixhawk models for its better computing power and reliability in high-stakes missions.

Justification: Necessary for advanced flight path planning and real-time decision-making.



Figure 7

VII. RC Telemetry

Weight: 20g

Description: Wireless telemetry module for real-time communication between the ground station and the drone.

Comparison: Selected over wifi telemetry for improved data rates and ease of configuration.

Justification: Essential for mission control and data monitoring.



Figure 8

VIII. Raspberry Pi 5

Weight: Approx. 50g

Description: A high-performance single-board computer (SBC) used for image processing and algorithm implementation.

Comparison: Preferred over Raspberry Pi 4 due to its faster processing power and support for advanced peripherals.

Justification: Ensures seamless execution of AI and vision algorithms.



Figure 9

IX. Arducam 64MP Autofocus Camera Module

Weight: 30g

Description: High-resolution camera module for detailed aerial imagery and video recording. Autofocus enhances clarity in diverse environments.

Comparison: Outperformed other lower-resolution cameras in terrain classification tasks.

Justification: Crucial for vision-based algorithms such as semantic segmentation and obstacle detection.



Figure 10

X. Buck Converter (5A)

Weight: 100g

Description: Voltage regulator to step down power from the battery for use in sensitive electronic components.

Comparison: Selected over linear voltage regulators for higher efficiency and compact size.

Justification: Prevents power fluctuations, ensuring stable operation of electronic modules.

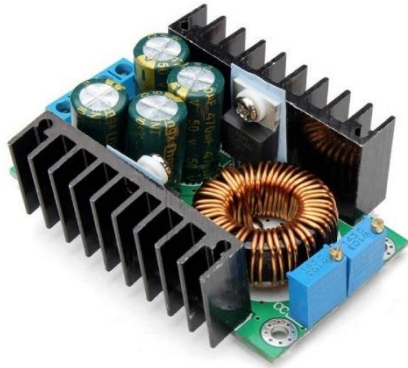


Figure 11

XI. TF02-Pro LiDAR Distance Ranging Sensor

Weight: 50g

Description: IP65-rated LiDAR sensor with a 40m range for obstacle detection and terrain mapping.

Comparison: Outperformed ultrasonic sensors in accuracy and range.

Justification: Required for precise altitude hold and collision avoidance.



Figure 12

XII. Miscellaneous Components

Weight: 100g

Description: Includes mounting accessories, wiring, and connectors necessary for integration of all sub-systems.

Justification: Ensures proper assembly and secure connections.

4 Outline the plan for realization of ANAV

Software Implementation Plan for Navigation and Guidance:

- **Navigation and Guidance Software:** A combination of ROS (Robot Operating System) and custom software will be developed. The Pixhawk Orange Cube+ will run the flight controller firmware (ArduPilot) that supports autonomous navigation, including waypoint navigation, GPS-based guidance, and obstacle avoidance. ROS will handle communication with onboard sensors such as the LIDAR, camera, and other telemetry components. The Raspberry Pi 5 will execute high-level decision-making algorithms, image processing, and path planning, using inputs from the LIDAR and camera to adjust flight dynamics in real time.
- **Mission Control:** The RC telemetry will facilitate real-time monitoring of the drone's health, position, and camera feed. The Raspberry Pi 5, connected to the telemetry, will allow for dynamic control and adjustments via a ground station.

Hardware for Navigation and Guidance:

- **Pixhawk Orange Cube+:** The primary flight controller for autonomous navigation.
- **TF02-Pro LIDAR:** Provides real-time distance measurements for obstacle avoidance and terrain mapping.
- **Raspberry Pi 5:** Handles sensor fusion, image processing, and mission planning.
- **Arducam 64MP Camera:** Supplies visual input for both manual and autonomous guidance.
- **RC Telemetry:** Enables communication between the ground station and drone for data exchange and monitoring.

Table 3

No.	Hardware Details	Procurement Source	Specifications/ Realization Plan	Quantity
1	Holybro S500 V2 Frame Kit	Robu.in	Lightweight carbon frame for drone build.	1
2	DYS D2836-9 880KV Outrunner Brushless Drone Motor (Original)	Robu.in	Brushless motors for stable flight.	4
3	Speedy bee 50A 4in1 ESC	Robu.in	4-in-1 electronic speed controller.	1
4	Orange HD Propellers 1050(10X5.0) ABS Black 1CW+1CCW – 2 pair	Market	Propellers for smooth propulsion.	2 pairs
5	GenX 14.8V 4S 5200mAh 40C / 80C Premium LiPo Lithium Polymer Battery	Market	High-capacity battery for long flight times.	1
6	Pixhawk Orange Cube+	Market	Autopilot system for navigation and control.	1
7	RC Telemetry	Market	For wireless data transmission.	1
8	Raspberry Pi 5	Market	For onboard processing and control.	1
9	Arducam 64MP Auto-focus Camera Module for Raspberry Pi	Robu.in	High-definition camera for visual data capture.	1
10	Buck Converter (5A)	Market	Voltage conversion for power regulation.	1
11	TF02-Pro LIDAR Distance Ranging Sensor FOR DRONES UAV UAS Robots	Market	LIDAR for precise distance measurement and navigation.	1
12	Miscellaneous	Market/Fabrication	Includes wiring, connectors, mounting materials, etc.	-

5 Test Plan:

In order to ensure that the Autonomous Navigation Aerial Vehicle (ANAV) meets its design objectives and performs reliably in real-world scenarios, a comprehensive test plan must be developed and executed. This plan outlines the essential tests required to verify the functionality, performance, and safety of the ANAV system. Testing is a critical phase in the development of autonomous systems, as it helps identify potential weaknesses and confirms that the vehicle will operate as expected in various operational conditions.

The tests are categorized into sub-system and system level assessments, covering all critical components such as propulsion, navigation, stability, sensor integration, and software performance. Each test has been designed to evaluate specific functionalities, with the expected outcomes providing benchmarks for success. By systematically assessing the performance under controlled and simulated conditions, the team will be able to validate the design, ensuring the ANAV achieves optimal performance, safety, and reliability during its deployment.

Table 4

Test No.	Test Name	Test Plan	Expected Outcome
1	Propeller Thrust Test	Measure thrust under different RPM settings to assess lift generation.	Consistent lift generation at various RPMs, ensuring stable flight.
2	Stability Test	Simulate Martian winds (wind speed and turbulence) and observe flight behavior.	Stable flight in the presence of simulated wind conditions (turbulence resistance).
3	Navigation Test	Use LiDAR and cameras to map terrain, identify obstacles, and adjust flight path autonomously.	Accurate 3D mapping of the environment and successful obstacle avoidance.
4	Battery Endurance Test	Measure flight time and performance under typical operating conditions (varying payload).	Consistent performance with battery capacity estimation.
5	Control Response Test	Test response to manual control inputs and autonomous commands under various conditions.	Quick, smooth response to both manual and autonomous control inputs.
6	GPS Accuracy Test	Assess GPS navigation accuracy in different environments (open space, forest, urban).	Accurate position tracking and minimal deviation from the planned path.

7	Emergency Landing Test	Simulate battery failure or communication loss and observe emergency landing protocol.	Successful emergency landing without damage to the system.
8	Payload Test	Test the system's ability to carry and deploy payloads (if applicable).	Stable flight with payload deployed safely and securely.
9	Camera Vision Test	Assess camera quality and image processing capability for autonomous navigation.	High-quality image feed with accurate object detection and tracking.
10	Software Stability Test	Run the onboard software and test for bugs, crashes, or slow response times during prolonged flight.	Smooth, error-free operation of software during long-duration flights.

6 System specification

The system specification provides a comprehensive overview of the key attributes, dimensions, and capabilities of the Autonomous Navigation Aerial Vehicle (ANAV). This document outlines the essential characteristics of the ANAV, including its size, mass, power requirements, and flight capabilities, as well as the features that enable autonomous navigation and environmental interaction.

The specifications presented here offer insight into the vehicle's performance, ensuring that it meets the design objectives for functionality, efficiency, and reliability. By detailing the system's core components—such as the propulsion system, power supply, and onboard sensors—this section serves as a foundation for understanding the ANAV's operational characteristics and potential applications.

Table 5

Sl. No.	Description	Specification
1	Overall mass	1970 g (including all components and payload)
2	Overall dimensions	500 mm (length) x 500 mm (width) x 200 mm (height)
3	Power requirements	14.8V LiPo Battery, 5200mAh, 40C/80C
4	Flight time per charge	Approximately 20-25 minutes (based on typical operating conditions)
5	Number of propellers and their size	4 propellers, 1050 (10X5.0) ABS Black
6	Features	Autonomous navigation, LiDAR & camera integration, GPS tracking, RC telemetry, obstacle avoidance

Sl. No.	Description	Specification
7	Any other specifications	Pixhawk Orange Cube+ (flight controller), Raspberry Pi 5 (processing unit), TF02-Pro LIDAR (distance sensor), Arducam 64MP camera (vision system)

7 Overview of the Emergency Response System.

In the development of the Autonomous Navigation Aerial Vehicle (ANAV), it is crucial to anticipate potential emergency situations that could arise during flight operations and ensure that robust systems are in place to handle these scenarios. The following outlines the key emergency situations, a proposed response system to address them, and alternative solutions with justifications for the chosen approach.

A) IDENTIFICATION OF EMERGENCY SITUATIONS

1. **Battery Failure / Low Battery Alert**
 - Situation: The battery charge drops below a safe operational threshold during flight, risking loss of power and control.
2. **Communication Loss**
 - Situation: The ANAV loses connection with the ground station, leading to a loss of remote control and telemetry data.
3. **GPS Signal Loss or Deviation**
 - Situation: The GPS signal becomes weak or is completely lost, affecting the ANAV's ability to navigate accurately.
4. **Motor Failure**
 - Situation: One or more motors fail mid-flight, causing instability or loss of control of the ANAV.
5. **Obstacle Collision / Obstacle Avoidance Failure**
 - Situation: The ANAV fails to detect an obstacle in its flight path, leading to a potential collision.
6. **Sensor Malfunction**
 - Situation: Malfunction or failure of critical sensors such as the LiDAR, camera, or proximity sensors, which may impair autonomous navigation or obstacle detection.
7. **Autopilot / Software Failure**
 - Situation: A failure in the flight control software or autopilot system, causing the ANAV to behave unpredictably or crash.

B) DESCRIPTION OF THE RESPONSE SYSTEM

The **proposed Emergency Response System (ERS)** will incorporate a combination of hardware and software solutions designed to mitigate the risks associated with the identified emergency situations.

1. **Battery Failure / Low Battery Alert**

- **Response:** The ANAV will be equipped with a **low battery detection system** that will trigger an automatic return-to-home (RTH) function when the battery reaches a predefined threshold. This ensures that the vehicle returns to the starting point safely, even if battery levels are critically low.

2. **Communication Loss**

- **Response:** In case of communication loss, the ANAV will use an **autonomous failsafe mode**. If the system detects a loss of telemetry, it will automatically engage RTH and return to the base station or landing zone without requiring human intervention.

3. **GPS Signal Loss or Deviation**

- **Response:** To handle GPS signal loss, the system will integrate **sensor fusion**, combining data from the onboard LiDAR, camera, and IMU (Inertial Measurement Unit) to maintain stable flight and navigation. If GPS is lost for a prolonged period, the ANAV will switch to a **visual odometry system** based on the camera feed to maintain positioning.

4. **Motor Failure**

- **Response:** The ANAV will be equipped with **redundant motor systems** (if applicable), and in the case of motor failure, the system will be designed to stabilize using the remaining motors. Additionally, the **autopilot software** will trigger a controlled descent to land safely.

5. **Obstacle Collision / Obstacle Avoidance Failure**

- **Response:** The ANAV will incorporate multiple **sensor-based obstacle avoidance systems**, using LIDAR, proximity sensors, and cameras. In case of failure in one system, the remaining sensors will take over to detect obstacles. The system will also employ **path re-planning** in real-time to avoid collisions.

6. **Sensor Malfunction**

- **Response:** The system will have **redundant sensors** for critical functions. If one sensor fails, the backup sensor will be activated automatically. Additionally, real-time diagnostics will constantly monitor sensor health and trigger alerts for any malfunction.

7. **Autopilot / Software Failure**

- **Response:** In case of software failure, the ANAV will revert to **manual control mode**, allowing the operator to regain control. A **failsafe procedure** will ensure a safe landing by guiding the vehicle to the nearest safe area. Furthermore, **self-checks** and periodic software reboots will be integrated into the system to minimize the risk of malfunction.

Alternative Emergency Response Systems

While the proposed response systems will address the identified emergency situations effectively, alternative systems were also considered:

1. **Parachute Deployment System:** In case of a complete system failure, a parachute could be deployed to slow the descent and reduce impact damage. However, this would add weight and complexity to the design, which is why it's not the preferred solution for the ANAV.
2. **Increased Redundancy in Motors and Sensors:** While this could improve reliability, the cost and complexity of adding more redundant systems would significantly increase the system's weight and overall cost, which is why it's not the preferred option.
3. **Autonomous Landing Zone Identification:** Another alternative is to integrate a system that identifies safe landing zones autonomously when communication or GPS is lost. While this approach is promising, it requires advanced machine learning algorithms and could lead to additional system complexity.

8 Project management

Table 6

Area	Primary Responsibility	Secondary Support
Project Leadership	ABINESH T	KANISHKAA P T
Control Systems	GLADSON PAUL E	GOKULAKRISHNAN M
Embedded Systems	GOKULAKRISHNAN M	MARIA INFANCIA C
Image Processing	SUMEET KUMAR	GLADSON PAUL E
AI/ML	SRIDHARAN I	DELHI KRISHNAN S
Fabrication	RAHUL SRINIVAS P	HARISH S
Material Selection	HARISH S	KANISHKAA P T
Simulation	DELHI KRISHNAN S	SUMEET KUMAR
Design	ABINESH T	MARIA INFANCIA C

Table 7

Task	Main Responsibility	Start Week	End Week	Secondary Support	Deliverables
Requirements Gathering	ABINESH T	1	2	KANISHKAA P T	Requirements Document
System Architecture	SUMEET KUMAR	3	5	MARIA INFANCIA C	Architecture Design
Hardware Selection	ABINESH T	4	6	KANISHKAA P T	Hardware Specs

Task	Main Responsibility	Start Week	End Week	Secondary Support	Deliverables
Control Algorithm Design	GLADSON PAUL E	6	9	MARIA INFANCIA C	Algorithm Documentation
Image Processing Pipeline	SUMEET KUMAR	7	10	GLADSON PAUL E	Processing Modules
AI/ML Implementation	KANISHKAA P T	8	12	SUMEET KUMAR	ML Models
System Integration	GOKULAKRISHNAN M	13	16	All Team Members	Integrated System
Testing & Validation	HARISH S	17	19	RAHUL SRINIVAS P	Test Reports
Documentation	GLADSON PAUL E	19	20	All Team Members	Final Documentation

9 Novelty in the overall proposal

The Autonomous Navigation Aerial Vehicle (ANAV) stands out due to its innovative integration of advanced technologies that push the boundaries of current aerial vehicle capabilities. The originality of our approach lies in several key aspects:

1. Autonomous Navigation and Real-time Data Processing

The ANAV employs a combination of **LiDAR**, **cameras**, and **AI-driven algorithms** for **real-time terrain mapping** and **obstacle detection**. This allows for **autonomous navigation** even in complex and dynamic environments.

2. Machine Learning for Dynamic Path Re-Planning

Using **machine learning models**, the ANAV can adapt its path and make decisions in response to environmental changes. This allows it to **self-correct** and re-route as necessary, which sets it apart from conventional drones that typically rely on pre-programmed paths.

3. Multi-layered Emergency Response System

The ANAV incorporates a sophisticated **emergency response system** with failsafes for critical issues such as **battery failure**, **GPS loss**, **communication breakdown**, and **sensor malfunctions**. These features enhance **mission reliability** and ensure that the vehicle can return safely in case of emergencies.

4. **Energy-efficient Design**

With an emphasis on **optimized power consumption** and **extended flight times**, the ANAV's **energy efficiency** is a significant innovation. This ensures that the vehicle can perform longer missions while minimizing operational costs.

5. **Redundancy and Safety**

The design features multiple **redundant systems** that ensure smooth operation even if certain components fail. These safety mechanisms significantly reduce the likelihood of mission failure.

10 Declaration format

Declaration

We hereby declare that the aerial vehicle (rotorcraft) built/procured by team **MARVEN**, college **KIT – KALAIgnarkarunanidhi Institute of Technology, KANNAMPALAYAM, COIMBATORE, TAMIL NADU, INDIA**, complies to Drone rules-2021, issued by Ministry of Civil Aviation as per the Gazette of India CG-DL-E-26082021-229221 or the latest version.

Team lead: ABINESH T

Mentor-1: Dr. ARIVUMANI RAVANAN

Mentor-2: Mr. PRASANNEswARAN