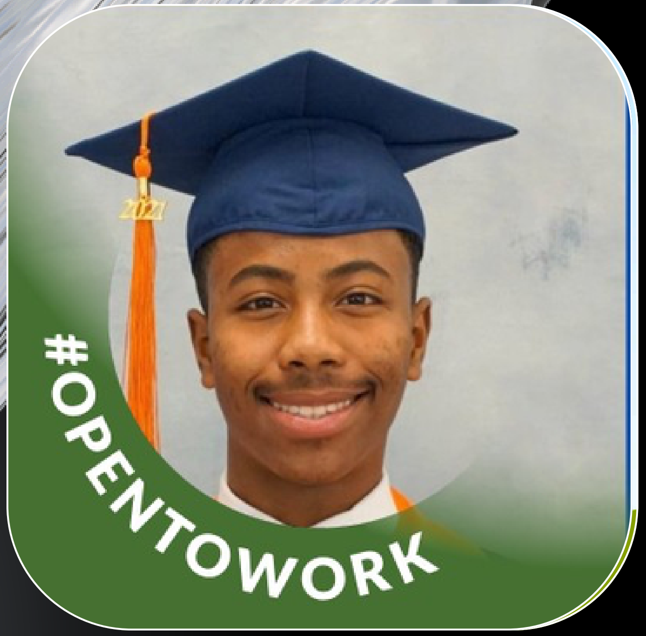
SCOUTING DRONE PROJECT

SPONSORED BY: RAYTHEON

ADVISORS: DR. RAWAT, DR. LESLIE

TEAM



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AGENDA

- Introduction
- Background
- Problem Formulation
- Constraints
- Real-world Applications
- Equipped Sensor Design Metrics
- Product Justification
- Final Product Specification
- Conclusion

INTRODUCTION

- Annual Raytheon Autonomous Vehicle Competition (AVC)!
  - Sponsored by Raytheon, an RTX business, in partnership with universities across four regions.
- Purpose of the Competition:
  - Provide students with real-world problem-solving opportunities using Unmanned Vehicle systems.
  - Encourage creativity, innovation, and teamwork in a professional environment.
- Benefits for Students:
  - Gain hands-on experience in project management and problem-solving.
  - Apply technical and collaborative skills to open-ended challenges.
- Benefits for Raytheon:
  - Identify and assess top graduates.
  - Strengthen relationships with universities.
  - Promote corporate branding and explore emerging technologies.

BACKGROUND

Background of the Project

- Focus: Raytheon AVC - "Mission Full Send."
- Objective: Develop autonomous UAV systems for real-world tasks.
- Tasks:
  - Scout UAV: Map and identify target zones.
  - Delivery UxV: Deliver payloads using Scout UAV data.
- Purpose: Drive innovation, teamwork, and industry readiness.

Dissatisfied Conditions

- Limited autonomy and target identification in current systems.
- Inefficient vehicle-to-vehicle communication.
- Lack of adaptability to varying environments.

Customer Needs

- Fully autonomous systems with reliable peer-to-peer communication.
- Operable in diverse conditions, with or without GPS.
- Cost-effective design within a $5,000 budget

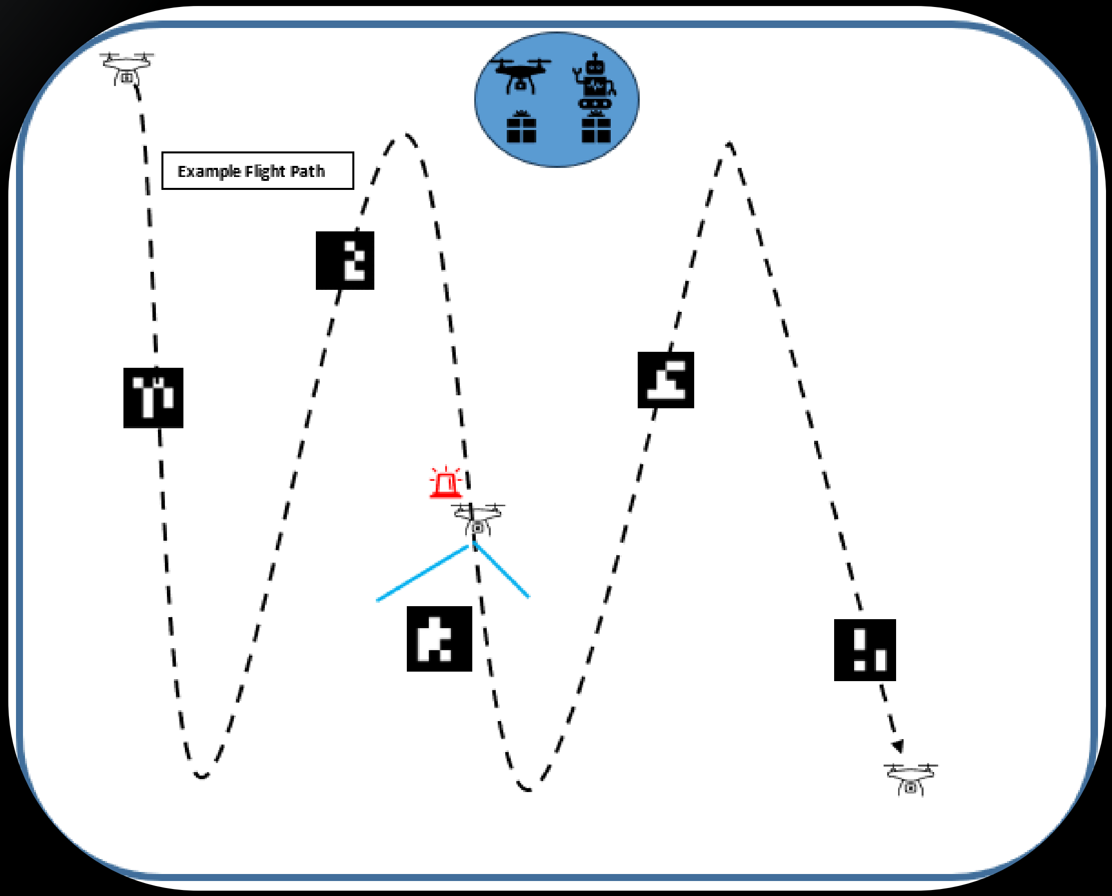
PROBLEM FORMULATION

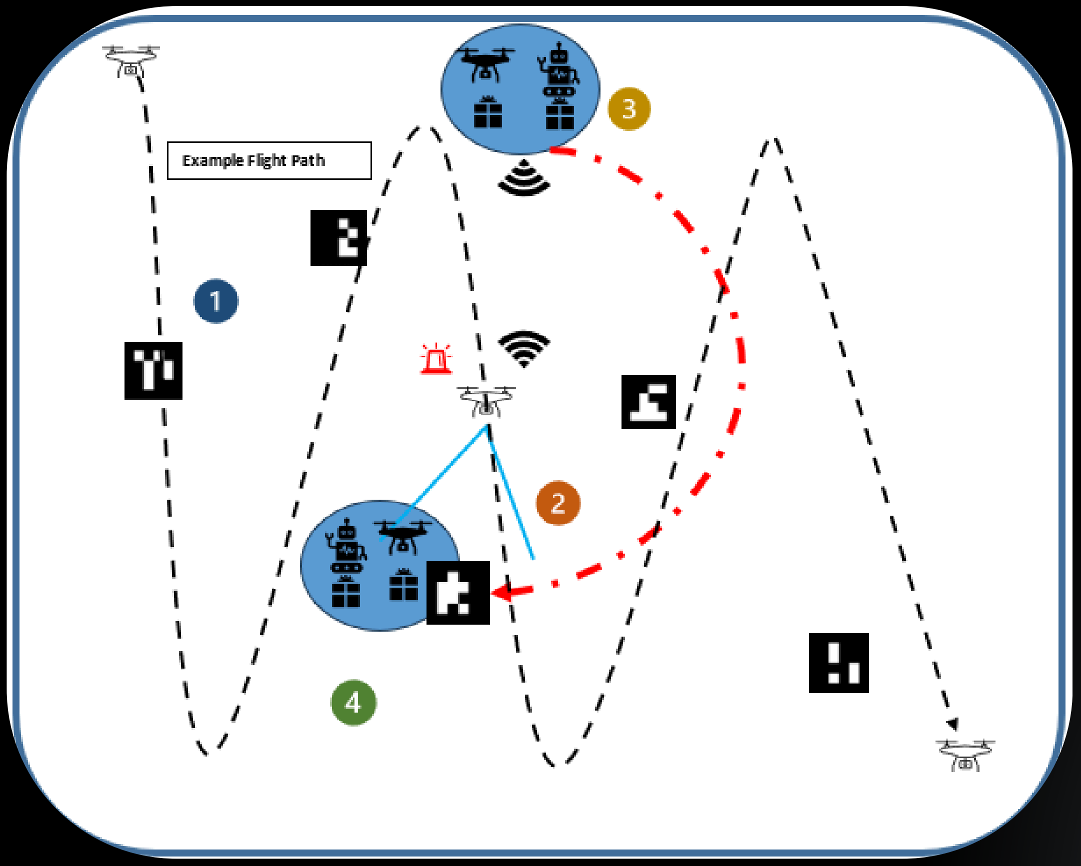
Problem Statement

- Develop an autonomous UAV systems for navigation, target identification, and payload delivery.
- Overcome challenges like limited communication, adaptability, and operational efficiency.

Design Requirements - Product for Software Spec

- Functional: Autonomous navigation, peer-to-peer communication, target identification.
- Performance: Timely payload delivery, flexible to field variations.
- System: Support GPS/non-GPS environments, modular architecture.





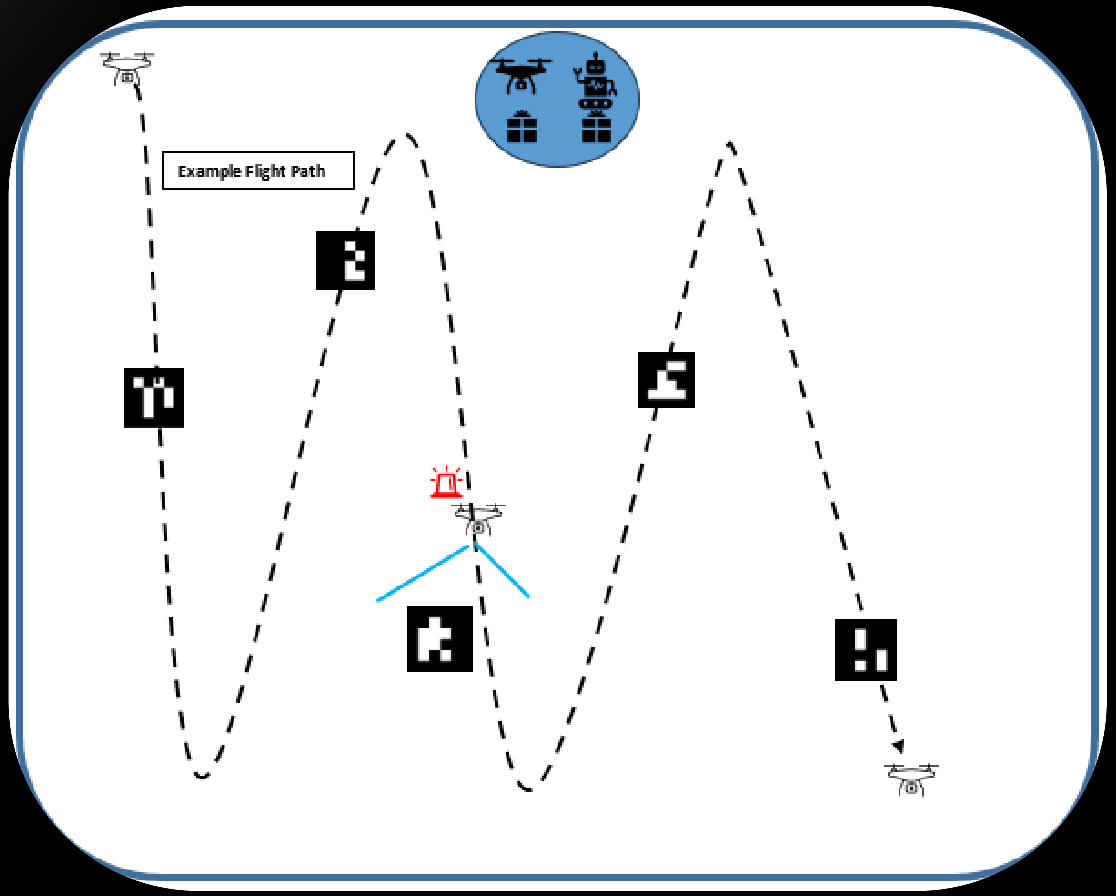
CONSTRAINTS AND REGULATIONS

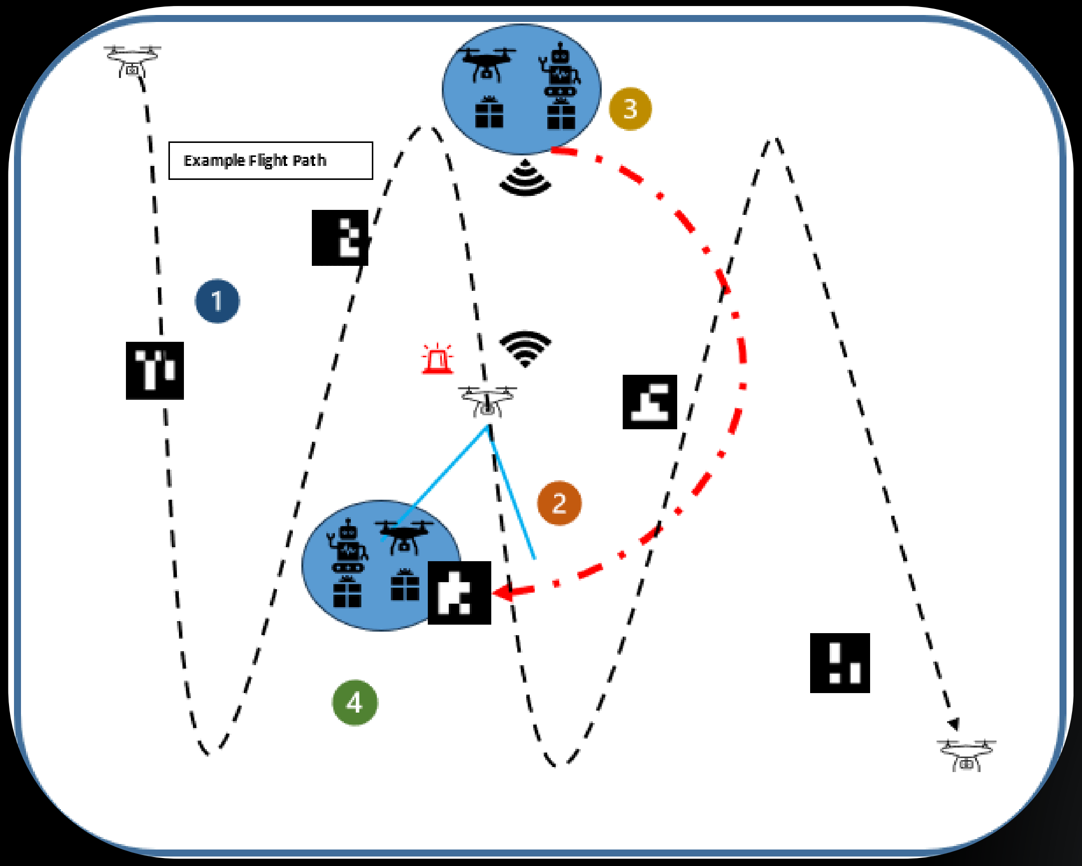
Constraints of Standards and Regulations

- Safety: FAA compliance, kill switches, weight limits (<55 lbs).
- Operations: Geofencing, RTK/NTRIP for accuracy high-precision GPS positioning).
- Budget: $5,000 maximum for hardware/software.

Constraints of Society, Culture, and Environment

- Societal: Ensure public safety, promote STEM education.
- Cultural: Foster diversity through regional university partnerships.
- Environmental: Operate reliably in diverse conditions with minimal impact





REAL-WORLD APPLICATIONS

Scenario:

- Many pet owners struggle to locate lost pets, leading to prolonged searches and distress

Solution:

A scouting drone equipped with image processing and recognition would be able to efficiently locate missing animals by scanning large areas in a shorter time.

Scenario: There are many cases where there is a shipwreck or plane crash and people go missing and are unacounted for

Solution: The drone will be able to search for key points of interest like floating debris, or SOS signs and send a signal to the nearest rescue search team or coast guard.

EQUIPPED SENSOR DESIGN METRICS

Criteria	Ultrasonic TOF Sensor	IMU (Inertial Measurement Unit)
Cost	4 - Generally affordable, though precision models can increase the cost	5 - IMUs are widely available and typically low-cost for standard performance
Range	2 - Limited range (typically 1-4 meters), suitable only for short distances	5 - Measures orientation and motion over a large range
Accuracy in Positioning	3 - Accurate for close distance but affected by the environment	4 - Provides high accuracy in orientation and motion changes, though subject to drift over time
Environmental Sensitivity	2 - Impacted by temperature, humidity, and wind; interference from sound	4 - Relatively low sensitivity to environmental changes but may be affected by magnetic fields
Real-time Responsiveness	3 - Slower response rate, not ideal for high-speed environments	5 - Extremely fast response rate, suitable for rapid motion and orientation tracking
Power Consumption	3 - Moderate; needs constant power for emission and reception of sound waves	5 - Low; typically requires minimal power for consistent operation
Ease of Integration	4 - Fairly straightforward to install, but may require careful positioning	5 - Small, lightweight, and easy to integrate with standard drone control systems
Obstacle Detection	5 - Effective for short-range obstacle detection (directly below or in front)	1 - Not capable of detecting obstacles; designed for motion and orientation sensing only
Altitude Measurement	4 - Accurate at low altitudes (when above ground)	3 - Provides altitude estimation but typically requires data from additional sensors (e.g., GPS) for accuracy
Weight and Size	3 - Moderate, can be bulky depending on the model	5 - Compact, lightweight, ideal for drone use without adding excess weight
Reliability Over Time	3 - Sensitive to wear and environment; calibration may be needed	5 - Highly reliable, stable measurements over time
Application Versatility	2 - Specialized for short-distance measurements and obstacle detection	5 - Versatile for any scenario requiring motion or orientation data, useful across various applications

Based on 12 Criterias :

- Cost, Range, Power Consumption, Ease of Integration, Obstacle Detection, Altitude Measurement etc...

Total Score out of 60:

- TOF Sensor - **38** (3.1 on 5 scale)
- IMU Sensor - **52** (4.3 on 5 scale)

PRODUCT JUSTIFICATIONS

Inertial Measurement Unit (IMU) Sensor

WHAT?
Measures an object's motion and orientation using accelerometers and gyroscopes. It provides real-time data for precise navigation and control in drones, robotics, and other systems.

WHY?

- Reliable Real-Time Data: Provides accurate stability and orientation information, critical for precise navigation and control in unmanned drones.
- Compact and Lightweight: Ideal for drones, minimizing power consumption and optimizing space for additional equipment.
- Independence from Environmental Factors: Unaffected by conditions like wind, ensuring versatile performance in both open and confined spaces.
- Enhanced Performance: Improves navigation and control across varied environments.
- Integration with LiDAR: Maximizes efficiency and capabilities, combining precise orientation data with advanced distance measurement.
- Optimal Solution: Considering these advantages, the IMU is the more viable option to achieve our goals effectively.

FINAL PRODUCT SPECIFICATIONS

Drone:

- Model: DJI Mavic 3 Pro Fly More
- Camera & Imaging: 20 MP CMOS sensor, 4K video (up to 5.1K)
- Battery & Power: 5000 mAh lithium polymer, 15.4V, (<43 minutes of flight time).
- Performance & Control: GPS/Galileo/BeiDou navigation, obstacle avoidance system

Raspberry Pi:

- Model: Raspberry Pi 4 or Raspberry Pi Zero 2 W (lightweight).
- Purpose: Serves as the central processing unit for the UAV, running the flight controller and managing sensor data.

IMU Sensor:

- Model: MPU6050, BNO055, or equivalent.
- Purpose: Measures acceleration, angular velocity, and orientation for stabilization and navigation.

LiDAR Module:

- Model: Garmin LIDAR-Lite v3 or RPLIDAR A1.
- Purpose: Provides distance measurement and obstacle detection.

THANK YOU!