

# Project ARES: Final Design Document

## Group L06

LION Autonomous Drone

## Team Members

Rayyan Jamil

Abraham Ng

Nathaniel D'Alfonso

Connor Hallman

## Sponsors

Madalyn Braganca

Christopher Griffith

Serco

## Design Coordinators

Matthew Gerber

Richard Leinecker

COP4935, Fall 2025

11/24/2025

## Table of Contents

<b>1. Executive Summary.....</b>	<b>6</b>
<b>2. Introduction.....</b>	<b>7</b>
2.1 Project Significance.....	7
2.2 Project Motivation.....	8
2.2.1 Rayyan Jamil.....	8
2.2.2 Abraham Ng.....	9
2.2.3 Nathan D'Alfonso.....	10
2.2.4 Connor Hallman.....	11
2.3 Broader Societal Impacts.....	12
2.4 Legal, Ethical, and Privacy Issues.....	14
2.4.1 Test Flight Location.....	14
2.4.2 FAA Regulations.....	14
2.4.3 Agentic Autonomy and Human Oversight.....	14
2.4.4 Personally Identifiable Information.....	15

2.4.5 Data Security.....	16
<b>3. Project Characterization.....</b>	<b>17</b>
3.1 Objectives and Goals.....	17
3.2 Specifications and Requirements.....	19
3.3 Concept of Operations.....	21
<b>4. Research.....</b>	<b>23</b>
4.1 Project Proposals.....	23
4.1.1 Space Invaders.....	23
4.1.2 Package Delivery System.....	24
4.1.3 Local Weather and Environmental Monitoring System.....	24
4.1.4 Infrastructure and Asset Inspection.....	24
4.1.5 Emergency Response.....	25
4.1.6 Traffic Monitoring and Navigation System.....	25
4.1.7 Geospatial Point Cloud Collection.....	26
4.1.8 Rationale for Final Proposal Selection.....	26
4.2 Hardware Research.....	27
4.2.1 Evaluation of Drone Platforms.....	27
4.2.2 Camera Selection: The ZED 2i Stereo Camera.....	28
4.2.3 Initial Platform Selection: Holybro X500 V2.....	28
4.2.4 Procurement Constraints.....	30
4.2.5 Final Platform Selection: S550 Hexacopter.....	30
4.3 Agentic and General AI Research.....	32
4.3.1 Model Context Protocol.....	32
4.3.2 Ollama and Localizing Models.....	33
4.3.3 Large Language Model Research.....	34
4.3.4 SmolAgents Agentic Framework.....	35
4.3.5 LangChain and LangGraph.....	36
4.3.6 Docker and Containerization.....	38
4.3.7 Vision Language Model Research.....	39
4.3.8 YOLO Vision Model Research.....	39
4.4 Navigation and Virtualization.....	41
4.4.1 Evaluating Mapping Approaches.....	41
4.4.2 RViz For Data Visualization.....	42
4.4.3 Automated Photogrammetry and Point-Cloud Processing.....	42
4.4.4 Rendering in Unity Using Pcx.....	43
4.4.5 Preparing for Real-Time and WebGL Rendering.....	44
4.4.6 Gazebo vs. Unity.....	45
4.4.7 ROS 1 vs. ROS 2.....	48
4.4.8 SLAM Algorithms.....	49
4.4.9 Exploration Algorithms.....	51
4.5 Multi-Drone Coordination and AI Research.....	52
4.5.1 Planning for Scalable Multi-Agent Systems.....	52
4.5.2 Task Distribution and ROS-Based Communication.....	53
4.5.3 AI-Driven Coordination Frameworks.....	54
4.5.4 Swarm Behavior and Control Models.....	55
4.5.5 Planning Around Human-AI Collaboration.....	56
4.6 Ground Control Station Research.....	57
4.6.1 Computational Power.....	58
4.6.2 Payload Weight & Flight Dynamics.....	58
4.6.3 Thermal Management.....	58
4.6.4 Power Consumption.....	59
4.6.5 Development Agility.....	59
4.6.6 Final Selection.....	59
<b>5. Diagram Design Documentation.....</b>	<b>61</b>
5.1 Block Diagram.....	61
5.2 Use-Case Diagram.....	63
5.3 Activity Diagram.....	64































































































































































