Capstone Project Proposal Report
(Individual Report)

Guide Approval (initials/date):		

CAP4001– Capstone Project Proposal Report

Student Name	Konakalla Rishitha
Student Register Number	22BCE7331
Programme	B.Tech, Computer Science and Engineering - AIML
Semester/Year	FallSem 2025-26
Guide(s)	Dr. Deepasikha Mishra
Project Title	XAI-UAV: Explainable Artificial Intelligence Framework for Robust Object Detection in Tactical Unmanned Aerial Vehicles
Team Composition:	

Reg. No	Name	Major	Specialization
22BCE7331	Konakalla Rishitha	CSE	AIML
22BCE9807	Kana Hakshay Reddy	CSE	AIML
22BCE7558	Appala Pranav Sai	CSE	AIML

(a) Project and Task Description:

Project Summary:

This project focuses on designing an Explainable AI (XAI)-based object detection system for UAVs. The system leverages YOLO (You Only Look Once) models trained on aerial imagery to detect objects such as vehicles and people in real-time. To address the resource constraints of UAV edge devices, the trained model undergoes DetDSHAP-guided pruning for size and speed optimization, ensuring efficient deployment without significant accuracy loss.

Project Requirements:

- **Accuracy:** Maintain high mean Average Precision (mAP) and F1-score across UAV datasets.
- **Efficiency:** Achieve real-time inference (<50ms per frame) on NVIDIA Jetson or FPGA hardware.
- **Interpretability:** Provide visual and numerical explanations for each detection via Grad-CAM, Saliency Maps, and SHAP.

Approach:
The pipeline includes dataset preparation, training, optimization, validation, deployment, explainability integration. The final system demonstrates both performance and transparency, bridging the gap between AI efficiency and human trust in UAV missions.

(b) Individual Role and Tasks
I will handle dataset preparation and model training. My tasks include collecting UAV datasets, annotating them with bounding boxes, applying augmentation techniques, and training YOLOv5/YOLOv8. I will evaluate models using mAP and F1-score.
Deliverables: Annotated datasets, trained YOLO model (best.pt), training/validation report

(c) Approach for My Portion
- Collect UAV aerial imagery datasets (VisDrone, UAVDT, custom flights).
- Annotate and preprocess images.
- Train YOLO models with tuned hyperparameters (batch size, learning rate).
- Validate model with accuracy metrics (mAP, F1).
- Document findings in a training logbook.

(d) Phases of the Design Process
1. Dataset Preparation: Data collection, annotation, augmentation.
2. Model Training: YOLO training on GPU workstation.
3. Validation: Evaluate with mAP/F1, compare with baselines.
4. Handoff: Provide trained weights (best.pt) to optimization team.

Outcome Matrix:

Outcomes:	Plan for demonstrating outcome:
a) an ability to apply knowledge of mathematics, science, and engineering	Use deep learning (YOLO), SHAP values (game theory), and CNN explainability.
c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	Optimize for UAV constraints: power, weight, latency, communication limits.
d) an ability to function on multidisciplinary teams	Division of roles across training, optimization, and explainability.
e) an ability to identify, formulate, and solve engineering problems	Address UAV-specific issues like small-object detection and hardware bottlenecks.
g) an ability to communicate effectively	Prepare reports, presentations, dashboards, and operator UI.
k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice	Use PyTorch, TensorRT, ONNX, Grad-CAM, SHAP, and UAV SDKs.

Realistic Constraints:

- Economic: Limited budget for UAV + Jetson hardware.
- Environmental: UAV flights in varied lighting/weather conditions.
- Computational: Must run efficiently on edge devices with limited GPU.
- Safety: Explanations required for operator trust in critical missions.
- Sustainability: Optimize power consumption for longer UAV flights.

Engineering Standards:

- IEEE Standards for AI interpretability and UAV communication.
- ISO 26262-inspired safety guidelines for trustworthy AI.
- COCO dataset annotation format standards for object detection.
- Latency benchmarks (<50ms/frame) for real-time UAV deployment.