Capstone Project Proposal Report
(Individual Report)

Guide Approval (initials/date):		

CAP4001– Capstone Project Proposal Report

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Student Register Number	**22BCE9807**
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 focus on model optimization and deployment. My tasks include applying DetDSHAP-guided pruning, converting the YOLO model to ONNX and TensorRT formats, and testing it on Jetson/FPGA hardware. I will also benchmark inference speed and memory usage.
Deliverables: Optimized YOLO model (.engine), Jetson deployment benchmarks, edge test logs.

(c) Approach for My Portion
- Take baseline YOLO model.
- Apply DetDSHAP pruning to remove unimportant neurons.
- Export model (PyTorch, ONNX TensorRT .engine).
- Deploy on Jetson/FPGA with sample UAV camera feeds.
- Record performance metrics (FPS, latency, power consumption).

(d) Phases of the Design Process
- Optimization: Apply DetDSHAP pruning, compress model.
- Conversion: Export to ONNX, optimize with TensorRT.
- Deployment: Load onto Jetson/FPGA hardware.
- Benchmarking: Measure latency, FPS, memory usage.
- Handoff: Deliver optimized engine model to XAI 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.