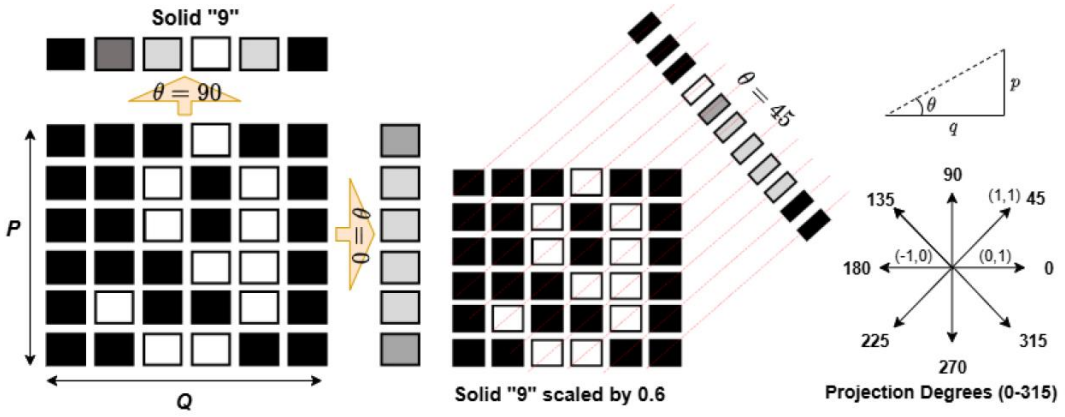
Project Short Summary

Title: Physics-Informed Low-Dimensional Representations for Efficient Object Recognition



Project Summary: This project aims to develop physics-informed object recognition methods that enable accurate perception from low-dimensional visual projections while preserving essential geometric and structural information. Inspired by real-world sensing constraints, the project investigates how object identity can be inferred from a small number of carefully selected projections rather than full-resolution images.

By encoding Euclidean geometry and depth-related information directly into projection representations, the proposed approach allows learning systems to recognize objects from minimal yet physically meaningful measurements. Projection saliency and learning-based selection mechanisms will be used to determine which viewpoints are sufficient for robust generalization. The outcomes are directly relevant for resource-constrained vision systems such as smart cameras, embedded AI platforms, medical imaging pipelines, and large-scale sensing infrastructures.

Objectives:

1. Develop physics-informed projection models incorporating depth-aware Euclidean geometry.
2. Identify minimal projection sets that achieve target recognition accuracy.
3. Design learning-based projection selection and saliency analysis mechanisms.
4. Demonstrate robustness under resolution degradation and partial observations.
5. Establish general design principles for projection-based perception systems.

Methodology: The project will generate low-dimensional projections from visual data using physics-informed distance encoding. Multiple projection angles will be evaluated, and minimal projection selection will be formulated as a constrained optimization problem. Classical machine learning models and deep neural networks will be trained on projection-

based representations, while saliency and feature-importance analyses will be used to interpret projection relevance.

Expected Outcomes and Impact: The project is expected to deliver a validated framework for low-dimensional, physics-aware object recognition, demonstrating that a small number of projections can achieve performance comparable to full-image systems. The results will support efficient sensor placement, reduced data acquisition costs, and scalable deployment of AI perception systems in smart environments, healthcare, and embedded intelligence.