# Object Detection in Low-light Scenes

**Coding Skills Required: Advanced**

## Goals

The goal of this project is to learn about challenges in low-light imaging as it relates to object detection using a standard pre-trained neural network model, and to explore and quantify the efficacy of PhyCV in reducing the model size while enhancing the classification accuracy.

## Introduction

Object detection in light-constrained scenes poses significant challenges. Most pre-trained object detection models are typically optimized for datasets with normal lighting conditions. Directly applying these models to low-light images will result in a substantial degradation of object detection performance. VEViD (Vision Enhancement via Virtual diffraction and coherent Detection), being part of the PhyCV library, is a physics-inspired algorithm for low-light enhancement. VEViD has demonstrated efficacy as a preprocessing tool for enhancing object detection in dark scenarios. In the project, the objective is to quantitatively assess VEViD’s capability to improve object detection in low-light conditions through fine-tuning a pre-trained object detection model on a specific low-light image dataset, both with and without VEViD preprocessing.

## Tasks

## 1. Familiarize yourself with VEViD

Read the VEViD paper, download the code from GitHub, and familiarize yourself with the codebase and the impact of various parameters.

## 2. Understanding Object Detection Model training and Finetuning

Explore the GitHub repo: <https://github.com/ultralytics/yolov5> which provides a comprehensive infrastructure for YOLO-v5 training, fine-tuning, and evaluation. Read the documentation, run demos, and become acquainted with the API. Understand the data formatting for training and evaluation. Explore different YOLO architectures and model sizes.

## 3. Exploring the ExDark Dataset

Investigate the Exclusively Dark (ExDark) Image Dataset designed for benchmarking object detection in light-constrained scenes: <https://github.com/cs-chan/Exclusively-Dark-Image-Dataset>. Reformat the data to align with the ultralytics infrastructure if necessary.

## 4. Finetuning pre-trained YOLO on ExDark w/ and w/o VEViD preprocessing

Finetune the pre-trained YOLO models of different sizes using ExDark dataset, both with and without VEViD preprocessing. Compare the results and demonstrate that VEViD preprocessing either enables superior performance with the same model or achieves comparable performance with a smaller model. See instructions of training/fine-tuning on custom data here: <https://docs.ultralytics.com/yolov5/tutorials/train_custom_data/>

## Deliverables

PowerPoint slides, final presentation, and GitHub repository.

## Resources

PhyCV GitHub: <https://github.com/JalaliLabUCLA/phycv>

VEViD paper: <https://elight.springeropen.com/articles/10.1186/s43593-022-00034-y>

ExDark Dataset: <https://github.com/cs-chan/Exclusively-Dark-Image-Dataset>

YOLO-v5 by Ultralytics: <https://github.com/ultralytics/yolov5>

Training and Fine-tuning on custom data: <https://docs.ultralytics.com/yolov5/tutorials/train_custom_data/>

## Contact

Yiming Zhou (Ph.D. student at Jalali-Lab): yimingz0416@g.ucla.edu

Callen MacPhee (Ph.D. student at Jalali-Lab): cmacphee@g.ucla.edu