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## **FACULTY MENTOR**

Nick Antipa

## **PROJECT TITLE**

Computational Camera Model Simulator

## **PROJECT DESCRIPTION**

The project is aimed at exploring existing camera simulators and then building on top of them a general enough and configurable simulator for modeling computational imaging cameras. There's no unified framework currently to do that, and this project will be a big step toward bridging this gap. This framework would potentially be of great use to the computational imaging, computer vision, and graphics communities. This simulator would also be very useful in optimizing the end-to-end design of cameras using state-of-the-art machine learning algorithms.

The student(s) working on this project would get to learn the basics of computer vision and computational Imaging, as well as hands-on experience in designing camera models and solving inverse problems. The experience gained in this project would be quite valuable for further research opportunities as well as industry roles. Some key topics the student will learn and work on in this project - Coded Apertures, Camera Matrices, Inverse Problems, and software design.

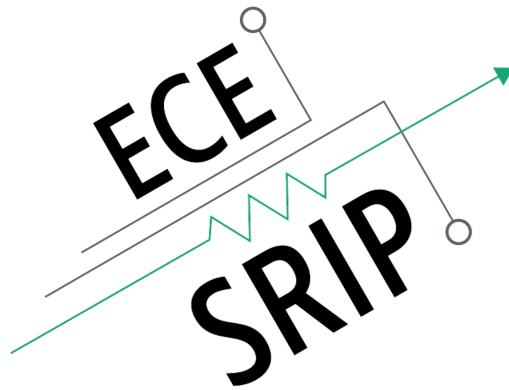
This project can accommodate both remote and in-person students.

## **INTERNS NEEDED**

2 Students

## **PREREQUISITES**

- Junior or Senior undergrad, or MS level. Experience in Python and C++, well-versed with Linear Algebra, and basic knowledge of optimization. Strong interest in computer vision and imaging.



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## **FACULTY MENTOR**

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## **PROJECT TITLE**

Fast Differentiable Wave Optics

## **PROJECT DESCRIPTION**

Differentiable rendering has been widely applied to estimate parameters associated with an optic system. Through computing the gradient in ray tracing, we can drive the optimization of system parameters. However, most of the existing system only considers geometric optics, not wave optics, a more general model of rendering. In other words, it is still an open problem to extend differentiable rendering to wave optics, and we believe that the differentiable wave optics model is applicable to large field-of-view imaging, image reconstruction, and image quality enhancement.

In this project, we have constructed a forward physic model. Nonetheless, when scaling up the simulations to capture entire scenes, the computational complexity of the backward propagation becomes a huge challenge. Therefore, we are looking for students who are excited about optimizing code and efficiently computing automatic differentiation. The students will help optimize the code, enabling high-resolution optimization of imaging systems.

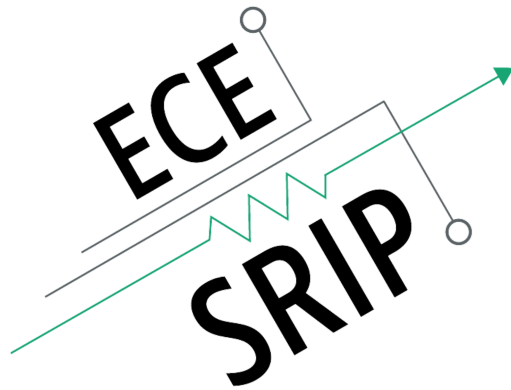
This project can accommodate both remote and in-person students.

## **INTERNS NEEDED**

1 Student

## **PREREQUISITES**

- Programming experience with C++ and Python, a basic knowledge of optics. Desired experience: code acceleration and parallel computing, toolkits for automatic differentiation such as PyTorch, and Jax.



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## **FACULTY MENTOR**

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## **PROJECT TITLE**

Mini-Scope Prototype

## **PROJECT DESCRIPTION**

Microscopes broaden the human ability to observe the microscopic world and have been used for decades. However, the bulky hardware of conventional imaging systems limits their usage in applications such as imaging neural activity in living animals. Miniature microscopes—imaging systems the size of a coin--aim to provide a portable means of capturing in-vivo biological data using compact imaging hardware.

This Summer project will entail building, calibrating, and testing an ultra-miniature microscope. The student will follow tutorial the tutorial material from UCLA and test the quality using some standard resolution targets as well as some real samples. During this time, students will learn basic optics and rapid prototyping and gain hands-on experience working in an optics lab."

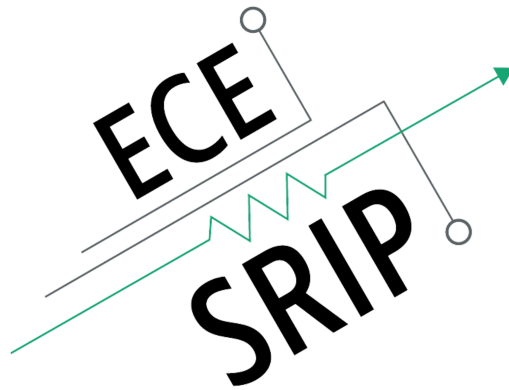
This project will be in person.

## **INTERNS NEEDED**

1 Student

## **PREREQUISITES**

- Some basic physics knowledge (geometric optics), and enthusiasm for hardware.



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## **FACULTY MENTOR**

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## **PROJECT TITLE**

High-Speed HDR Imaging

## **PROJECT DESCRIPTION**

High Dynamic Range (HDR) imaging is used in most phone cameras to obtain an image of bright and dim objects in a single capture, a task which conventional cameras cannot do without the help of algorithms. The algorithm applied in most phones requires multiple images to reconstruct a single HDR image, which creates issues when imaging fast-moving scenes. To deal with this problem, our lab has developed a method using random fiber bundles to capture data which can be used to solve the HDR image from a single shot using post-capture processing of the image data. The ability to reconstruct HDR data depends on the scene being imaged.

While the hardware we have built works correctly, our algorithms underperform machine learning methods for image processing. The aim of this project is to study the use of various machine learning methods to post-process the captured data, improving the quality of HDR imaging. Specifically, we want to compare data-driven methods to untrained neural networks (such as Deep Image Prior and Deep Decoder) and identify which approach yields the best results.

This project can accommodate both remote and in-person students.

## **INTERNS NEEDED**

1-2 Students

## **PREREQUISITES**

- This project requires students have some coding experience in Python and some knowledge of machine learning.
- No optics experience is required.
- Knowledge of computer vision and optimization is a plus.