**EE 267 - Final Project Proposal**

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**Introduction**

Wildlife photography in low-light is often challenging. Photographers need to deal with moving objects, whether that is an animal moving, camera motion, or the photographer being in a moving vehicle. All these scenarios can introduce motion blur in the captured images. Besides motion blur, capturing images at low-light poses a difficulty on its own. In most cases, using a flash might not be an option as it might scare the animals away. But without using a flash, one might need to adjust the exposure time to have enough light, and maintain the camera steady. If using a mobile camera, adjusting the exposure time and other settings might not even be possible, and maintaining the device completely steady would be extremely difficult without using a tripod. Moreover, increasing the exposure time would mean having additional blur especially when capturing moving objects or not having the camera completely steady.

Our goal for this project is to come up with a post-processing solution for low-light captured images involving moving objects. We want to develop an algorithm that would improve the quality of wildlife images captured in low-light.

**Related Work**

Although motion deblurring techniques and low-light photography have been studied at length, rarely do researchers consider them in tandem. As a result, the solutions to one of these issues may cause problems in scenarios that impose additional constraints on the other. For example, in 2011, Scott McCloskey proposed an algorithm that used temporally coded flash illumination for motion deblurring [4]. A flash-focused approach, however, violates the constraint of nocturnal wildlife photography that cautions against the use of bright lights, which might scare the subjects of the photographs - nocturnal creatures. Similarly, Zhe Hu et al. proposed a system for deblurring low-light images using light streaks, which although popular in urban environments are unlikely to be prevalent in the natural settings in which wildlife photography takes place [2].

Fortunately, there have been some breakthroughs in the space that allow photographers to capture images in low-light settings and deblur them without relying on flashes of visual light. Feng Li et al. proposed a hybrid camera for low-light imaging, a specialized solution that would address the needs of parties looking to capture photographs of moving objects in low-light conditions [3]. This, however, is still far from a generalized solution for casual tourists hoping to capture high-quality images during their nighttime excursions. The techniques that could apply in this use case were discussed in Bong-Seok Choi et al.’s paper on multi-spectral flash imaging in low light conditions [1]. Using this approach, we could brighten an image without introducing the great degree of motion blur that would come with long exposure and without frightening the subjects. The technique was further refined in 2019 by Jian Wang et al., who used stereoscopic dark flash to develop an image with the color and tone of a traditional RGB photograph with the low levels of noise that accompany traditional flash [5]. Applying this approach to our scenario, we hope to create an algorithm that allows users to brighten their low-light photographs and deblur them without requiring that they rely on flash in the process.

**Project Overview**

The first step of the project will be to capture several images in low-light settings that involve motion, this includes capturing moving subjects and/or introducing camera motion.

Once the images are collected, we will need to implement a post-processing algorithm with two main stages. The first one will adjust the brightness and contrast of the captured image, and the second one will apply motion deblurring. There is a possibility we might also need to implement some type of denoising algorithm, since brightening the images will most likely introduce digital noise.

After implementing our base algorithm, we will test it with our captured images dataset and adjust any parameters as needed. Testing the algorithm with different images will help us find the optimal tuning to achieve sharp images with minimal motion blur and balance lighting.

**Timeline / Milestones**

The project will consist of refining an algorithm in two stages.

1. We will take an image taken in low lighting conditions and figure out how to best brighten it using one of the aforementioned approaches to a point where the motion blur is clear to see without magnifying the noise to an unreasonable extent.
2. Now that the image is bright enough to get a clear sense of the motion blur, we will implement a motion deblurring algorithm to make the subject of the image appear steady.

Each of these stages should take approximately 1-2 weeks to complete successfully, with the remaining time before the March 17 presentation dedicated to formalizing our progress in a report. The goal is to show how these techniques can help wildlife photographers capture images of nocturnal creatures without scaring them or sacrificing quality. As a stretch goal, we will see how the steps interact with each other and consider whether applying the algorithm in reverse order would improve the outcome.

**References**

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