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Project: deblurring a photograph

The aim of this project is to build an algorithm that sharpens misfocused photographs. The data is measured using a digital camera, and consequently the reconstruction methods must be applicable to large-scale data.

The optical construction of regular consumer cameras produces a plane of sharp focus. This means that details located in a two-dimensional plane in the three-dimensional scene under imaging show up sharp and crisp in the photograph, and details away from that plane are blurred. Moreover, the blur becomes worse as the distance grows between a detail and the plane of sharp focus. By "worse blur" we mean wider point spread function.

To keep the project simple, we choose a planar scene so that the point spread function is the same in all parts of the image. Take a printed paper with some text and an image; a newspaper page will do. Make sure that the page contains a small isolated black dot.

Now you need to take a misfocused photograph of the printed paper. The use of a tripod to keep the camera steady is recommended; it's also a good idea to use two light sources illuminating the paper with roughly 45 degree angles. If you have a camera with manual focus, you can simply focus perfectly on the plane of the paper and then turn the focus a little (or move the camera slightly away from the paper). A simple way to achieve the same result with an autofocus camera is to place the paper on the floor and put a book on top of the paper. (Of course, the book should not cover the important part of the paper.) Let the camera focus on the book cover; then the paper is out of focus. Varying the distance between the camera and the book will adjust the amount of blur.

It's a good idea to take a sharp picture for comparison and a few misfocused versions with different amount of blur. Also, take photographs with different sensitivities (ISO settings in the camera), resulting in various amounts of measurement noise.

Read the photograph into MATLAB using the `imread` command and pick out only one of the three color components (red, green or blue). Then you have a grayscale pixel image that can be viewed as a discrete approximation of a real-valued light intensity distribution on the paper. You can read off the shape of the point spread function from the image of the isolated black dot.

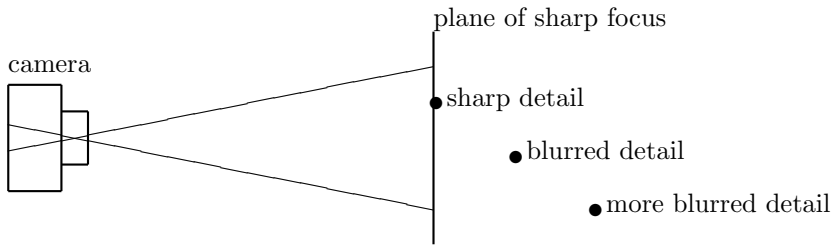

Figure 1: Schematic illustration of the focal plane of a camera. Details in the focal plane appear sharp, and details off the focal plane appear blurred. The blurring is stronger if the detail is more far away from the focal plane.