Synthetic Aperture

Computational Photography: Project 8

1 - Objective

The goal of this project is to explore the post processing effect known as *synthetic aperture focusing*. This technique is used to change the focus plane in an image after you have already taken it and works best with large depth of field images.

2 - Deadline

It should be submitted on T-Square by 11:55PM on Thursday, July 17th.

3 - Process

3.1 Download the base source

Download and unzip the folder with the base code for this project.

3.2 Project description

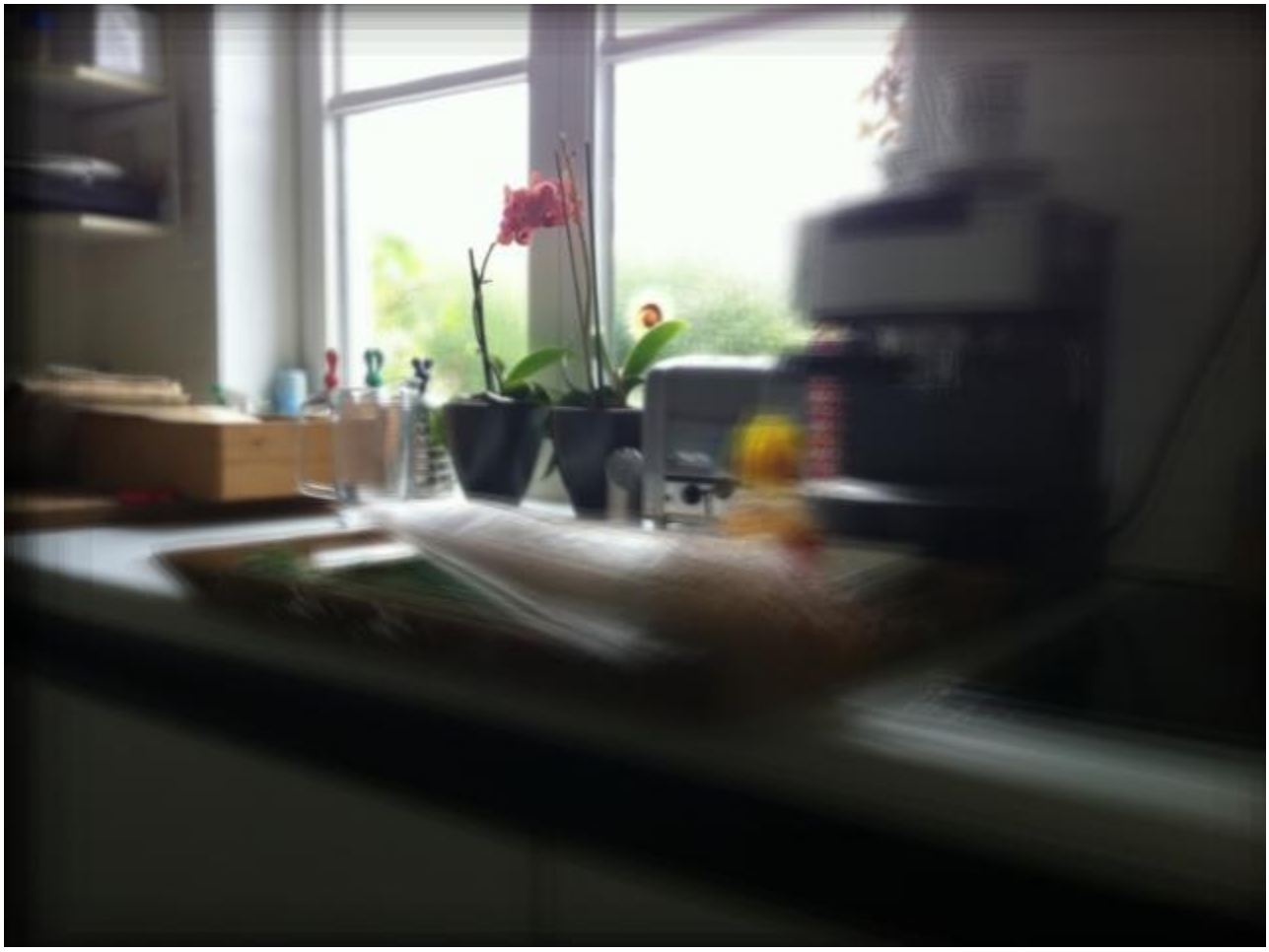
For this project, you will be implementing a blending technique for the synthetic aperture focusing method. Your input will be a set of images taken of the same scene from different camera positions, but the optical axis pointing in the same view direction (no rotation).

First, you will define the 2D location of an object in the scene on which you want to focus (the center of the flower in the image below). You will find the location of this object in all of the scene images. You can do this with the provided *Focus Interface* program. Simply click on the object in each of the images and once you have done so for each image, it will print a list of the o_{nx} and o_{ny} locations of the selected point which you can then place into your own code.

To achieve the goal of synthetic aperture, you will implement the following algorithm. You will create a new image which is the equal weighted average of all of the other images shifted such that all of the in focus points are aligned. This means that the color of a single pixel $p_{i,j}$ in the new image is defined as follows:

$$p_{i,j} = \frac{\sum_{n=0}^{N}(c_{n_{i+o_{nx},j+o_{ny}}})}{N}$$

Where N is the number of scene images, o_{nx} and o_{ny} are the offsets of image n's focus point from the base image's focus point. In other words, each image is translated by the difference between its focus point and the base image's focus point and then all images are averaged to create the new image. You can assume that the 1st image in the stack of images is the base image. However, when you organize your images, the base image should be the centermost image of the scene you have.



Example output of your program on the flower point set.

Photography Component

After you have your synthetic aperture code working, you should then take a collection of photos of your own. You should take at least 16 images as input to the synthetic aperture program. Select a scene that has a good deal of depth variation, so that you will be able to put different parts of the scene in focus. You will need to be able to focus on three or more different objects that are at different depths.

Keep in mind when you take your photos that the goal is different than for a photo mosaic. We are NOT shooting different parts of a scene. Instead, we are shooting the exact same objects in the scene from slightly different camera positions. The slight changes in camera position will cause depth parallax, that is, the relative positions of object at different depths will change as the camera position is altered. When you take your photos, you should be sure that your photo collection has both vertical and horizontal variation in terms of camera position. You may have to experiment by shooting the same scene several times to determine what a good distance to move the camera is. If you move it too little, you will not see any blurring effect of the out-of-focus objects. If you move too much, the blurring will be too much.

You will turn in your original photos as part of the deliverables for this project. More importantly, you will also turn in three screen shots from your synthetic aperture program that are the results of focusing on three different parts of your scene at different depths.

3.3 Authorship Rules

The code that you turn in entirely your own. You are allowed to talk to other members of the class and to the Professor and the TA about general implementation of the assignment. It is, for example, perfectly fine to discuss how one might organize the data for a matrix stack. It is also fine to seek the help of others for general Processing/Java programming questions. You may not, however, use code that anyone other than yourself has written. Code that is explicitly not allowed includes code taken from the Web, from books, from previous assignments or from any source other than yourself. You should not show your code to other students. Feel free to seek the help of the Professor and the TA's for suggestions about debugging your code.

3.4 Submission

For this assignment, you will submit a Processing sketch and a PDF containing your 3 result images as described in the project process section.

Your unedited pictures should be located in the data folder where the default photos also reside. Your result images should be in the same folder as your code. In order to run the source code, it must be in a folder named after the main file. When submitting any assignment, leave code in this folder such that all code will run without any changes to folder structure or code. For this assignment, compress the parent folder containing your code folders and PDF and submit that via T-square.