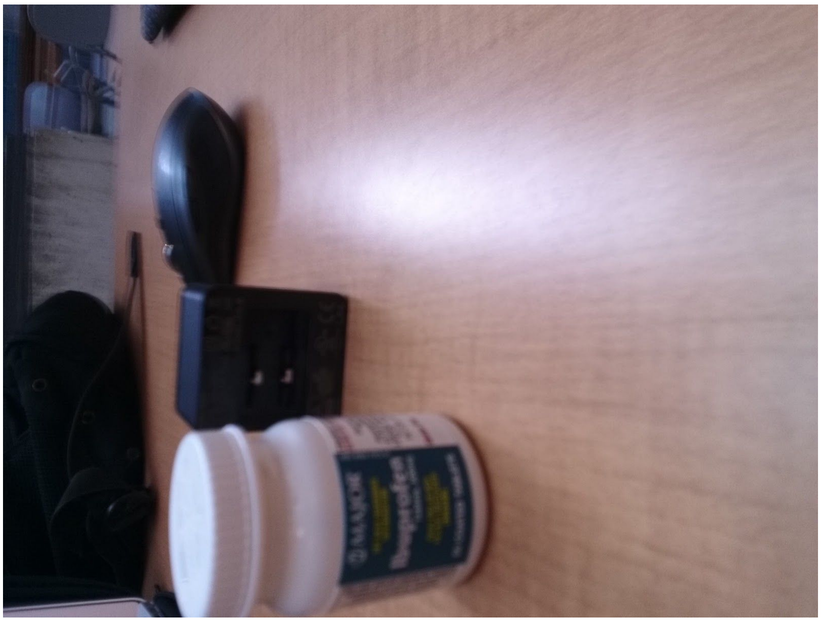
Homework 5

Sylvia Wang

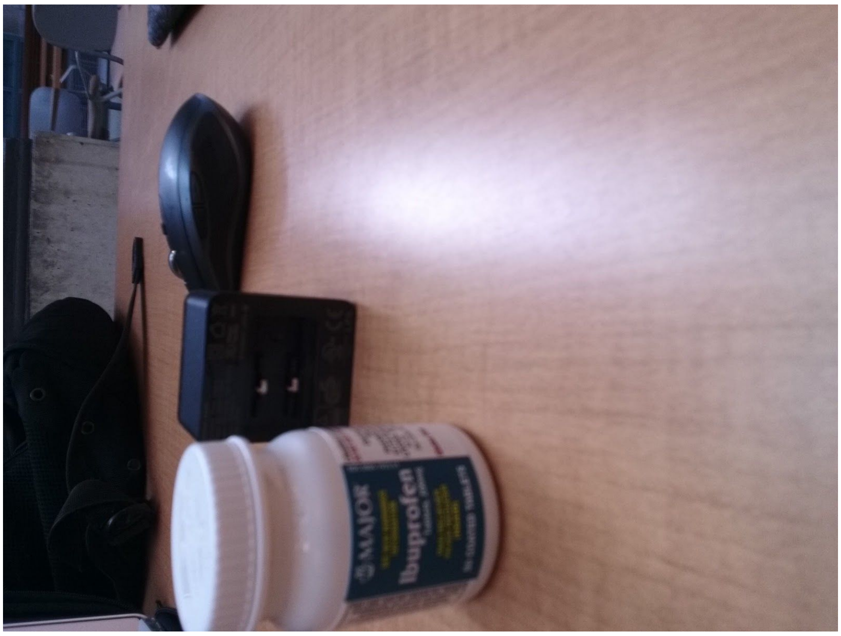
1. Capture images and Keep track of the focal distance used for each exposure.

- focus distance = 1.0

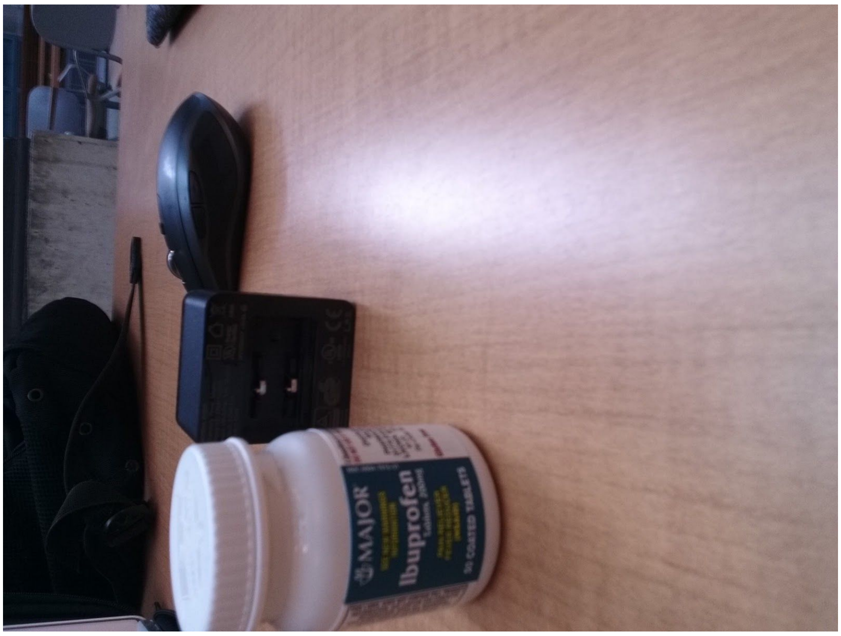


- focus distance = 1.5

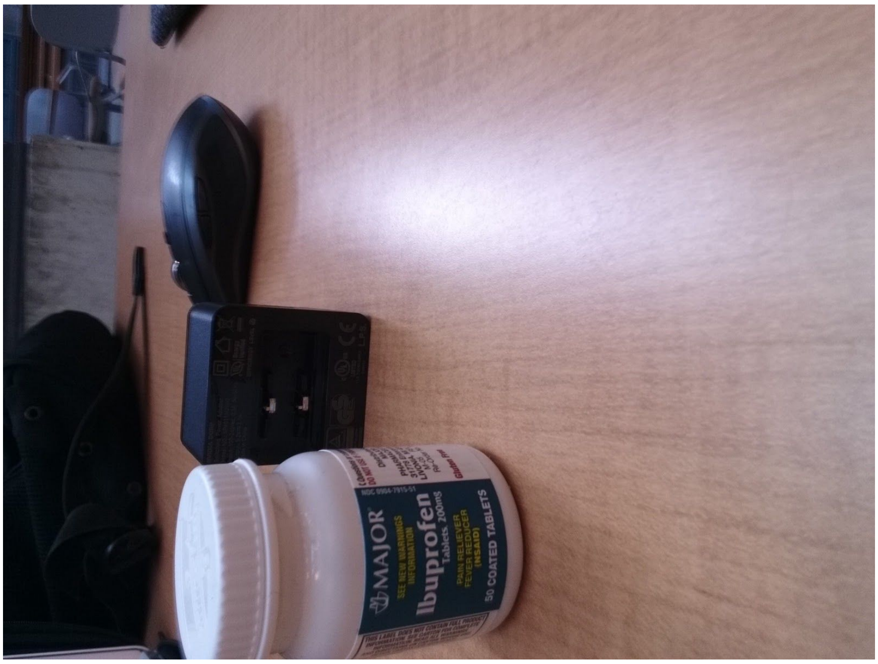
- focus distance = 2.25



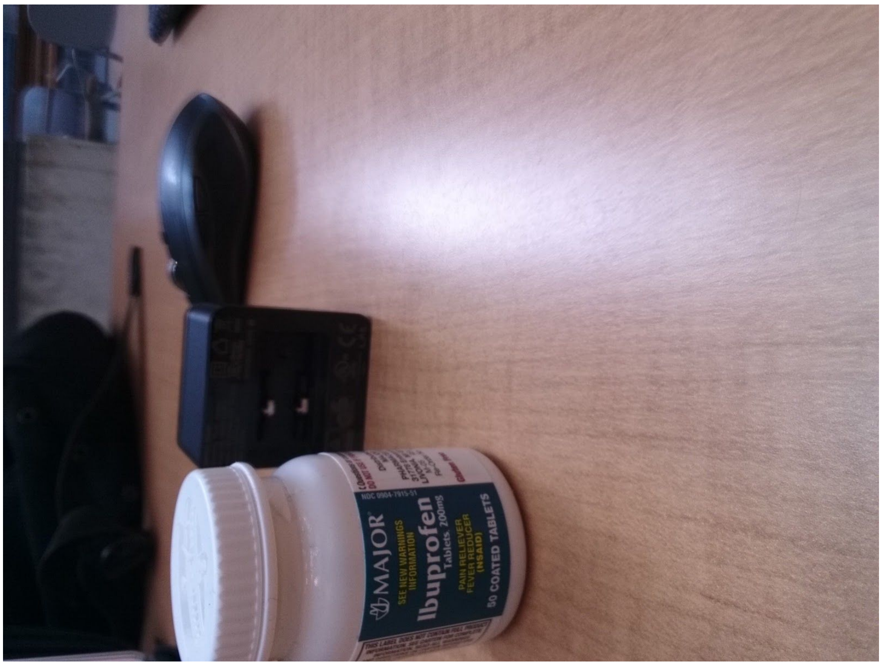
- focus distance = 3.375



- focus distance = 5.0625



- focus distance = 7.59375



2. Calibrate focal stack $I(x, y, k)$

- read images
- compensate for this small change in magnification:

$k \in [1, N]$: the index into the focal stack

(x, y) : pixel coordinates

v_k : the set of focal distances (in meters)

u_k : lens-to-sensor distance during each exposure

using the Gaussian Lens Law $\frac{1}{u_k} = \frac{1}{f} - \frac{1}{v_k}$. **(1)**

(The rear camera has an F/2.0 aperture with 2.95mm focal length, and the front camera has an F/2.8 aperture, with a claimed 4.76mm focal length)

- rescale each of the images in the stack using:

$$I'(x, y, k) = I(m_k \cdot x, m_k \cdot y, k), \qquad \textbf{(2)}$$

m_k is different for each image: $m_k = {}^{u_N}/_{u_k}$. **(3)**

3. Compute a depth map from the focal stack

- convert the focal stack to grayscale images
- focus measure:

$$M(x, y, k) = \sum_{i=x-K}^{x+K} \sum_{j=y-K}^{y+K} |\nabla^2 I'(i, j, k)|^2, \textbf{(4)}$$

K : a variable that is chosen based on the amount of texture in the scene

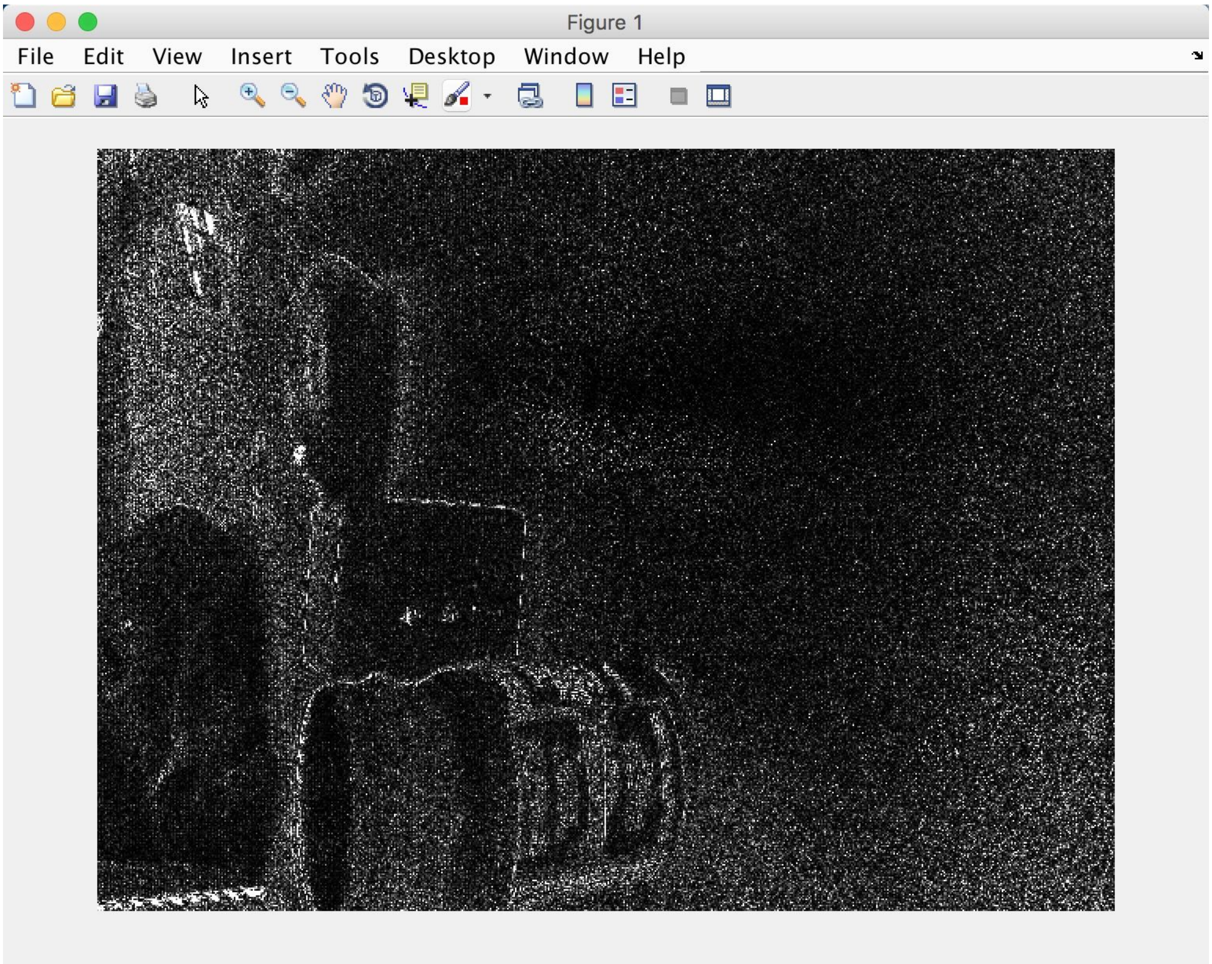
- The depth for each pixel :

  finding the index into the focal stack $D(x, y)$ where the focus is maximum :

  $$D(x, y) = \underset{k}{\operatorname{argmax}} M(x, y, k), (5)$$

- Pixel map: tell which image in the stack a given pixel is in focus

  (depth map of the focal stack)



4. Recover an all-focus image of the scene

The all-focus image: $A(x, y) = I'(x, y, D(x, y)).$ (8)

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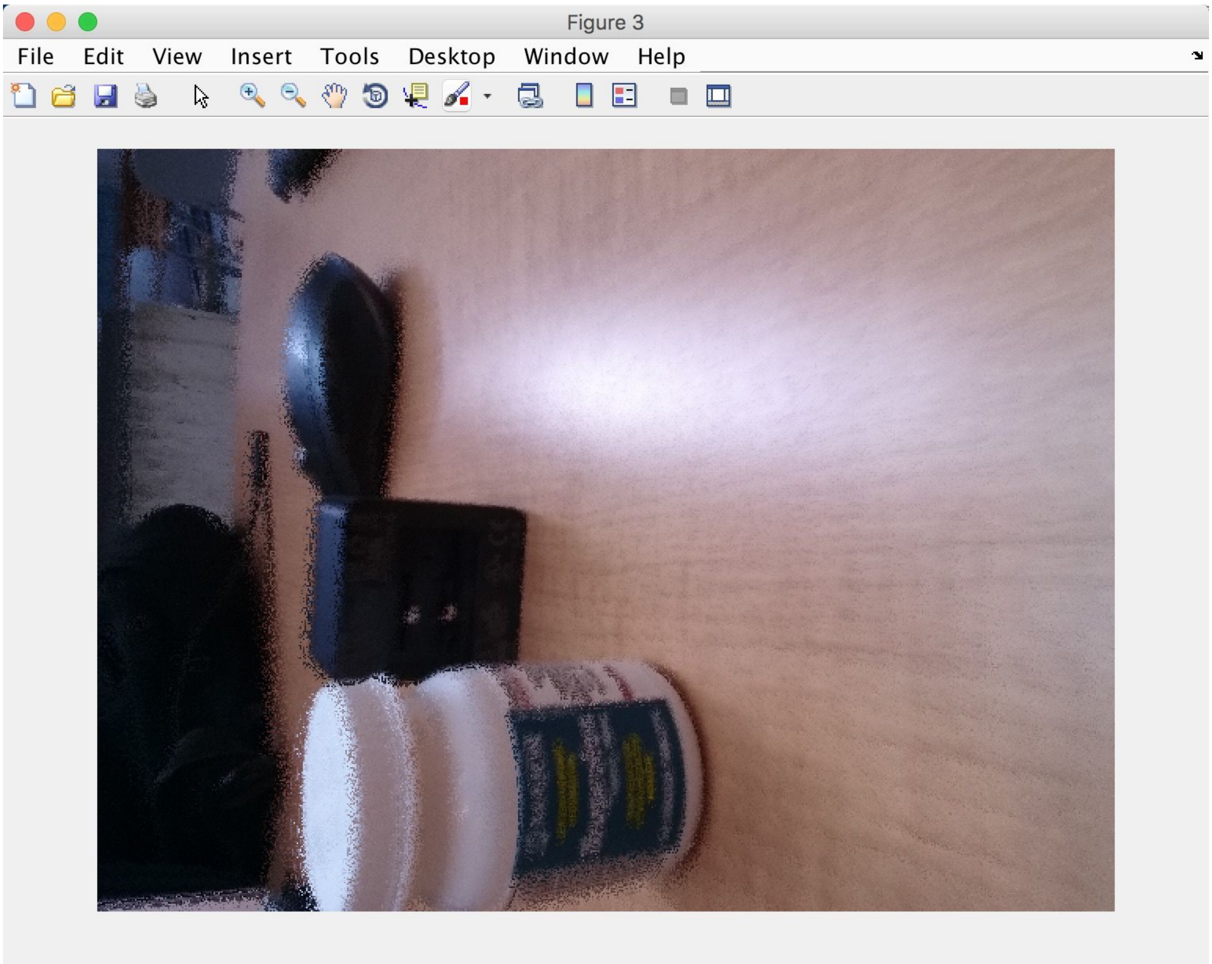
- The all-focus image computed from the focal stack and the depth index map



There are still a lot of obvious noise in this all-focus image. The result may be distorted when calibrating the focal stack.