CS 477 HW #13

Questions completed: All undergrad level questions in MATLAB

A. Computing disparity between image locations.

Below in Figure 1, the two disparity maps for the two pairs of left/right images are shown.

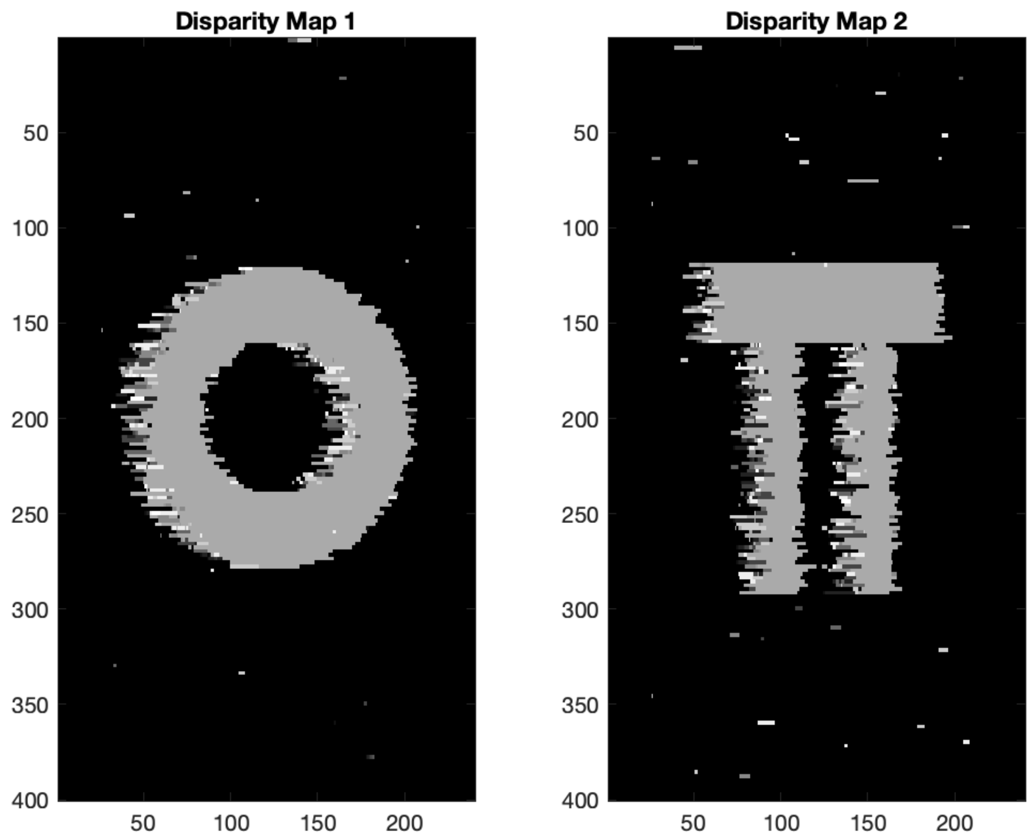

Figure 1: The two disparity maps for the two pairs of left/right random dot stereograms given in the assignment are shown using `imagesc()`. The disparity map on the left is for the left1/right1 pair and the disparity map on the right is for the left2/right2 pair. Black pixels indicate no disparity while lighter pixels indicate more disparity, up to a maximum of 15 pixels in disparity.

The disparity map was computed as suggested in the assignment. The margins were avoided with the suggested row indexing method. In particular, $D = 15$ was set as the maximum disparity distance, and $C = 10$ was set as the number of local pixels on both sides of the current pixel to make disparity matches of 21-length row vectors. This gave a total margin of $D + C = 15 + 10 = 25$. Additionaly, the row vectors were normalized before taking their dot product if their sum did not equal zero. The absolute value of the disparity value that gave the highest dot product was recorded in a matrix for each pixel, and the resulting disparity map matrices for both pairs of stereograms were displayed using `imagesc()` which took care of scaling the disparity values for display.

The single interesting distance relative to the background for each pair of stereograms is reported as follows.

```
Average disparity (set 1): 10.3035
Average disparity (set 2): 10.3275
```

The interesting distance was calculated by averaging the top 10% of the largest absolute value disparities in the disparity map for both sets.

The distance associated with the surface for each set is reported as follows.

```
Estimated distance (set 1): 77.6432 cm
Estimated distance (set 2): 77.4631 cm
```

This distance was calculated using the equation in the slides $z = f * \frac{d-D}{D}$ for focal length $f = 2cm$, inter-ocular distance $d = 10cm$, pixel size $p = 0.025cm$, disparity $D = (average\ disparity) * (pixel\ size) = 10.3 * 0.025cm \approx 0.25cm$, and $(d - D) \approx d$ as the assignment suggested that $D \ll d$. However, I thought that $D \ll d$ did not hold in my case since $D \approx 0.25cm$ and $d = 10cm$ for both sets, so I recomputed z with $d - D$ to get the following.

```
Estimated distance (set 1): 75.6432 cm
Estimated distance (set 2): 75.4631 cm
```

It appears that the distance is $2cm$ lower compared to the calculation with the $(d-D) \approx d$ assumption. It seems that either calcuation is fine according to a post on Piazza discussing this.

B. Measuring how far away a star is.

For focal length $f = 2m$, inter-ocular distance $d = 80,000,000\ miles * \frac{1{,}609.344m}{mile} = 1.2875 * 10^{11}m$, and disparity $D = 6.2 * 10^{-6}m$, the distance calcuation in miles is as follows.

$$z = \frac{f * d}{D}$$

$$z = \frac{(2m) * (1.2875 \times 10^{11}m)}{6.2 \times 10^{-6}}$$

$$z = (4.1531 \times 10^{16}m) * \frac{1\ mile}{1,609.344m}$$

$$z = 2.5806 \times 10^{13}\ miles$$

The conversion to from miles to light-years is as follows.

$$z = (2.5806 \times 10^{13}\ miles) * \frac{1\ light\text{-}year}{5.879 \times 10^{12}}$$

$$z = 4.3896\ light\text{-}years$$

According to the table of nearest stars from the Wikipedia page linked in the assignment, the star that we observed would be either Rigil Kentaurus or Toliman in the Alpha Centauri star system with a listed distance of 4.3441 $\pm$0.0022 light-years for both. It was clarified in a Piazza post discussion that Rigil Kentaurus and Toliman are a binary pair, and early experiments could have treated them as a single star.