COMP 546 HW 1

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colab notebook link

I did not collaborate with anyone.

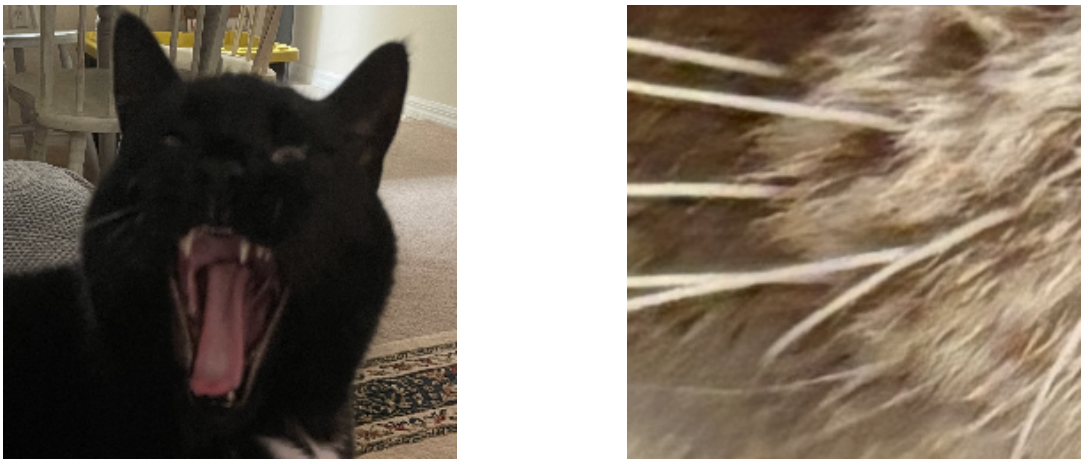
1.1

(a)

(a) Mavis (b) Hazel

Figure 1: Two Cute Cats

(b)



(a) Mavis downsized to 256x256 (b) Hazel cropped at center to 256x256

Figure 2: Two Cute Cats, Edited

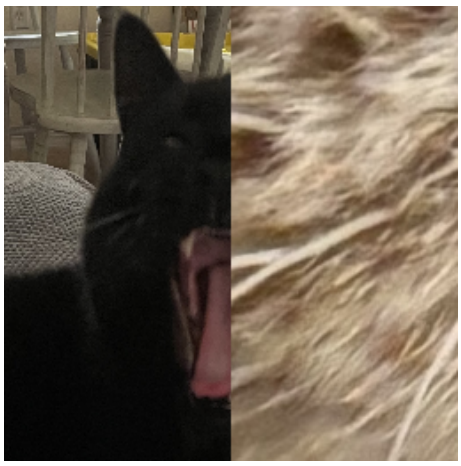


Figure 3: New image created by taking left half of Mavis and right half of Hazel.

(c)

(d)

Figure 4: New image created by replacing all even rows of image A with respective rows from image B.

(e)

I was able to accomplish this task without a loop by using python slicing in order to index the Mavis image at every other line, and replace them with the respective lines from the Hazel image.

```
lines = range(mavis.shape[0])[::2]
new_img[lines, :] = hazel[lines, :]
```

1.2

(a)

Figure 5: Extracting yellow peppers using RGB colorspace.

(b)

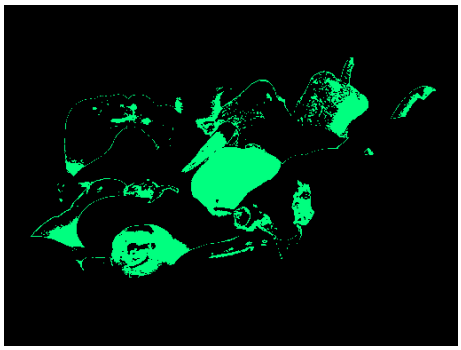


Figure 6: Extracting yellow peppers using HSV colorspace.

(c)

I found using RGB to be easier to work with because finding the exact hue range to include yellow but not yellow-green or orange peppers difficult. This surprised me, because I would have expected HSV to be easier to work with, because I should have been able to find a good hue value with small range, and then allowed saturation and value to vary more widely.

2.1

(a)

- *Translation* has 2 dof. One corresponds to the translation in the x direction, the other in the y direction.
- *Euclidean* has 3 dof, with the extra dof corresponding to the amount of rotation applied to the image.
- *Similarity* has 4 dof, with the extra dof corresponding to the amount the image is scaled.
- *Affine* has 6 dof, with the two extra dof corresponding to the amount of shear in each direction.
- *Projective* has 8 dof to describe exactly how each plane is mapped to another plane in 3D space. This is because one of the 9 values of the transformation matrix is redundant.

(b)

$$T = \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix} \tag{1}$$

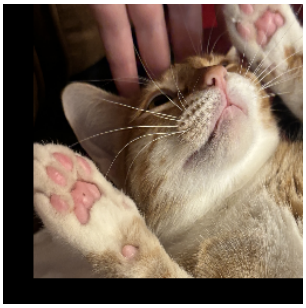
2.2

see colab notebook

2.3

see colab notebook

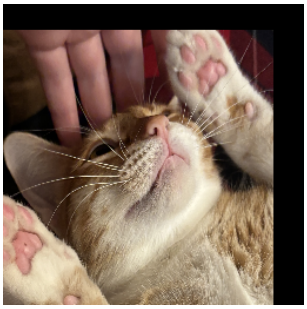
2.4



(a) Translation 21 right, 25 up

(b) Translation 21 right, 25 down

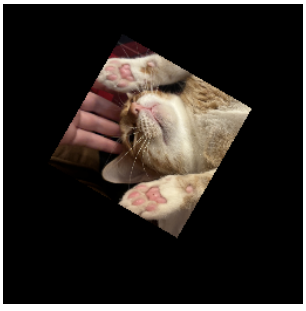
(c) Translation 21 left, 25 up



(d) Translation 21 left, 25 down

(e) Rotation CCW 30 Degrees

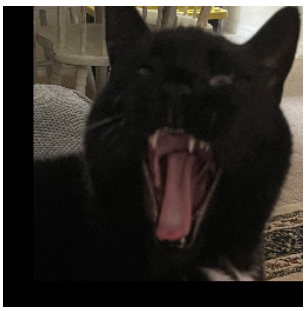
(f) Rotation CW 30 Degrees



(g) Similarity Transformation

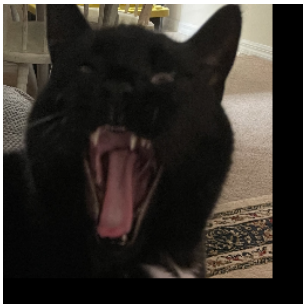
(h) Affine Transformation

Figure 7: Image 1

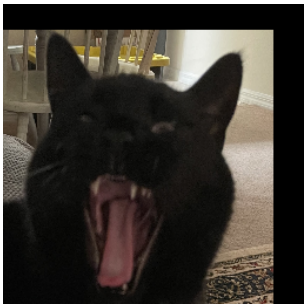


(a) Translation 21 right, 25 up

(b) Translation 21 right, 25 down

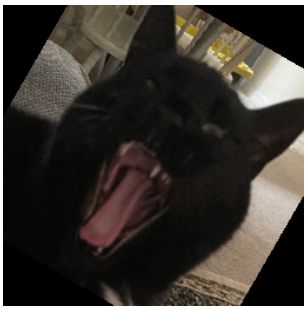


(c) Translation 21 left, 25 up

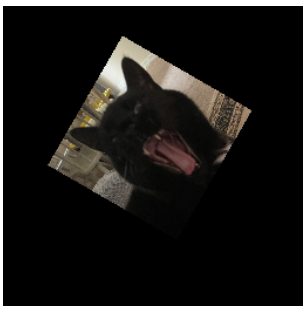


(d) Translation 21 left, 25 down

(e) Rotation CCW 30 Degrees



(f) Rotation CW 30 Degrees



(g) Similarity Transformation

(h) Affine Transformation

Figure 8: Image 1

3.1

(a)

The intrinsic parameters in K relate the camera coordinates to image coordinates. The extrinsic parameters in R is the rotation applied to the camera relative to the world, and T is the translation of the camera relative to the world.

(b)

$$E = \begin{bmatrix} 1 & 0 & 0 & 1 \\ 0 & 0 & -1 & -2 \\ 0 & 1 & 0 & 0 \end{bmatrix}$$

$$K = \begin{bmatrix} 100 & 0 & 25 \\ 0 & 100 & 25 \\ 0 & 0 & 1 \end{bmatrix}$$

We can then multiply the two to get:

$$P = KE = \begin{bmatrix} 100 & 0 & 25 \\ 0 & 100 & 25 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & 1 \\ 0 & 0 & -1 & -2 \\ 0 & 1 & 0 & 0 \end{bmatrix} = \begin{bmatrix} 100 & 25 & 0 & -100 \\ 0 & 25 & -100 & 200 \\ 0 & 1 & 0 & 0 \end{bmatrix}$$

(c)

$$\begin{bmatrix} 25 \\ 50 \\ 1 \end{bmatrix} = \begin{bmatrix} 100 & 25 & 0 & -100 \\ 0 & 25 & -100 & 200 \\ 0 & 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} X_w \\ Y_w \\ Z_w \\ 1 \end{bmatrix}$$

We solve this matrix equation in a program such as MATLAB to find $X_w = 1$, $Y_w = 1$, $Z_w = 1.75$.

3.2

A shorter focal length corresponds with a larger field of view. Per the hint, if we have a pinhole camera and we move the fixed sensor farther away from the aperture (increase focal length), then we expect the angle it draws out to be narrower (decrease in field of view).

4.0

(a)

*** see colab notebook ***

(b)

*** see colab notebook ***

(c)

(a) I1 (b) I2 (c) I12 (d) I12_synth (e) D

Figure 9: Relighting

(d)

The synthetic image is pretty good compared to the real image. I know this because before D was rescaled, it was primarily black, showing little difference. The most difference is on the right side of the image, where D is most white. This makes sense as my two light sources were on the ceiling and on the left.