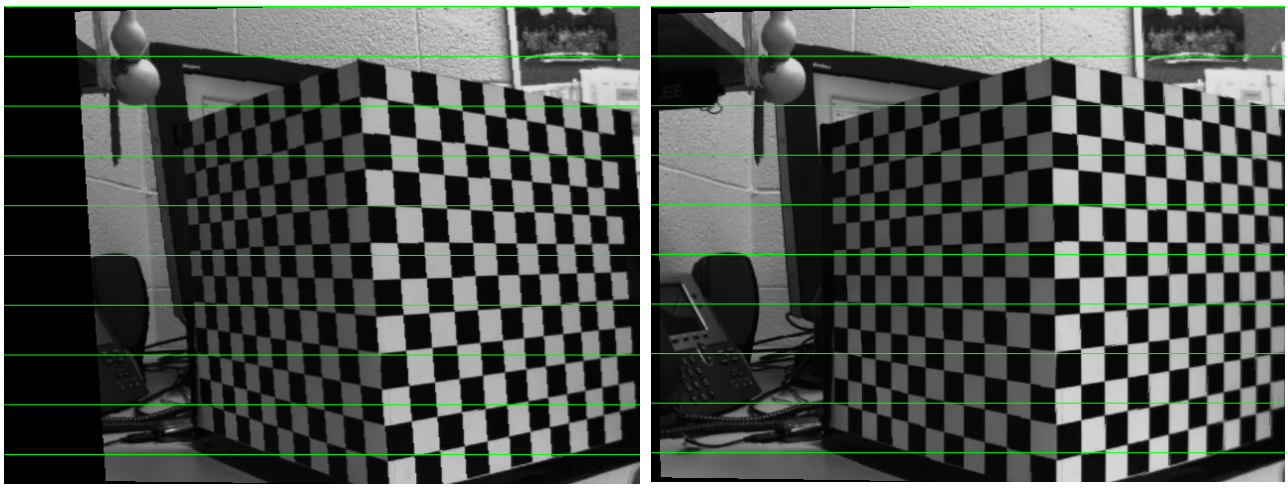
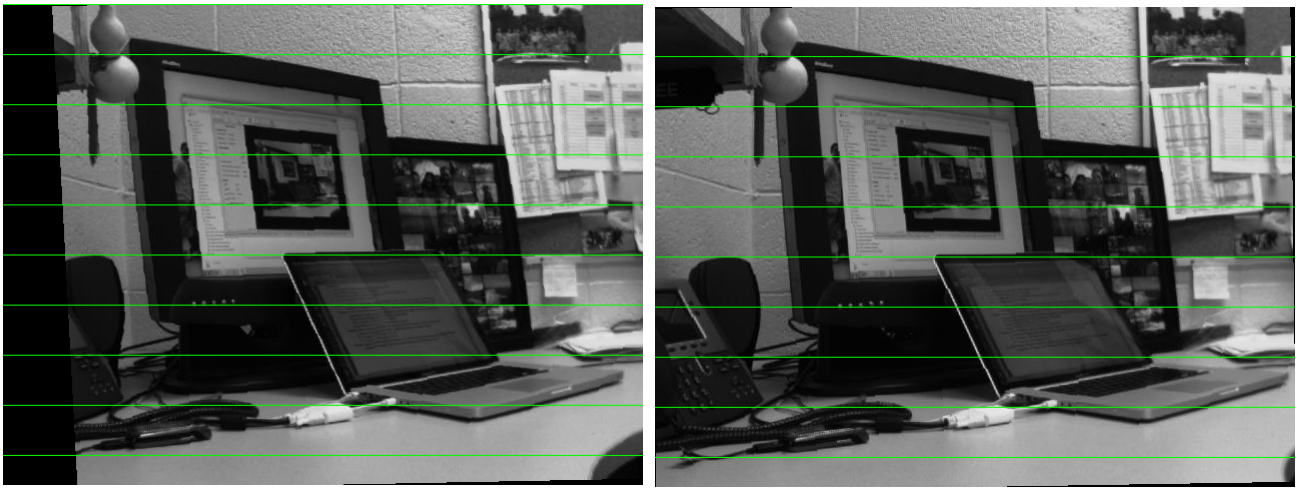
ECEn 631
HW 6
Jae Lee

Task 1

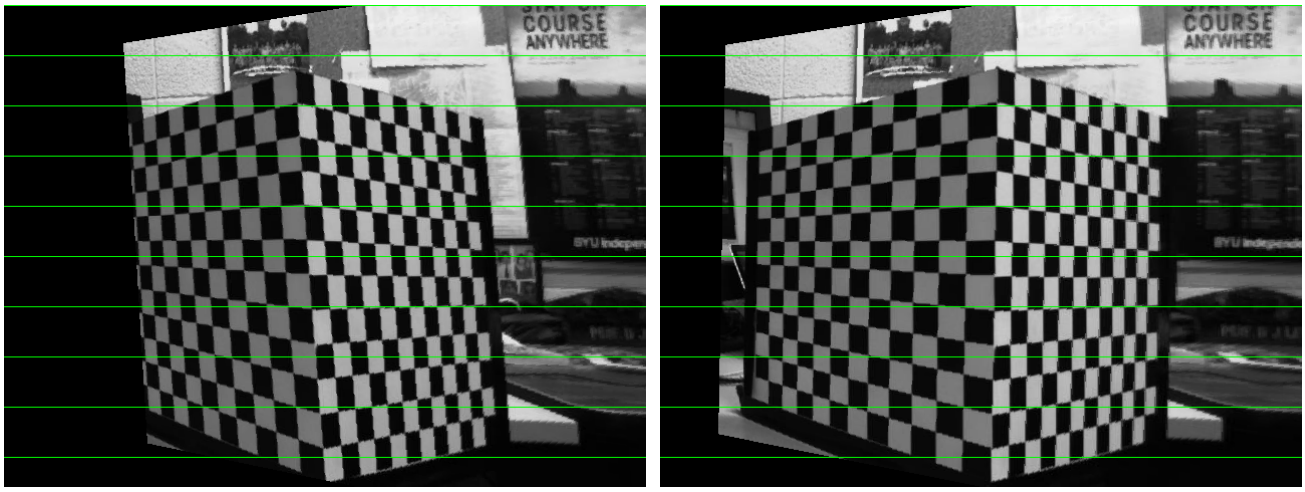
Parallel cube



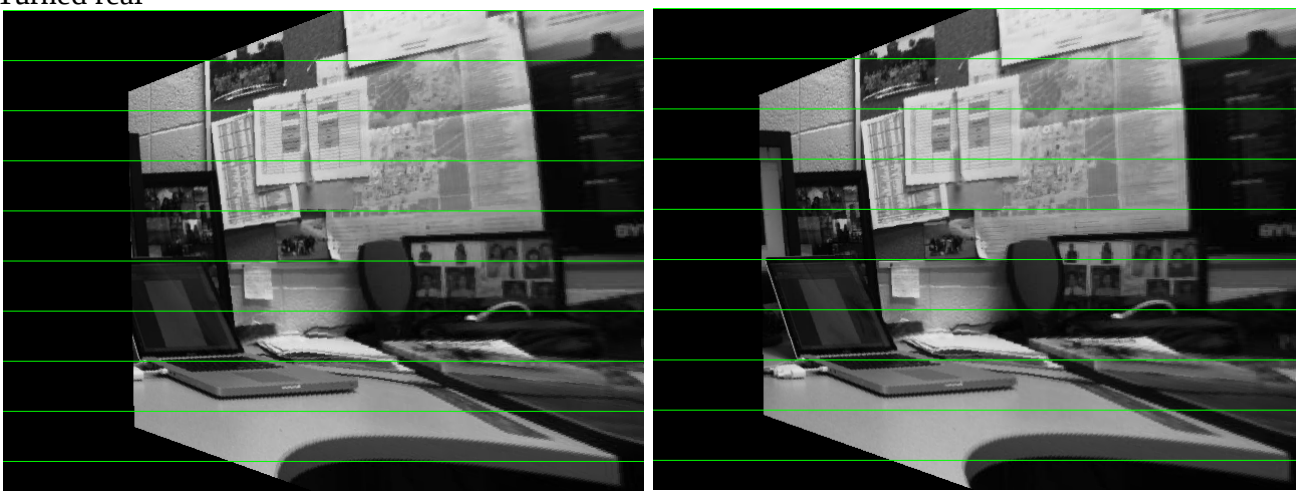
Parallel real



Turned cube



Turned real



As I guessed my camera intrinsic parameters and distortion coefficients, it is difficult to reconstruct good 3D structure and we don’t know the projective transformation of the environment. However, as I observed the result, even without camera intrinsic parameters, it was able to distinguish between just parallel motion and turned motion.

Task 2

Parallel cube

```
======= R =======
[0.9995227669854118, -0.0006550053211005608, 0.03088380232185295;
 0.0007130507848924886, 0.999998000125253, -0.001868503163681653;
 -0.03088251667860189, 0.001889633171770113, 0.9995212351171294]
======= t =======
[0.9989106293852017;
 -6.597255647030404e-05;
 -0.04666422772190727]
======= E =======
[0.008694825120062142, 11.05083602500624, -0.01521233278900214;
 -3.749346220760843, -0.8928158809509099, -237.3511569543765;
 0.1914251585086839, 236.5592876861306, 0.009919840258461932]
======= F =======
[1.277197739173531e-08, 1.624896688227513e-05, -0.004132498715694287;
 -5.512976795010576e-06, -1.3140922513389 34e-06, -0.28579336895387;
 0.001622157852078718, 0.2819367846605372, 1]
```

Parallel real

```
======= R =======
[0.999668954010507, -0.0002022826924522542, 0.02572822320431564;
 0.0002625506817002477, 0.9999972297674706, -0.002339129009802255;
 -0.02572767876584069, 0.002345109613065597, 0.9996662378045107]
======= t =======
[0.9971598631222766;
 -0.001076421995454358;
 -0.07530636555863124]
======= E =======
[0.01403154503771144, 19.00030075234064, -0.2745881695923025;
 -12.56271852781486, -1.149622761042082, -252.8144902504879;
 0.365367255093706, 251.6065492758449, -0.02221888572150021]
======= F =======
[2.061117659275998e-08, 2.793772860075315e-05, -0.007405879388248389;
 -1.847201395875317e-05, -1.692073802091493e-06, -0.3001599500981693;
 0.005108082751075769, 0.296411084358832, 1]
```

By observing R, t, I am convinced that these results are correct. Rotation is almost identity matrix and translation vector tells there is camera movement in only X direction.

Turned cube

```
======= R =======
[0.999959532215049, 0.008591823721511549, 0.002667301520012544;
 -0.008677579176319127, 0.9993840566385442, 0.03400304333917802;
 -0.002373510458983319, -0.0340248130314595, 0.9994181700100694]
======= t =======
[0.9604453896165015;
 0.0111701499012161;
 0.278244283527247]
======= E =======
[-0.2077296055601418, -136.2275202325705, 5.531712491081208;
 135.6125889692463, 34.74466684015653, -464.3238526412063;
 -4.727141160485328, 468.8361929872827, -0.4540640347715055]
======= F =======
[-3.051375719664e-07, -0.000200306697131745, 0.05746883238499154;
 0.0001994025123524197, 5.113898446942269e-05, -0.6423842491948731;
 -0.0560626067451275, 0.6222894854600207, 1]
```

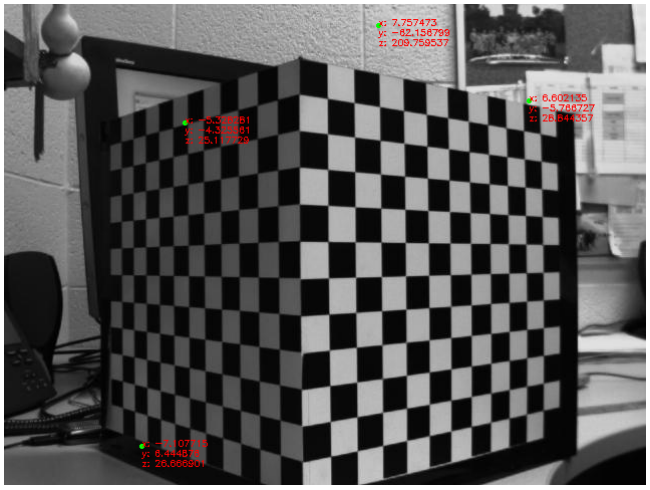
Turned real

```
======= R =======
[0.9999246330328863, 0.00639983096964615, 0.01047713785380638;
 -0.006489622015849246, 0.9999423147074225, 0.008558741943383744;
 -0.01042175897529352, -0.008626089561440387, 0.9999084845718327]
======= t =======
[0.791655818394585;
 0.0446559938756687;
 0.6093331661849501]
======= E =======
[0.07811152043979831, 70.56719243984597, -5.176751808845307;
 -69.7146645435291, -2.646448099871301, 88.74548439934293;
 5.007671275083948, -91.48812473423376, 0.2218620116695575]
======= F =======
[1.147393489018264e-07, 0.0001037608349572398, -0.03255628445868406;
 -0.0001025072920106137, -3.895178183779124e-06, 0.1426480509085971;
 0.0319581965950295, -0.1444207585849626, 1]
```

When the first image was taken, camera was turned already. Thus, there is no rotation movement between the first and last frame and my rotation matrices are identity matrix. There are some translations in X and Z directions which makes sense because camera moved into the optical axis little bit and X axis of the camera frame.

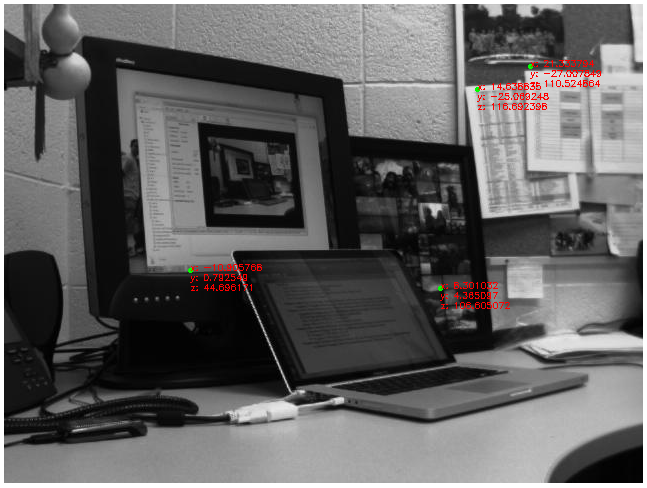
Task 3

Parallel cube



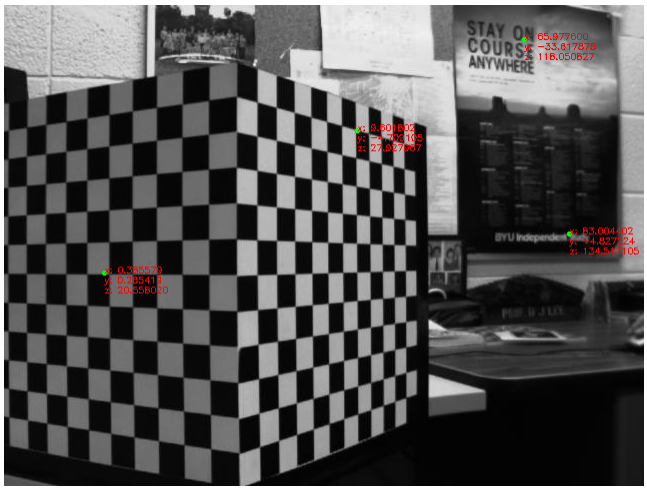
T = [2.07773; -0.00014; -0.09706]
scale factor = 2.08
Camera moved to the left about 2.08-inch and estimated 3d position of four random points are shown in the image above. Those 3d points seem reasonable because Z values make sense for the points. The point on the background wall seems to be too far probably due to not perfect feature matching.

Parallel real



T = [2.07409; -0.00224; -0.15664]
scale factor = 2.08
Camera moved to the left about 2.074-inch. Same as the Parallel cube image set, camera moved only side way without turning or moving forward and backward. The bigger Z-value is, the more change occurs by the change in X-direction with the same amount of change in X-direction in image coordinates.

Turned cube



T = [2.15954; 0.05305; 0.5536]
scale factor = 2.23
Camera moved to the left about 2.15-inch and back about half-inch which is the same movement as turned camera moved parallel.

Turned real

T = [1.76539; 0.09958; 1.35881]
scale factor = 2.23
Camera moved to the left about 1.77-inch and back about 1.36-inch which is the same movement as turned camera moved parallel.