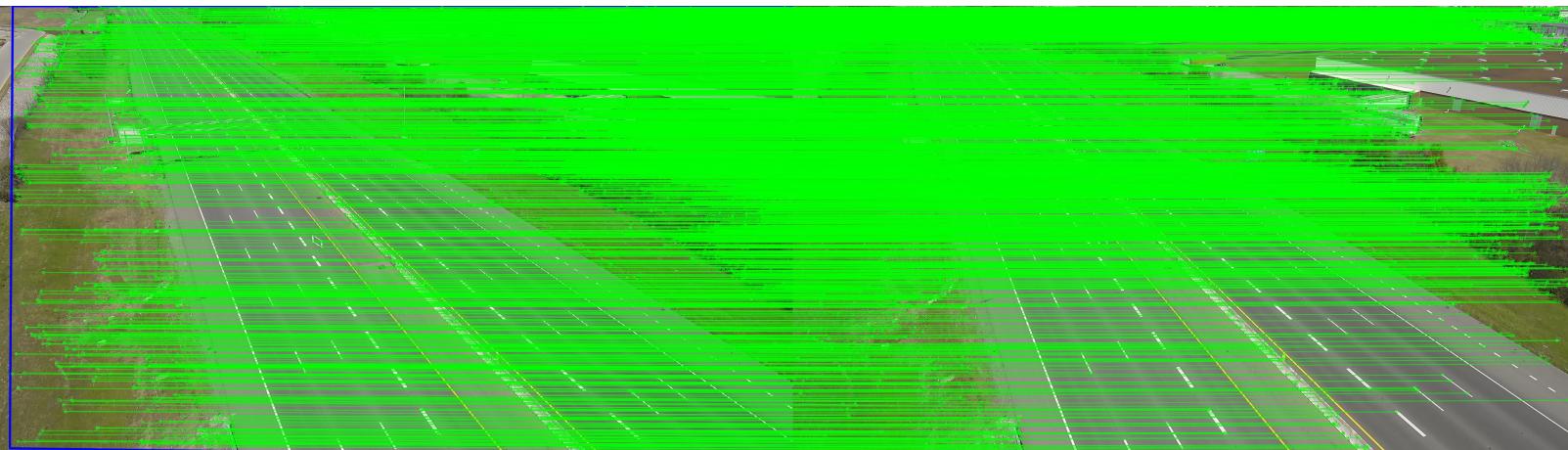


The following slides show feature detection results, calculates homography, and the transform from the homography.

SIFT

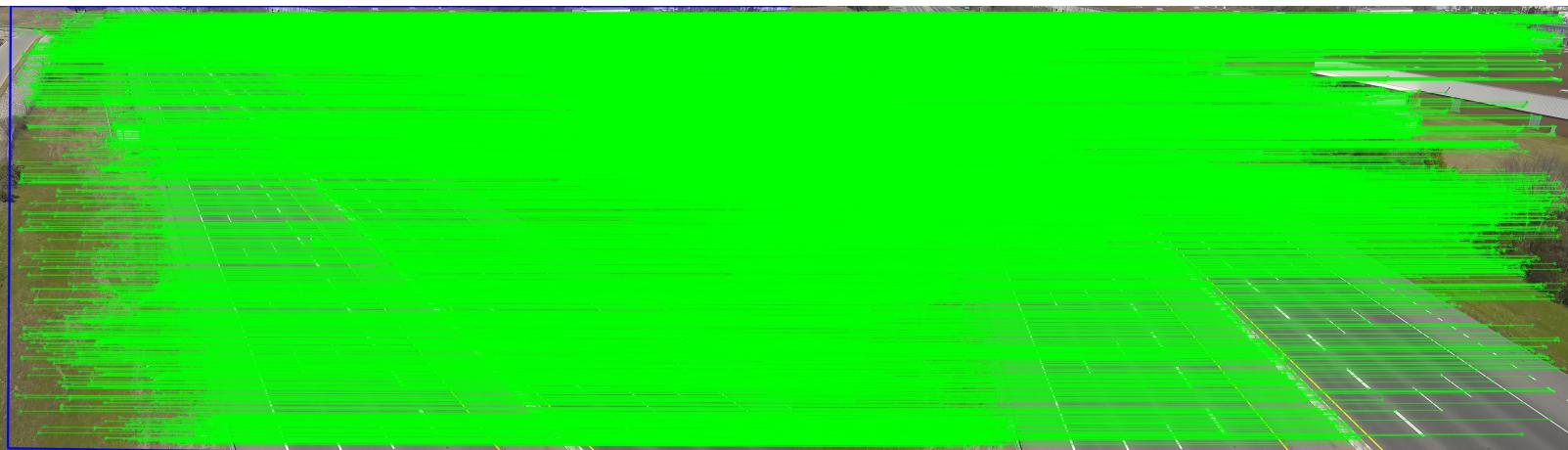


ORB



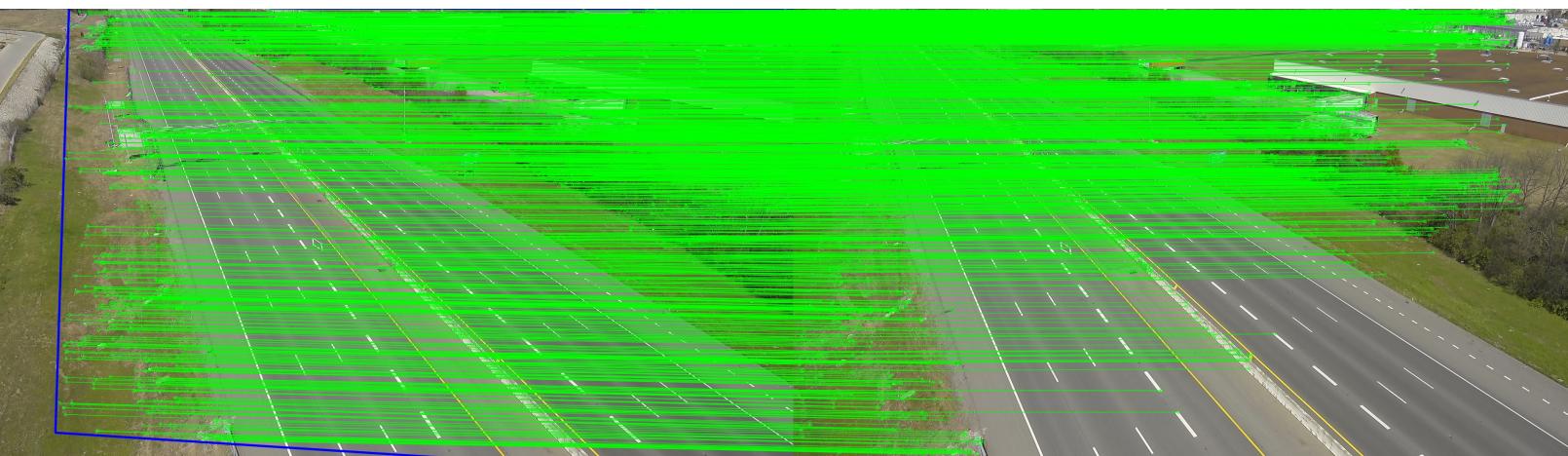
BRISK

1080 points

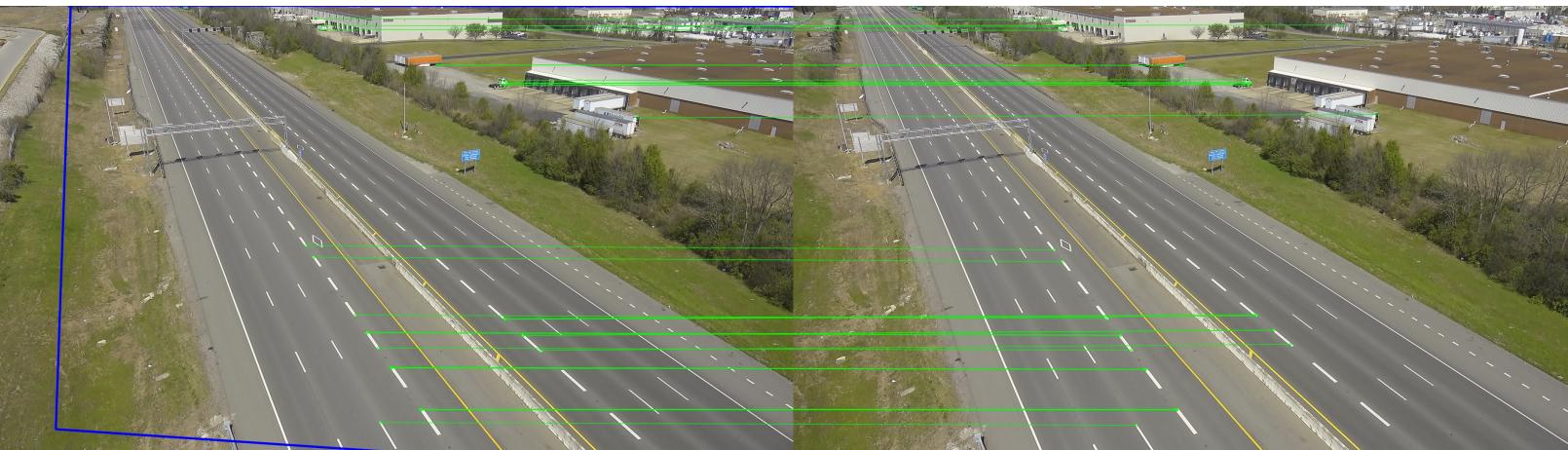


Degree 1

SIFT

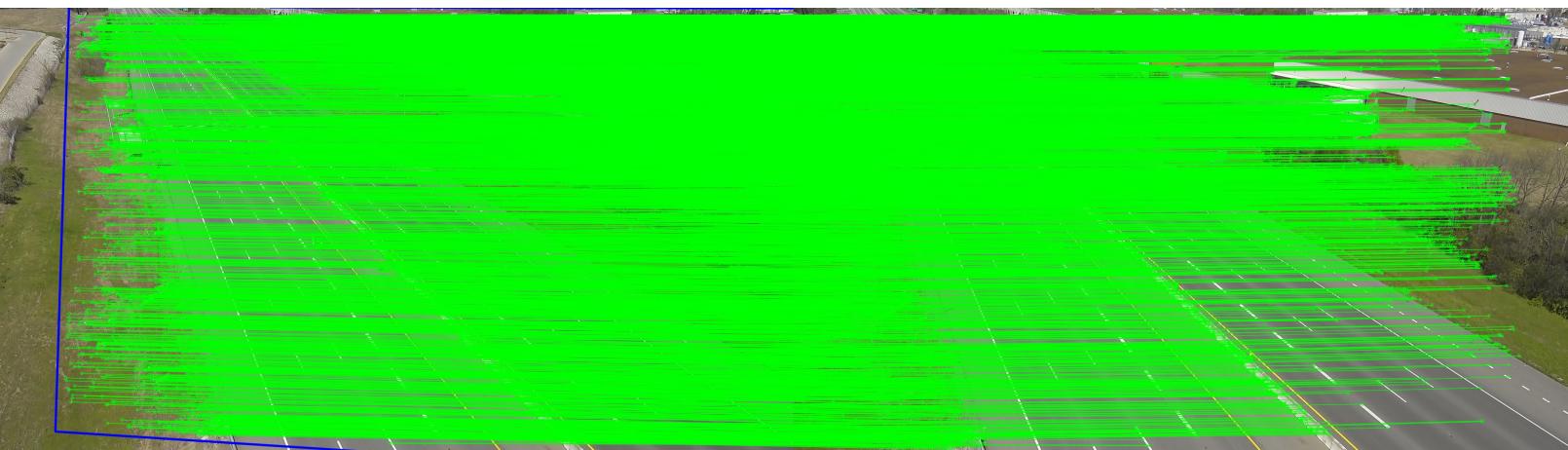


ORB

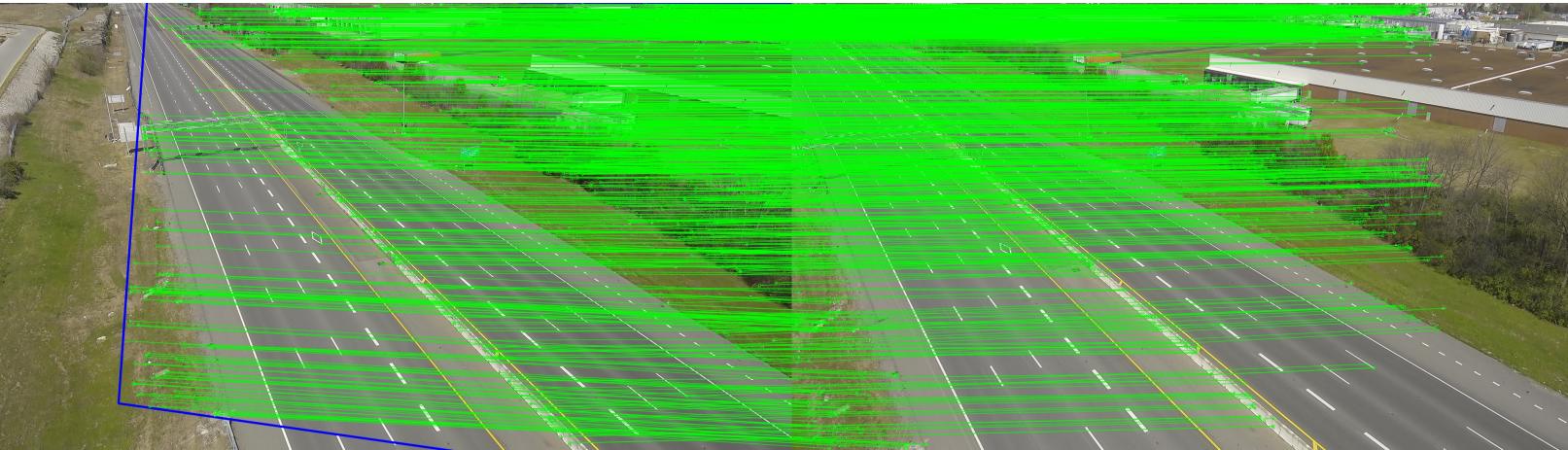


Degree 5

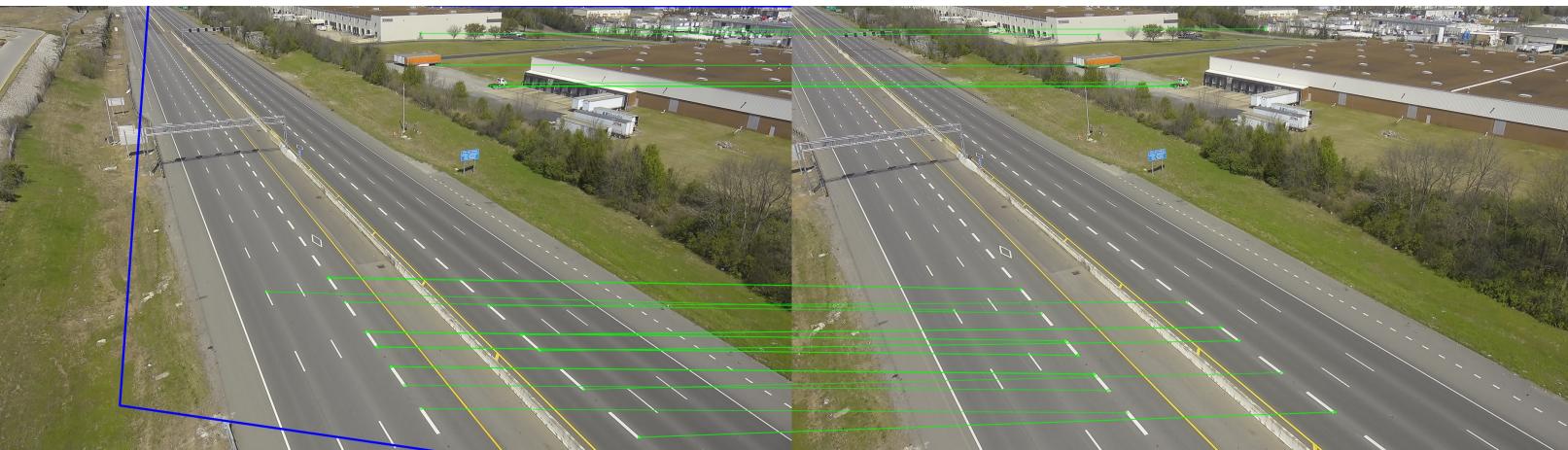
BRISK



SIFT

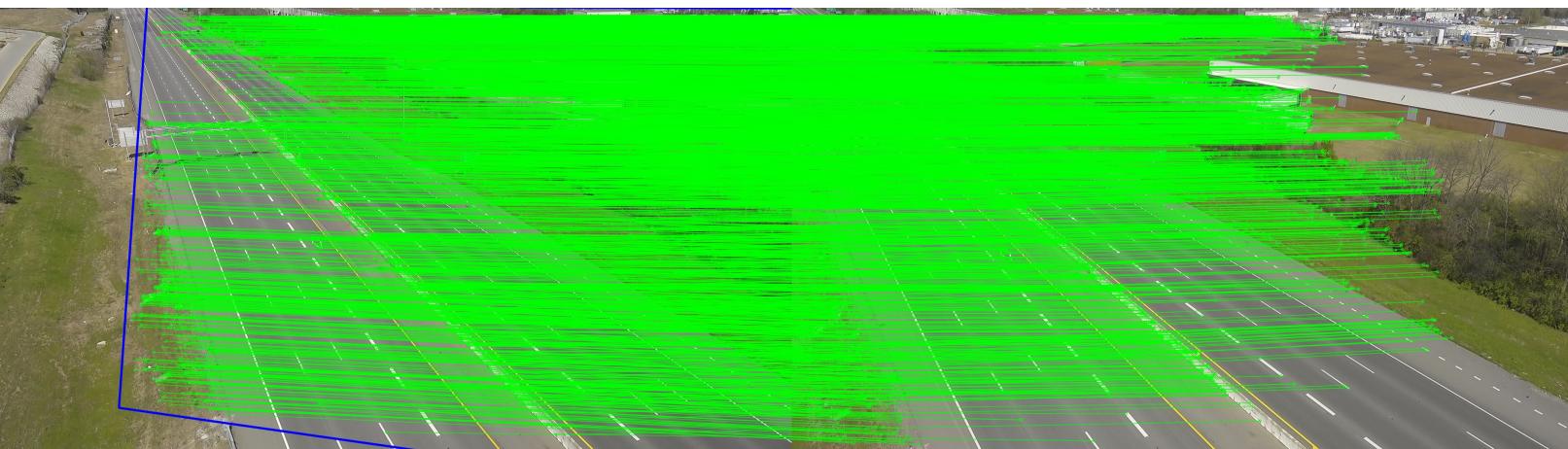


ORB

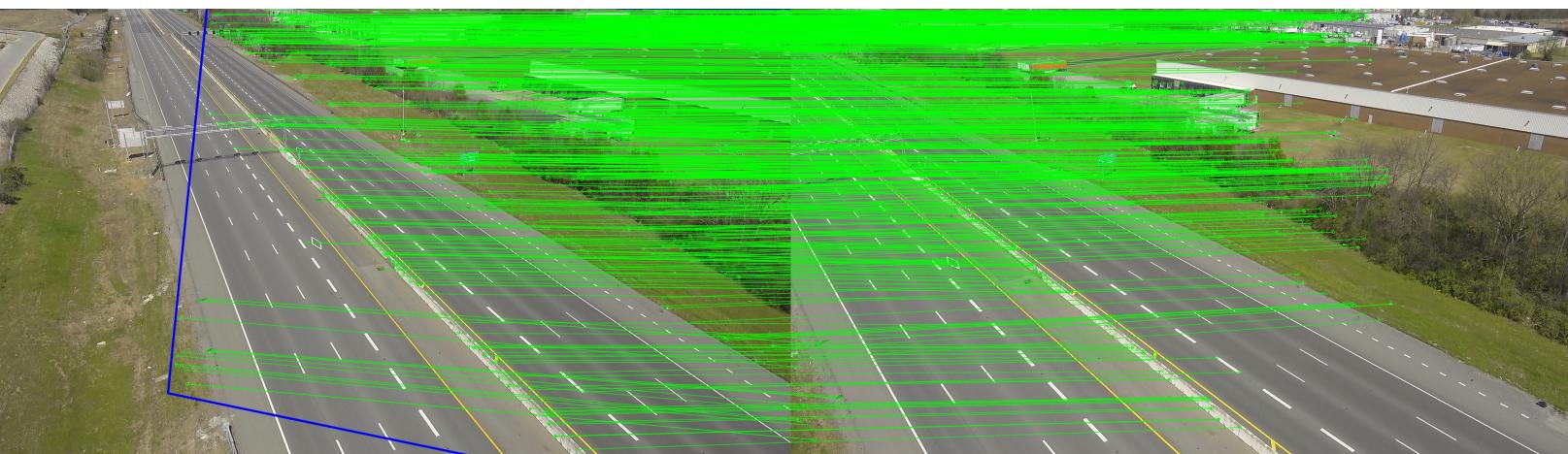


Degree 10

BRISK



SIFT

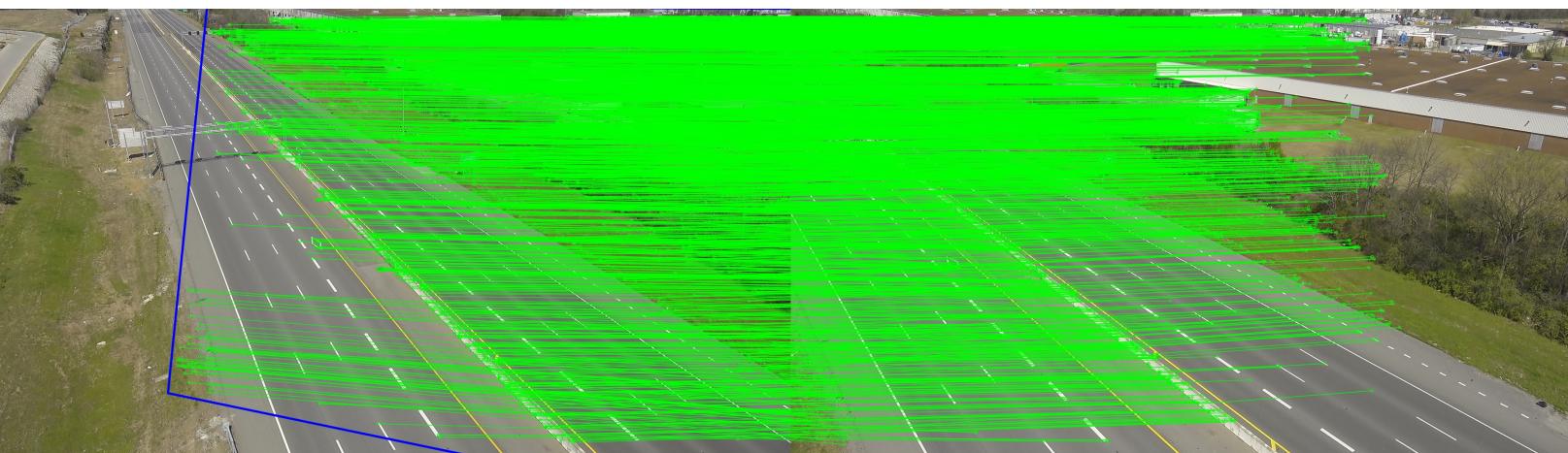


ORB

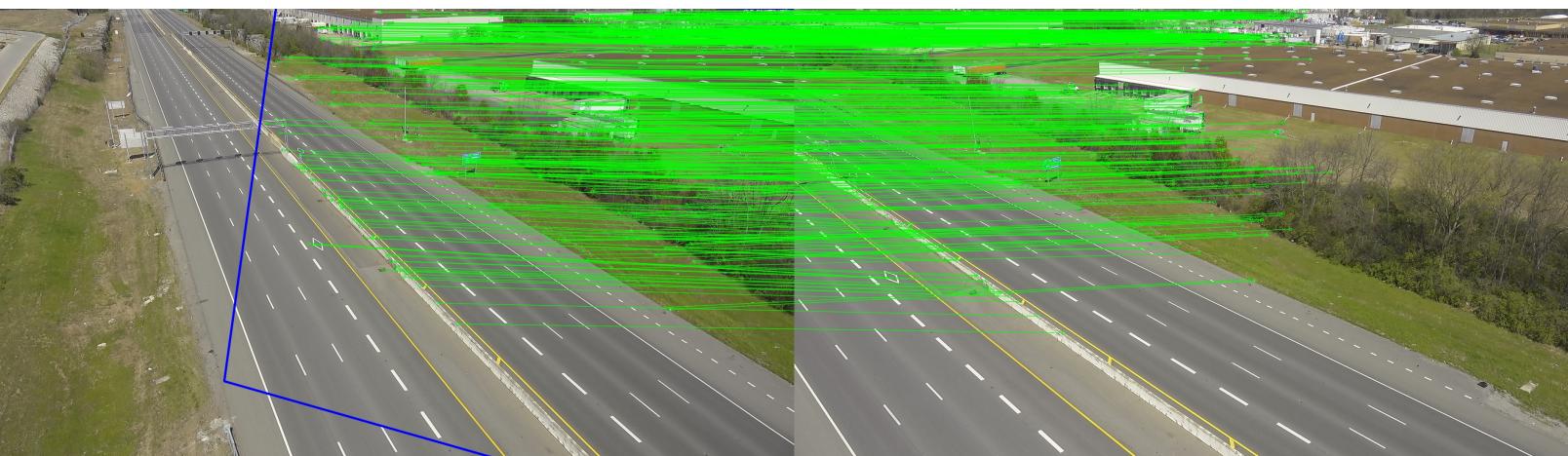


Degree 15

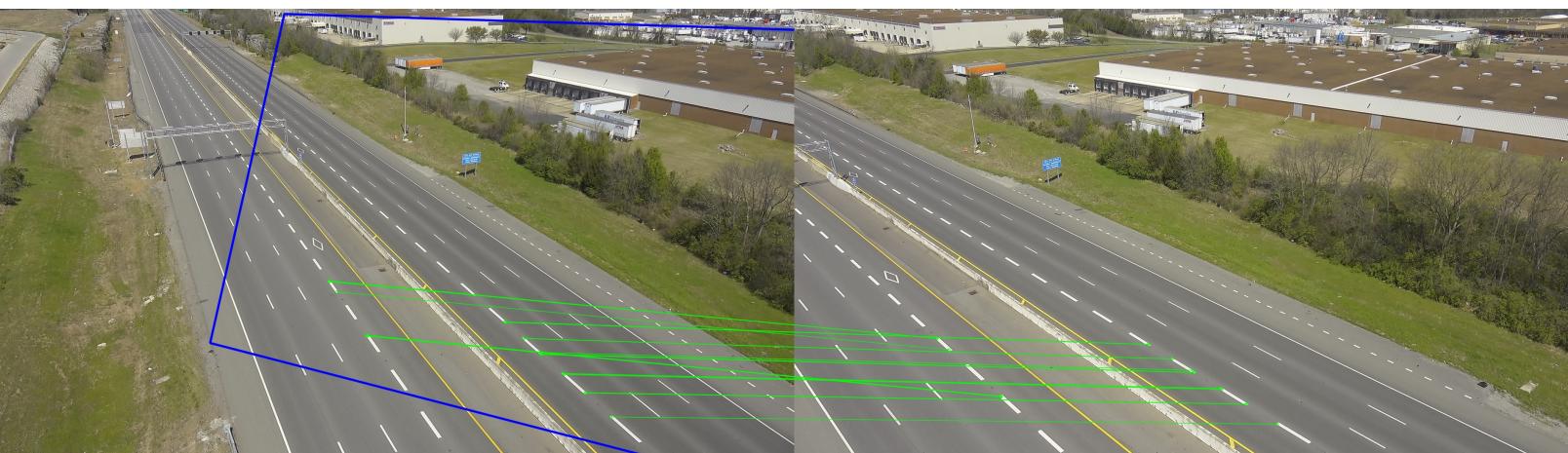
BRISK



SIFT

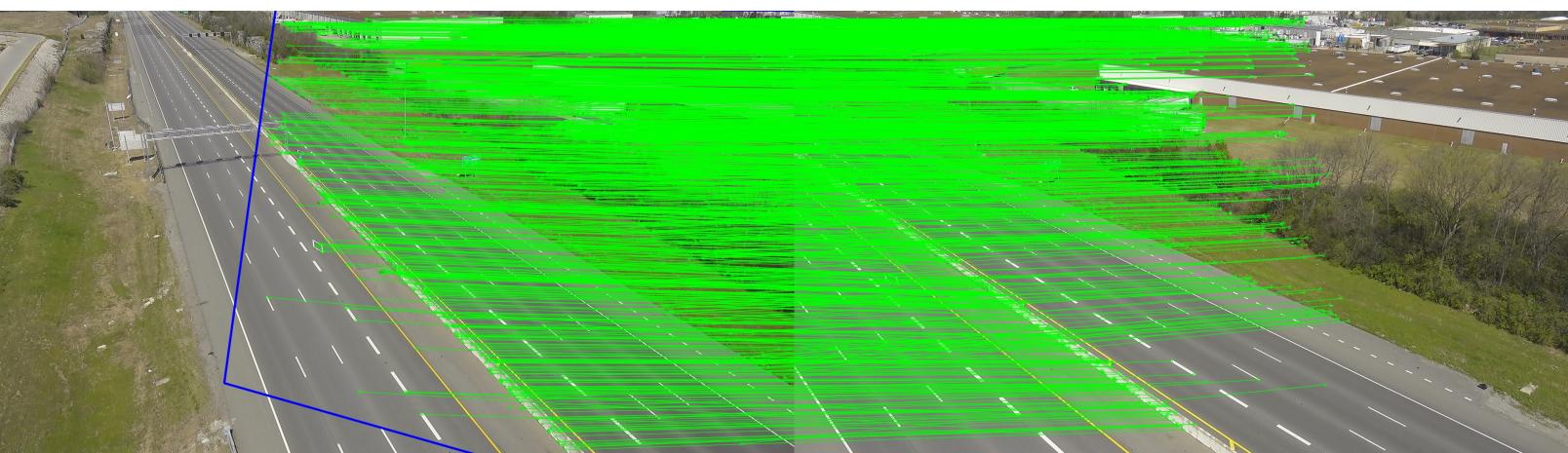


ORB

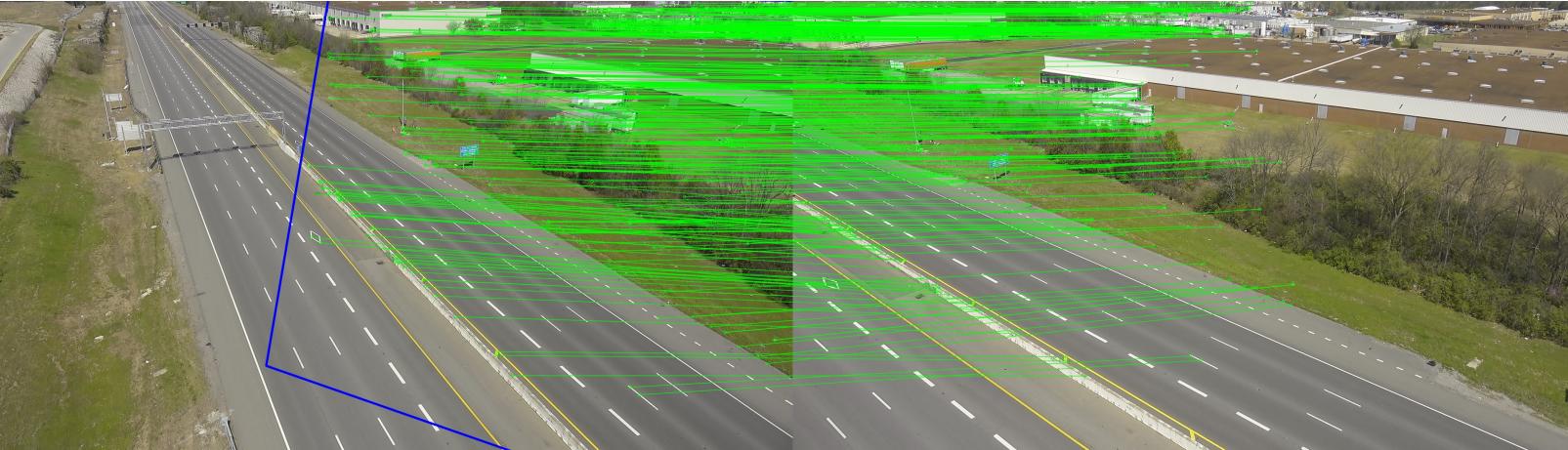


Degree 20

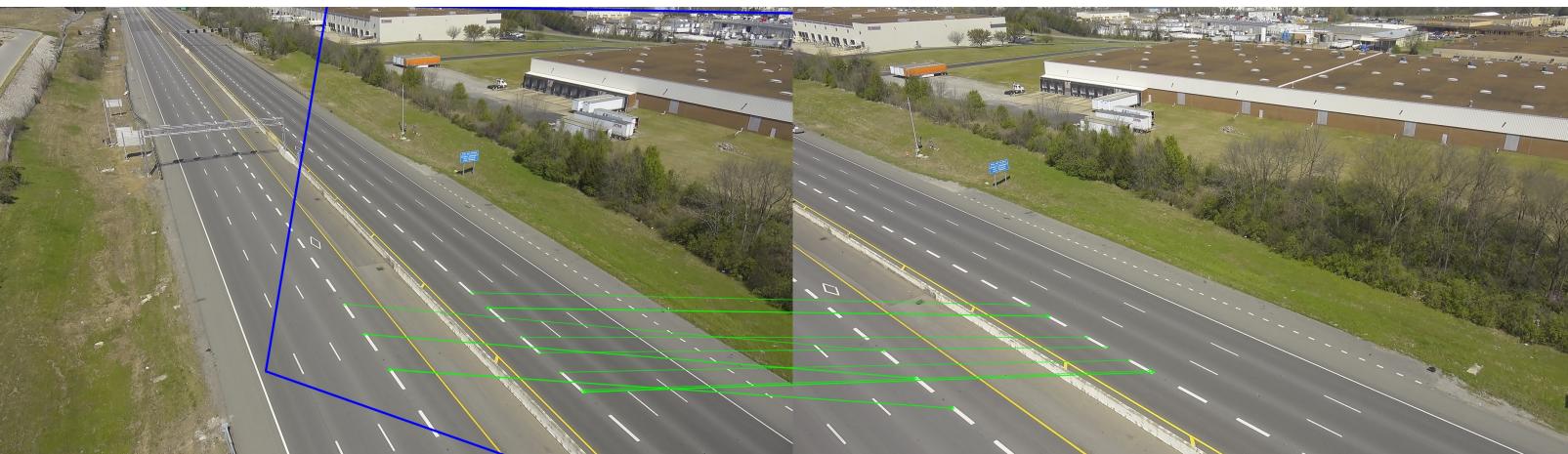
BRISK



SIFT

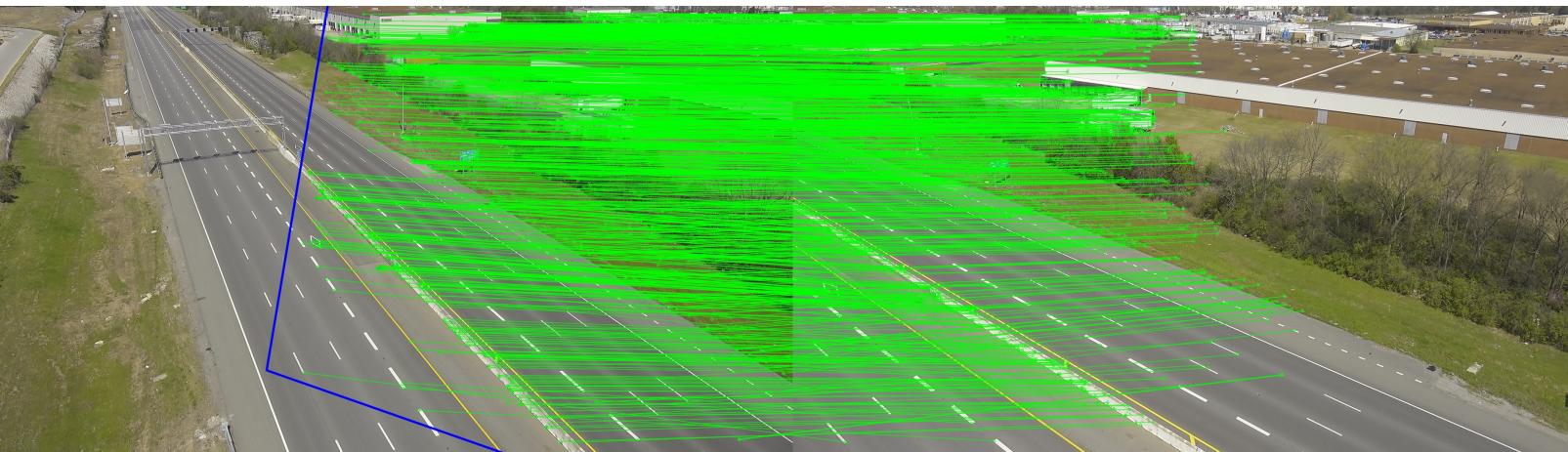


ORB



Degree 25

BRISK



Using SIFT for feature detection and  
`decomposeHomographyMat( )`

- 1 degree:

```
homography:  
[[ 9.78319864e-01 -6.39065333e-03 3.56818137e+01]  
[ 5.00883029e-04 9.89425429e-01 -8.27483795e-01]  
[-1.13641475e-05 2.12845942e-07 1.00000000e+00]]  
  
rotation 0 in degrees: [0.01967483 0.83507097 0.37805786]  
rotation 1 in degrees: [0.01967483 0.83507097 0.37805786]  
rotation 2 in degrees: [0.0242051 0.98459251 0.40935196]  
rotation 3 in degrees: [0.0242051 0.98459251 0.40935196]
```

- 5 degrees:

```
homography:  
[[ 8.96383635e-01 -3.00629710e-02 1.71596625e+02]  
[ 2.48409239e-03 9.51993034e-01 -3.57483710e+00]  
[-5.42455722e-05 1.62890403e-06 1.00000000e+00]]  
  
rotation 0 in degrees: [0.14255782 4.18785779 1.89448819]  
rotation 1 in degrees: [0.14255782 4.18785779 1.89448819]  
rotation 2 in degrees: [0.18273728 4.88989472 2.04513431]  
rotation 3 in degrees: [0.18273728 4.88989472 2.04513431]
```

- 10 degrees:

```
homography:  
[[ 7.80677421e-01 -6.19790001e-02 3.60478948e+02]  
[ 4.80269011e-03 9.07416859e-01 -6.34727695e+00]  
[-1.14400069e-04 5.11202817e-06 1.00000000e+00]]  
  
rotation 0 in degrees: [0.49724993 9.20825539 4.2545896 ]  
rotation 1 in degrees: [0.49724993 9.20825539 4.2545896 ]  
rotation 2 in degrees: [ 0.56667635 10.86368431 4.57215866]  
rotation 3 in degrees: [ 0.56667635 10.86368431 4.57215866]
```

- 15 degree:

```
homography:  
[[ 6.91031613e-01 -8.37497233e-02  5.06117028e+02]  
 [ 6.39462140e-03  8.80550368e-01 -8.81770872e+00]  
 [-1.61210569e-04  1.02849233e-05  1.00000000e+00]]  
  
rotation 0 in degrees: [ 0.98273041 13.39594427 6.26597388]  
rotation 1 in degrees: [ 0.98273041 13.39594427 6.26597388]  
rotation 2 in degrees: [ 1.16164451 15.86157987 6.75516895]  
rotation 3 in degrees: [ 1.16164451 15.86157987 6.75516895]
```

- 20 degrees:

```
homography:  
[[ 5.89399535e-01 -1.06812057e-01  6.71224516e+02]  
 [ 8.25975700e-03  8.58083428e-01 -1.08162999e+01]  
 [-2.13976617e-04  1.77610144e-05  1.00000000e+00]]  
  
rotation 0 in degrees: [ 2.1034555 21.79265633 9.5155107 ]  
rotation 1 in degrees: [ 2.1034555 21.79265633 9.5155107 ]  
rotation 2 in degrees: [ 1.7605034 18.39826479 8.7742864 ]  
rotation 3 in degrees: [ 1.7605034 18.39826479 8.7742864 ]
```

- 25 degrees:

```
homography:  
[[ 5.08447338e-01 -1.23031829e-01  8.03291257e+02]  
 [ 1.03234406e-02  8.47585329e-01 -1.23594646e+01]  
 [-2.56039933e-04  2.61510559e-05  1.00000000e+00]]  
  
rotation 0 in degrees: [ 3.22294939 26.64718924 12.0167366 ]  
rotation 1 in degrees: [ 3.22294939 26.64718924 12.0167366 ]  
rotation 2 in degrees: [ 2.59914909 22.5354957 11.00822735]  
rotation 3 in degrees: [ 2.59914909 22.5354957 11.00822735]
```

Using ORB for feature detection and  
**decomposeHomographyMat( )**

- 1 degree:

```
homography:  
[[ 9.77817301e-01 -7.35458168e-03 3.60496165e+01]  
[ 5.63001565e-04 9.88656213e-01 -9.59390192e-01]  
[-1.15443996e-05 -6.88594633e-07 1.00000000e+00]]
```

```
rotation 0 in degrees: [-0.05342742 0.99752714 0.42230047]  
rotation 1 in degrees: [-0.05342742 0.99752714 0.42230047]  
rotation 2 in degrees: [0.02529322 0.83786471 0.38146182]  
rotation 3 in degrees: [0.02529322 0.83786471 0.38146182]
```

- 5 degrees:

```
homography:  
[[ 8.89195009e-01 -3.30444618e-02 1.75207168e+02]  
[ 1.87889958e-03 9.47132810e-01 -2.66675716e+00]  
[-5.75056170e-05 -9.92755793e-07 1.00000000e+00]]
```

```
rotation 0 in degrees: [-0.04788591 5.19572771 2.1416074 ]  
rotation 1 in degrees: [-0.04788591 5.19572771 2.1416074 ]  
rotation 2 in degrees: [0.14062028 4.19312112 1.90567419]  
rotation 3 in degrees: [0.14062028 4.19312112 1.90567419]
```

- 10 degrees:

```
homography:  
[[ 7.73848845e-01 -6.24399628e-02 3.63173111e+02]  
[ 3.37744185e-03 9.03749617e-01 -4.81159259e+00]  
[-1.17783532e-04 5.03636371e-06 1.00000000e+00]]
```

```
rotation 0 in degrees: [ 0.56383615 11.21621387 4.62431588]  
rotation 1 in degrees: [ 0.56383615 11.21621387 4.62431588]  
rotation 2 in degrees: [0.50610356 9.20533854 4.29493565]  
rotation 3 in degrees: [0.50610356 9.20533854 4.29493565]
```

- 15 degree:

```
homography:  
[[ 6.91927458e-01 -8.27715146e-02  5.06454403e+02]  
 [ 6.05448478e-03  8.82591630e-01 -8.52153016e+00]  
 [-1.62926183e-04  1.38285170e-05  1.00000000e+00]]  
  
rotation 0 in degrees: [ 1.01133157 13.4522798  6.48848403]  
rotation 1 in degrees: [ 1.01133157 13.4522798  6.48848403]  
rotation 2 in degrees: [ 1.45296861 15.97215942  6.79306703]  
rotation 3 in degrees: [ 1.45296861 15.97215942  6.79306703]
```

- 20 degrees:

```
homography:  
[[ 5.91174683e-01 -1.26856908e-01  6.90883750e+02]  
 [ 2.01444539e-02  7.97126063e-01  1.26722630e+01]  
 [-1.97740535e-04  7.77707654e-05  1.00000000e+00]]  
  
rotation 0 in degrees: [ 0.2125345 20.41413547  9.73457032]  
rotation 1 in degrees: [ 0.2125345 20.41413547  9.73457032]  
rotation 2 in degrees: [10.81600486 14.93486678 16.67024673]  
rotation 3 in degrees: [10.81600486 14.93486678 16.67024673]
```

- 25 degrees:

```
homography:  
[[ 5.04427993e-01 -1.32153977e-01  7.99433658e+02]  
 [ 1.51819671e-02  8.25350056e-01 -6.50041046e+00]  
 [-2.49734788e-04  7.83596289e-06  1.00000000e+00]]  
  
rotation 0 in degrees: [ 2.13646398 26.21313952 12.06256391]  
rotation 1 in degrees: [ 2.13646398 26.21313952 12.06256391]  
rotation 2 in degrees: [ 1.76241871 22.47748936 10.02954739]  
rotation 3 in degrees: [ 1.76241871 22.47748936 10.02954739]
```

Using BRISK for feature detection and  
`decomposeHomographyMat( )`

- 1 degree:

```
homography:  
[[ 9.78293542e-01 -6.44670582e-03 3.57439725e+01]  
[ 5.36036781e-04 9.89464584e-01 -8.68321264e-01]  
[-1.13595555e-05 1.86892403e-07 1.00000000e+00]]
```

```
rotation 0 in degrees: [0.02140358 0.9844492 0.41167879]  
rotation 1 in degrees: [0.02140358 0.9844492 0.41167879]  
rotation 2 in degrees: [0.01950662 0.83546893 0.37943464]  
rotation 3 in degrees: [0.01950662 0.83546893 0.37943464]
```

- 5 degrees:

```
homography:  
[[ 8.96199813e-01 -2.99712704e-02 1.71594934e+02]  
[ 2.57567194e-03 9.52324899e-01 -3.72740003e+00]  
[-5.43710974e-05 1.81310310e-06 1.00000000e+00]]
```

```
rotation 0 in degrees: [0.14195825 4.18310495 1.90234056]  
rotation 1 in degrees: [0.14195825 4.18310495 1.90234056]  
rotation 2 in degrees: [0.19513924 4.90198442 2.05285675]  
rotation 3 in degrees: [0.19513924 4.90198442 2.05285675]
```

- 10 degrees:

```
homography:  
[[ 7.80204406e-01 -6.14047911e-02 3.60404532e+02]  
[ 4.46962325e-03 9.07757399e-01 -6.14712768e+00]  
[-1.14998841e-04 6.07195325e-06 1.00000000e+00]]
```

```
rotation 0 in degrees: [0.50488683 9.20257737 4.29612011]  
rotation 1 in degrees: [0.50488683 9.20257737 4.29612011]  
rotation 2 in degrees: [ 0.64511933 10.91651172 4.5669095 ]  
rotation 3 in degrees: [ 0.64511933 10.91651172 4.5669095 ]
```

- 15 degree:

```
homography:  
[[ 6.90446284e-01 -8.37094670e-02  5.06201763e+02]  
 [ 6.33944427e-03  8.80407106e-01 -8.78876595e+00]  
 [-1.61550904e-04  1.03437023e-05  1.00000000e+00]]  
  
rotation 0 in degrees:  [ 0.98225271 13.39363789  6.26969626]  
rotation 1 in degrees:  [ 0.98225271 13.39363789  6.26969626]  
rotation 2 in degrees:  [ 1.16821625 15.89751085  6.76669985]  
rotation 3 in degrees:  [ 1.16821625 15.89751085  6.76669985]
```

- 20 degrees:

```
homography:  
[[ 5.89785188e-01 -1.05987962e-01  6.70797875e+02]  
 [ 8.58055734e-03  8.58760716e-01 -1.11227913e+01]  
 [-2.14070404e-04  1.86848606e-05  1.00000000e+00]]  
  
rotation 0 in degrees:  [ 2.19688366 21.78835844  9.53986487]  
rotation 1 in degrees:  [ 2.19688366 21.78835844  9.53986487]  
rotation 2 in degrees:  [ 1.76358493 18.38859196  8.8043793 ]  
rotation 3 in degrees:  [ 1.76358493 18.38859196  8.8043793 ]
```

- 25 degrees:

```
homography:  
[[ 5.06327894e-01 -1.20259594e-01  8.02978110e+02]  
 [ 9.61621749e-03  8.48054310e-01 -1.20165359e+01]  
 [-2.58021586e-04  2.85113711e-05  1.00000000e+00]]  
  
rotation 0 in degrees:  [ 3.48184105 26.83727807 12.08333506]  
rotation 1 in degrees:  [ 3.48184105 26.83727807 12.08333506]  
rotation 2 in degrees:  [ 2.60813717 22.53421914 11.06029679]  
rotation 3 in degrees:  [ 2.60813717 22.53421914 11.06029679]
```

Using SIFT for feature detection  
and `recoverPose()`

- 1 degree:

```
Essential Matrix:  
[[ -0.00149396 -0.57594346 -0.34257561]  
[ 0.57294289  0.00387818 -0.23355713]  
[ 0.3410592   0.2274982  -0.00495088]]  
  
rotation in degrees: [-0.02192558 -0.8363852  -0.3630847 ]
```

- 5 degrees:

```
Essential Matrix:  
[[ 0.01588012 -0.67613603 -0.10204025]  
[ 0.66132207  0.02329403 -0.22806597]  
[ 0.09400814  0.18272407 -0.00681796]]  
  
rotation in degrees: [-0.01141532 -4.17032057 -1.96930922]
```

- 10 degrees:

```
Essential Matrix:  
[[ -0.01426034  0.0387366  -0.05757523]  
[ -0.17181738 -0.0050901  -0.68334269]  
[  0.00322019  0.70601646 -0.00269194]]  
  
rotation in degrees: [ 0.16791216 -10.94863021 -4.53762695]
```

- 15 degree:

```
Essential Matrix:  
[[ 0.05526949 -0.69663846 -0.09409475]  
[ 0.66462867  0.07514246 -0.2132947 ]  
[ 0.0759853   0.06158954 -0.01862798]]  
  
rotation in degrees: [ 0.48281923 -13.40473551 -6.30976661]
```

- 20 degrees:

```
Essential Matrix:  
[[ 0.07311784 -0.69501474 -0.10586226]  
[ 0.66371715  0.10317526 -0.20198416]  
[ 0.086956   -0.00666991 -0.02885215]]  
  
rotation in degrees: [ 1.07268493 -18.4275579 -8.77361231]
```

- 25 degrees:

```
Essential Matrix:  
[[ -0.01675802 -0.04509549 -0.05143679]  
[ -0.27776834 -0.01768611 -0.64768513]  
[ -0.08010729  0.70108972  0.0114789 ]]  
  
rotation in degrees: [-178.60653667 19.64131185 2.44437934]
```

Using ORB for feature detection  
and `recoverPose()`

- 1 degree:

```
Essential Matrix:  
[[ 0.00393628 -0.69939284 -0.08396423]  
[ 0.70027366  0.00515367  0.05110414]  
[ 0.08398199 -0.06089461 -0.00128095]]  
  
rotation in degrees: [-0.02935944 -0.85259168 -0.4243239 ]
```

- 5 degrees:

```
Essential Matrix:  
[[ 0.00147145 -0.57829802 -0.25659395]  
[ 0.60017319  0.02060925  0.27186757]  
[ 0.26616978 -0.30650359 -0.0198342 ]]  
  
rotation in degrees: [ 0.00698441 -4.26976389 -2.03792101]
```

- 10 degrees:

```
Essential Matrix:  
[[ 0.00542163 -0.54279985 -0.24339178]  
[ 0.59735205  0.04756194  0.28706982]  
[ 0.26964009 -0.36056571 -0.04341975]]  
  
rotation in degrees: [ 0.29254182 -9.52876876 -4.86531737]
```

- 15 degree:

```
Essential Matrix:  
[[ 0.00311458 -0.50089826 -0.23226984]  
[ 0.59022481  0.06712668  0.30515272]  
[ 0.27662159 -0.41064617 -0.06326671]]  
  
rotation in degrees: [ 0.94820671 -14.21159884 -7.11893097]
```

- 20 degrees:

```
Essential Matrix:  
[[ 0.00326496 -0.46427996 -0.20699397]  
[ 0.59579627  0.09066789  0.30452383]  
[ 0.27362732 -0.45179223 -0.08167127]]  
  
rotation in degrees: [ 2.15794523 -19.8215089 -9.84240459]
```

- 25 degrees:

```
Essential Matrix:  
[[-0.00160189 -0.43038239 -0.18400516]  
[ 0.60144623  0.10582049  0.30032621]  
[ 0.26854784 -0.48676767 -0.09337269]]  
  
rotation in degrees: [ 3.60314569 -24.74651545 -11.72410066]
```

Using BRISK for feature detection  
and `recoverPose()`

- 1 degree:

```
Essential Matrix:  
[[ 4.36488103e-03 -6.38801497e-01 -2.10716702e-02]  
[ 6.43340944e-01  4.46734813e-03  2.92695115e-01]  
[ 2.27550652e-02 -3.02280519e-01 -5.63322048e-04]]  
  
rotation in degrees: [-0.04119179 -0.87118699 -0.41955637]
```

- 5 degrees:

```
Essential Matrix:  
[[ 0.01423533 -0.68567941 -0.12298751]  
[ 0.67515857  0.02314124 -0.1698916 ]  
[ 0.11706392  0.12450452 -0.00848925]]  
  
rotation in degrees: [-0.01098945 -4.15946956 -1.93023266]
```

- 10 degrees:

```
Essential Matrix:  
[[ 0.01313894  0.08144876  0.10151754]  
[-0.2105955   -0.0126905   -0.66700649]  
[-0.15531345  0.68469086  0.02355076]]  
  
rotation in degrees: [ 0.53513702 -10.91303609 -4.58868218]
```

- 15 degree:

```
PIERRE@PIERRE-OptiPlex-5070:~/PycharmProjects/untitled$ python3 main.py
PIERRE@PIERRE-OptiPlex-5070:~/PycharmProjects/untitled$ Essential Matrix:
[[ -0.01795907 -0.00378846 -0.06332475]
 [-0.19276237 -0.00614531 -0.67710283]
 [-0.01574279  0.7069207 -0.00224544]]

rotation in degrees: [ 0.5514762 -16.14952032 -6.6721389 ]
PIERRE@PIERRE-OptiPlex-5070:~/PycharmProjects/untitled$
```

- 20 degrees:

```
PIERRE@PIERRE-OptiPlex-5070:~/PycharmProjects/untitled$ python3 main.py
PIERRE@PIERRE-OptiPlex-5070:~/PycharmProjects/untitled$ Essential Matrix:
[[ -0.0202083 -0.02897136 -0.06211008]
 [-0.23526666 -0.01070105 -0.66348208]
 [-0.04510963  0.70511198  0.0018565 ]]

rotation in degrees: [-179.01782459  17.2515004 -1.50856359]
PIERRE@PIERRE-OptiPlex-5070:~/PycharmProjects/untitled$
```

- 25 degrees:

```
PIERRE@PIERRE-OptiPlex-5070:~/PycharmProjects/untitled$ python3 main.py
PIERRE@PIERRE-OptiPlex-5070:~/PycharmProjects/untitled$ Essential Matrix:
[[ 0.07815151 -0.68953297 -0.13405771]
 [ 0.6406303  0.12426666 -0.24740119]
 [ 0.10689968 -0.00105199 -0.04449465]]

rotation in degrees: [ 1.81018441 -22.60415369 -10.90984031]
PIERRE@PIERRE-OptiPlex-5070:~/PycharmProjects/untitled$
```