530.646 Robotics
Lab1 Lab Report
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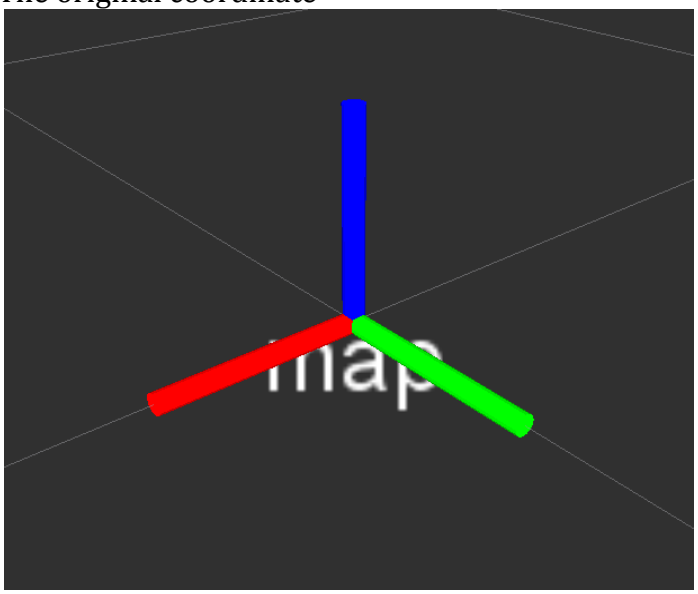
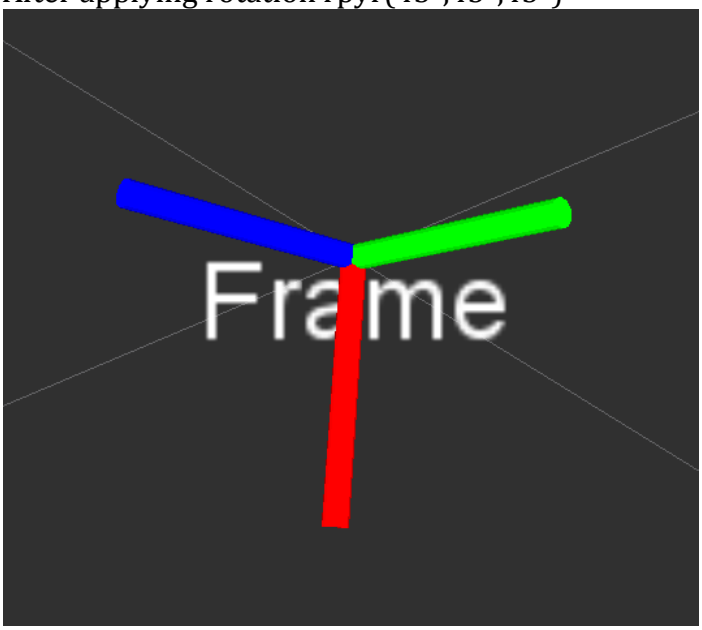
9/19/2104

1. See source codes.
2. See source codes.
3. See source codes.

4.
The original coordinate



After applying rotation rpyr(45°,45°,45°)



5.

(a) Experiment result is:

```
Matrix of rpyr(1,1,1):
[  0.29, -0.072,   0.95]
[  0.45,   0.89, -0.072]
[ -0.84,   0.45,   0.29]

Matrix of rpyr(1+2*PI,1,1):
[  0.29, -0.072,   0.95]
[  0.45,   0.89, -0.072]
[ -0.84,   0.45,   0.29]
```

We know that the results are the same.

(b) R is numerically ill defined for matrix which $R_{31} = \pm 1$. It means pitch is $\frac{\pi}{2}$ or $-\frac{\pi}{2}$. In this case, roll and yaw angles will have infinite many solutions. Then R does not represent specific rotations.

(c) According to the experiment result:

```
rpyrinv(rpyr(4*PI,0,0)):
[-2.1e-07]
[-0]
[0]

Vector3f(4*PI,0,0):
[13]
[0]
[0]
```

The return value of the function is (0,0,0)', which is different from the input value.

(d) The experiment result is:

```
R:
[ 0, -1,  0]
[ 1,  0,  0]
[ 0,  0,  1]

rpyr(rpyrinv(R)):
[-4.4e-08,       -1,        0]
[       1, -4.4e-08,        0]
[       0,        0,        1]
```

The two results are the same.

6. See source codes.

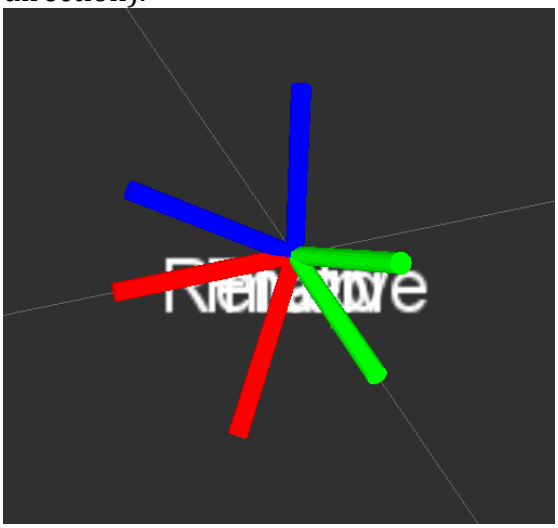
7. We use the definition in the book.

$$H^{-1} = \begin{pmatrix} R^T & -R^T d \\ 0 & 1 \end{pmatrix}$$

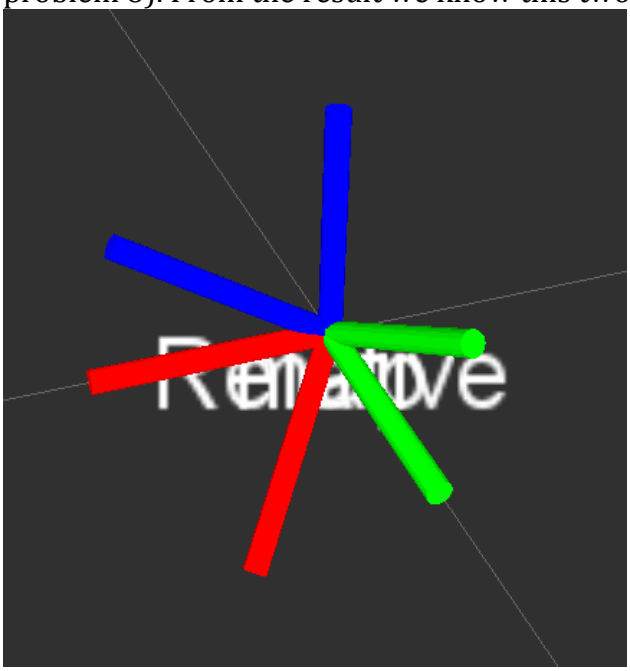
```
Problem 7
************************
Original transformation Matrix
[  0.5, -0.15,  0.85,     0]
[  0.5,  0.85, -0.15,     0]
[-0.71,   0.5,   0.5,     0]
[    0,     0,     0,     1]

Eigen inverse()
[  0.5,   0.5, -0.71,    -0]
[-0.15,  0.85,   0.5,     0]
[ 0.85, -0.15,   0.5,    -0]
[   -0,     0,    -0,     1]

Our implementation of inverse
[  0.5,   0.5, -0.71,     0]
[-0.15,  0.85,   0.5,     0]
[ 0.85, -0.15,   0.5,     0]
[    0,     0,     0,     1]
```

According to the result, our implementation of inverse is the same as normal inverse function.

8. See source code and animation.
This is the original frame and frame after intrinsic transformation (rotate 45 degree in each direction).



9. See source code and animation.
This is the original frame and frame after extrinsic transformation (same angle as in problem 8). From the result we know this two kind of rotations have same results.



10. See source code and animation.