Lidar SLAM

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Homework 1

Task 1: Linux

Linux Commands

1. `cd`: change directory
2. `ls`: list all the files in the current directory
3. `source`: execute the content of a file

Vim

Vim is a terminal text editor that allows you to edit any file

1. Insertion: key in `i` in viewing mode to change to **insertion mode** and start inserting your text
2. Deletion: use backspace as usual, or key in `dd` in viewing mode to delete a whole line
3. Quit: key in `:wq` in viewing mode

Zipping and Unzipping

```
# zipping
zip [options] myfile
# unzipping
unzip [options] myfile.zip

# Or use `tar`
tar -zcvf myfile.tgz .
tar -zxvf myfile.tgz
```

Task 2

The Turtle Sim was run successfully:

Task 3

Given:

$$Robot\ A's\ Pose : [x_a, y_a, \theta_a]^T$$
$$Object\ B's\ Pose : [x_b, y_b, \theta_b]^T$$
$$(in\ World\ Frame,\ O)$$

Solution for Question 1:

Transformation Matrix from A to World's Frame:

$$T_A^O = \begin{bmatrix} \cos(\theta_a) & -\sin(\theta_a) & x_a \\ \sin(\theta_a) & \cos(\theta_a) & y_a \\ 0 & 0 & 1 \end{bmatrix}$$

Transformation Matrix from B to World's Frame:

$$T_B^O = \begin{bmatrix} \cos(\theta_b) & -\sin(\theta_b) & x_b \\ \sin(\theta_b) & \cos(\theta_b) & y_b \\ 0 & 0 & 1 \end{bmatrix}$$

Transformation Matrix from B to A:

$$\begin{aligned} T_B^A &= T_O^A T_B^O \\ &= {T_A^O}^{-1} T_B^O \end{aligned}$$

Therefore, the object's pose in the robot's frame is given by:

$$\begin{bmatrix} x_{b,A} \\ y_{b,A} \\ \theta_{b,A} \end{bmatrix} = \begin{bmatrix} T_B^A(0,2) \\ T_B^A(1,2) \\ atan2(T_B^A(1,0), T_B^A(0,0)) \end{bmatrix}$$

Solution for Question 2:

After the motion, the Robot's Frame transformation to its previous Frame can be represented as:

$$T_{A'}^{A} = \begin{bmatrix} \cos(\theta_d) & -\sin(\theta_d) & d \\ \sin(\theta_d) & \cos(\theta_d) & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

Thus, transformation matrix from B to A is given by:

$$\begin{aligned} T_B^{A'} &= T_A^{A'} T_O^A T_B^O \\ &= {T_{A'}^A}^{-1} {T_A^O}^{-1} T_B^O \end{aligned}$$

Now the object's pose in the new frame is given by:

$$\begin{bmatrix} x_{b,A'} \\ y_{b,A'} \\ \theta_{b,A'} \end{bmatrix} = \begin{bmatrix} T_B^{A'}(0,2) \\ T_B^{A'}(1,2) \\ atan2(T_B^{A'}(1,0), T_B^{A'}(0,0)) \end{bmatrix}$$

Task 4

The code implemented for transforming Robot B to coordinate A:

```
Eigen::Matrix3d TOA;
TOA << cos(A(2)), -sin(A(2)), A(0),
       sin(A(2)),  cos(A(2)), A(1),
           0,          0,      1;

Eigen::Matrix3d TBA = TBO * TOA;
BA << TBA(0,2), TBA(1,2), atan2(TBA(1,0), TBA(0,0));
```

And the result was `2, 1, 1.5708`:

```
ss (main *) build $ cmake .. && make
-- Configuring done
-- Generating done
-- Build files have been written to: /home/ss/ss_ws/Lidar-SLAM/Homeworks/HW1/basicTransformStudy/build
Scanning dependencies of target basicTransformStudy
[ 50%] Building CXX object CMakeFiles/basicTransformStudy.dir/basic_transform_study.cpp.o
[100%] Linking CXX executable basicTransformStudy
[100%] Built target basicTransformStudy
ss (main) build $ ./basicTransformStudy
The right answer is BA: 2 1 1.5708
Your answer is BA:      2      1 1.5708
ss (main) build $
```