Self-Driving Car
Assignment 4
Name: Nguyen Dang Khoa (阮登科) ID: 0760816

Q1. What's the difference between our launch (robot_pose_ekf.launch) file and original launch file? And please explain why we add these modification.

Ans: We set "odom_used" = "false" since we don't have it. Instead we remap 'vo' topic to '/zed/odom' which is available. This tag will tell **robot_pose_ekf** node subscribe our topic of visual odometry.

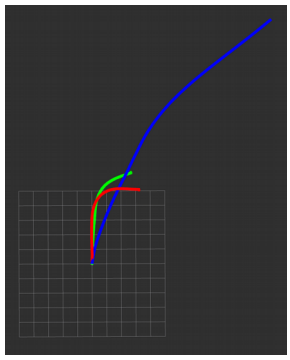
Q2. Which parts in IMU data and ZED odometry are used? And please explain why it choose this way.(odom_estimation_node.cpp)

Ans: **robot_pose_ekf** uses orientation from IMU and pose from ZED odometry.
This is because IMU doesn't provide direct pose, only orientation, so inferring position from IMU is not reliable. ZED odometry provides both pose and orientation, so it's more reliable than IMU.

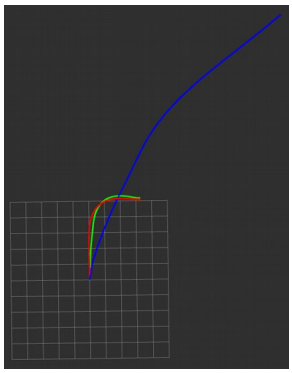
Q3. Please try to adjust covariance setting in odom_estimation_node.cpp (in imuCallback() & voCallback()), and observe how it affect the resulting path. Also, give your opinion which setting Is better, and why?

Modify IMU covariance:

$$\begin{bmatrix} 0.17^2 & 0 & 0 \\ 0 & 0.17^2 & 0 \\ 0 & 0 & 0.17^2 \end{bmatrix}$$



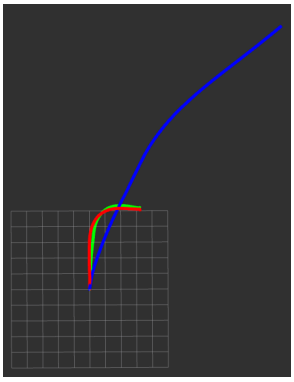
$$\begin{bmatrix} 0.000017^2 & 0 & 0 \\ 0 & 0.000017^2 & 0 \\ 0 & 0 & 0.000017^2 \end{bmatrix}$$



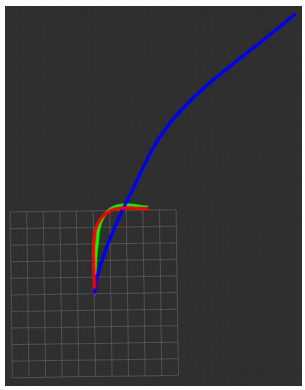
When we increase IMU covariance, the sensor fusion result (green) will move closer to IMU(blue) since the EKF believe in IMU more while decrease IMU covariance, the result is far away from IMU.

Modify Visual Odometry (VO) covariance:

$$\begin{bmatrix} 0.1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0.1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0.1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0.0000017 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0.0000017 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0.0000017 \end{bmatrix}$$



$$\begin{bmatrix} 0.1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0.1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0.1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1700000 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1700000 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1700000 \end{bmatrix}$$



When we decrease or increase covariance of VO position, the sensor fusion result (green) is unchanged since VO is the only sensor which provides position (xyz) for EKF!

Covariance matrix settings for accurate state estimation depends on quality of sensors we used. Specifically, if ZED camera provides more reliable than IMU, we should decrease covariance of IMU and vice versa, so that the sensor fusion result will be closer to ZED pose.

Q4. Comparing the resulting path and the single sensor paths, what is the difference, and why?

Ans: The result path (sensor fusion) is between IMU and VO poses since it compromise poses from two sensors.