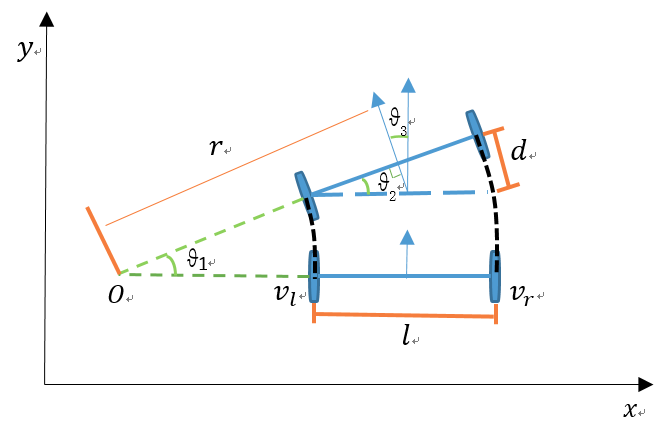
Wheel motion module:

The forward speed of robot is equal to the average speed of left and roght wheels.

Superimpose the robot positions of two moments together, we can get geometric relations:

Due to the time interval of two measurements is very small, Therefore the is also very small.

Therefore, robot’s angular velocity is equal to equation below:

By the way, we also can calculate the motion radius:

The core parameters of motion is v and w, and the state we can measure is the angle of two wheels at a period time.Which is and .

Assuming that the state at time is known, the continuous evolution of dynamics orientation and position in the world frame can be obtained as follows:

(1)

(2)

Which .

Multiply at both left side of two equations (1) and (2).

In order to get the information matrix and Jacobians of dynamics measurements residual in optimization part, we introduce the noise and derive discrete-time error-state kinematics:

Considering two consecutive vehicle dynamics frames and in the sliding window, the dynamics measurements residual can be written as:

Which , and the state with is the variables to be estimated in the system. means take the virtual part of quaternion, and 2 is used to eliminate coefficient in derivation.

Let ,

But if we want our state to be , and the state with is the variables to be estimated in the system.

Substitute equation to cost function:

Let ,

But if we want our state to be , and the state with is the variables to be estimated in the system. And also multiply a small disturbution on the left side.

Substitute equation to cost function:

Let ,

Appendix:

I: Quaternion in a continuously change process can be express as:

According to quaternion muliply law,

For convenience, let , and we will have:

Therefore,

Under these circumstances, we can derive quaternion derivation as below:

As we can assume that ,

And while ,

Appendix II:

The following equation will be tenable when is extremely small.

But, due to the lie algebras used in camera’s optimize, we need to guarantee that the vertex plus are consistent. Which means, we either use method lie algebras or method quaternion in appendix II.

To calculate the jacobian of , derived by , and . We add perturbations, then expand and organize equation.

Here use the trick that ,