

# 从零开始手写 VIO - 作业 1

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July 12, 2020

1. (a) IMU 可以估计短时间快速的运动但对于长期运动则会产生漂移，而视觉可以估计长期的运动但很难估计短时间快速的运动，而且视觉方法估计出的运动不具有尺度信息。因此 IMU 和视觉是互补的方法，将二者进行结合可以有效的克服两种方法本身的缺陷。
- (b) 常见的视觉 +IMU 融合方案包括 MSCKF、OKVIS、ROVIO、VIOORB、VINS-Mono、VINS-Mobile、VINS-Fusion 等
- (c) 目前学术界有使用深度学习来实现端对端 VIO 的案例

## 2. 验证程序代码如下:

```
#include <Eigen/Core>
#include <sophus/se3.hpp>

using namespace std;

int main() {
    Eigen::Vector3d w;
    w << 0.01, 0.02, 0.03;

    Eigen::Quaterniond q = Eigen::Quaterniond::UnitRandom();
    Eigen::Matrix3d R = q.matrix();

    // update with quaterniond
    Eigen::Quaterniond dq;
    dq.w() = 1;
    dq.vec() = 0.5*w;

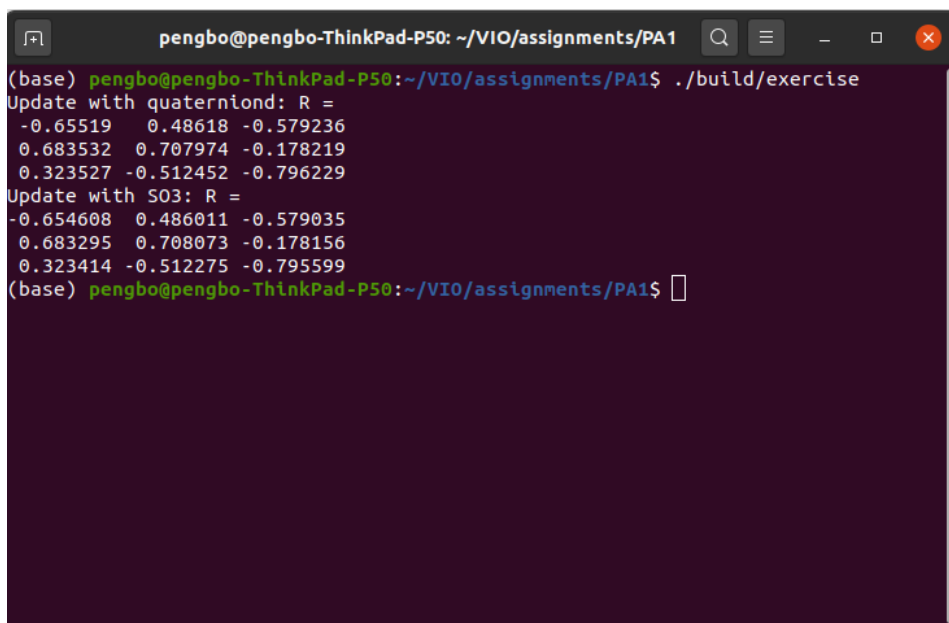
    q = q * dq;
    cout << "Update with quaterniond: R = " << endl;
    cout << q.matrix() << endl;

    // update with SO3
    Sophus::SO3d dR = Sophus::SO3d::exp(w);
    R = R * dR.matrix();

    cout << "Update with SO3: R = " << endl;
    cout << R << endl;

    return 0;
}
```

程序运行截图如图 Fig.1所示, 可以看出两种更新方式的差异非常小应视为等同。



```
(base) pengbo@pengbo-ThinkPad-P50: ~/VIO/assignments/PA1$ ./build/exercise
Update with quaterniond: R =
-0.65519  0.48618 -0.579236
 0.683532 0.707974 -0.178219
 0.323527 -0.512452 -0.796229
Update with SO3: R =
-0.654608 0.486011 -0.579035
 0.683295 0.708073 -0.178156
 0.323414 -0.512275 -0.795599
(base) pengbo@pengbo-ThinkPad-P50: ~/VIO/assignments/PA1$
```

Figure 1: 更新旋转

3. (a)

$$\begin{aligned}
\frac{dR^{-1}p}{dR} &= \lim_{\varphi \rightarrow 0} \frac{(R \exp \{\varphi^\wedge\})^{-1}p - R^{-1}p}{\varphi} \\
&= \lim_{\varphi \rightarrow 0} \frac{\exp \{\varphi^\wedge\}^{-1}R^{-1}p - R^{-1}p}{\varphi} \\
&= \lim_{\varphi \rightarrow 0} \frac{\exp \{-\varphi^\wedge\}R^{-1}p - R^{-1}p}{\varphi} \\
&= \lim_{\varphi \rightarrow 0} \frac{(I - \varphi^\wedge)R^{-1}p - R^{-1}p}{\varphi} \\
&= \lim_{\varphi \rightarrow 0} \frac{-\varphi^\wedge R^{-1}p}{\varphi} \\
&= \lim_{\varphi \rightarrow 0} \frac{(R^{-1}p)^\wedge \varphi}{\varphi} \\
&= (R^{-1}p)^\wedge
\end{aligned} \tag{1}$$

(b)

$$\begin{aligned}
\frac{d \ln (R_1 R_2^{-1})^\vee}{dR_2} &= \lim_{\varphi \rightarrow 0} \frac{\ln (R_1 (R_2 \exp \{\varphi^\wedge\})^{-1})^\vee - \ln (R_1 R_2^{-1})^\vee}{\varphi} \\
&= \lim_{\varphi \rightarrow 0} \frac{\ln (R_1 \exp \{\varphi^\wedge\}^{-1} R_2^{-1})^\vee - \ln (R_1 R_2^{-1})^\vee}{\varphi} \\
&= \lim_{\varphi \rightarrow 0} \frac{\ln (R_1 \exp \{-\varphi^\wedge\} R_2^T)^\vee - \ln (R_1 R_2^{-1})^\vee}{\varphi} \\
&= \lim_{\varphi \rightarrow 0} \frac{\ln (R_1 R_2^T \exp \{-(R_2 \varphi)^\wedge\})^\vee - \ln (R_1 R_2^{-1})^\vee}{\varphi} \\
&= -J_r^{-1}(\ln (R_1 R_2^{-1})^\vee) R_2
\end{aligned} \tag{2}$$