HW7

August 19, 2019

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Green line for ground truth trajectory, while red line for estimated trajectory.

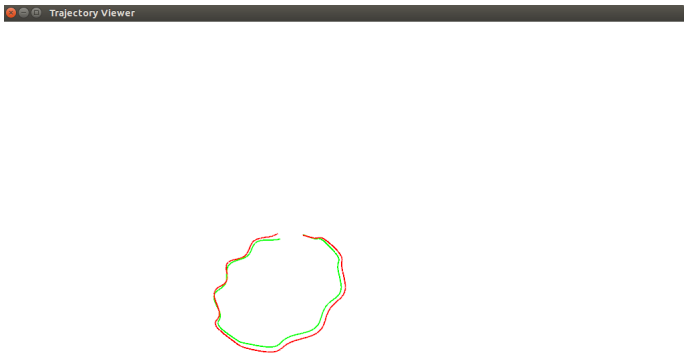

Figure 1: Ground truth trajectory vs estimated trajectory without noise

RMSE = 1.42145

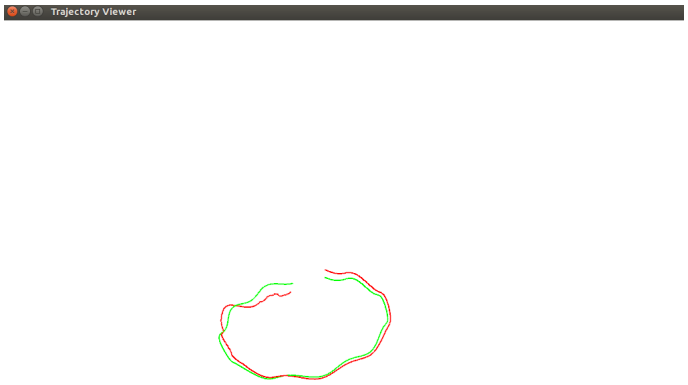

Figure 2: Ground truth trajectory vs estimated trajectory with noise

RMSE = 1.60324

```
// noise
double gyro_bias_sigma = 1.0e-5;
double acc_bias_sigma = 0.0001;

double gyro_noise_sigma = 0.015;    // rad/s
double acc_noise_sigma = 0.019;      //  m/(s^2)

double pixel_noise = 1;              // 1 pixel noise
```

Figure 3: Set IMU noise

According to the result, at the beginning of the system, the estimated trajectory is not able to perfectly align with the ground truth trajectory because of the error. However, with more data inputted into the system, the vins system is able to find a accurate estimation aligned with the ground truth.

If we set a smaller noise for IMU data, we will obtain a trajectory estimation that better aligned with the IMU ground truth trajectory.

RMSE = 0.27324

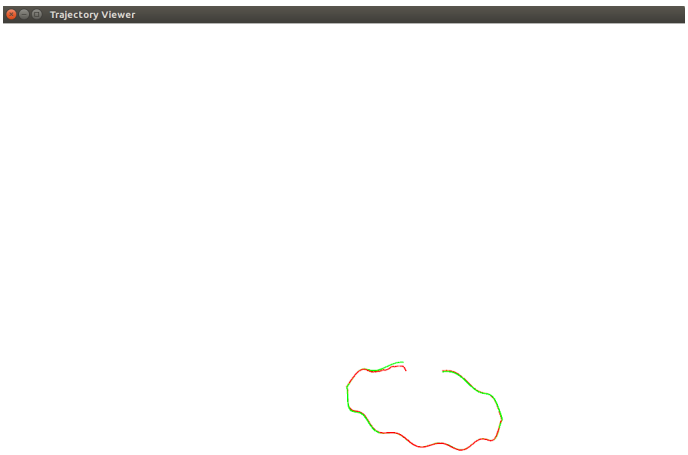

Figure 4: Ground truth trajectory vs estimated trajectory with noise

```
// noise
double gyro_bias_sigma = 1.0e-5;
double acc_bias_sigma = 0.0001;

double gyro_noise_sigma = 0.0015;    // rad/s
double acc_noise_sigma = 0.0019;      //  m/(s^2)

double pixel_noise = 1;              // 1 pixel noise
```

Figure 5: Set IMU noise

As we can observe from the experiment, higher IMU noise results in higher co-variance in IMU estimation. Then, the information matrix is smaller than the one with lower noise. The estimation process tends to rely on the visual data instead of IMU data. Therefore, the estimated trajectory with smaller noise is better aligned with the ground truth trajectory compared with the one with higher noise.

Furthermore, with these settings of noise, we can also modify the IMU data noise within the $comfig$ file to see the effect of noise.

The experiment is done under the settings of noise

```
// noise
double gyro_bias_sigma = 1.0e-5;
double acc_bias_sigma = 0.0001;

double gyro_noise_sigma = 0.015;    // rad/s
double acc_noise_sigma = 0.019;      //  m/(s^2)

double pixel_noise = 1;              // 1 pixel noise
```

Figure 6: Set IMU noise

As illustrated above, the accuracy for setting the noise exactly as the noise supposed to be is RMSE = 1.60324.

If we set a smaller noise than the noise supposed to be, RMSE = 1.81218.

Figure 7: Set smaller IMU noise

If we set a little bit larger noise, RMSE = 0.866718

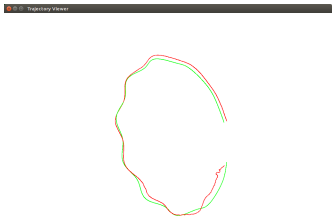

Figure 8: Set larger IMU noise

As a result, we may add some more noise (by setting the 'conf' file) to the *vins* system to capture the noise that added to the system.

PS:

IMU noise 设置大的时候， 轨迹与IMU ground truth 匹配度会降低

IMU noise 设置小的时候， 轨迹与IMU ground truth 匹配读高

因为IMU noise 影响了IMU数据的协方差 (和信息矩阵), 当IMU的协方差大(信息矩阵小), vins 系统会更加 rely on 视觉的估计, 此时就导致了 vins 系统估计出来的 trajectory 更偏向视觉的估计, 从而与IMU的 trajectory 相差较大。

补充:

已知当前的各项noise时（可从 calibration 得出)

当我们标定误差时， 我们通常假设传感器绝对静止来获取数据。

所以当物体运动或有外界因素如温度变化而产生干扰时，我们需要增加一定量的噪声模型参数 来捕获这些误差 从而得到最优解

如果我们直接从静态的数据去取值，可能会使系统过多地信任IMU的数据 从而得不到最优解。

2 Reference:

https://www.cnblogs.com/feifanrensheng/p/10654132.html