深蓝学院
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第十六章：VINS 系统构建
作业思路提示

主讲人 Horizon

作业内容

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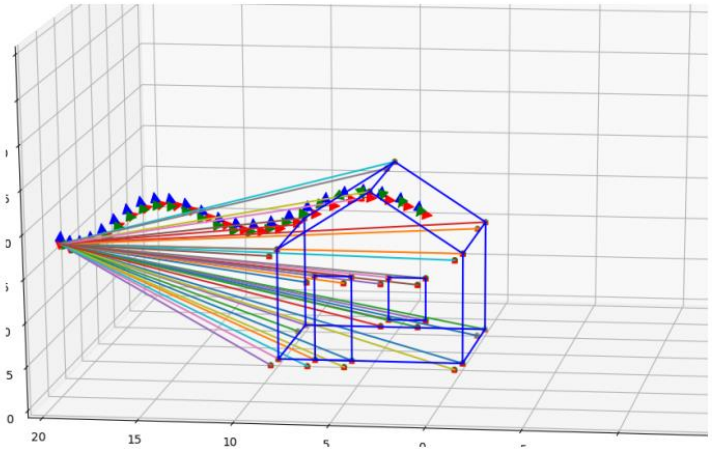
作业

1. 将第二讲的仿真数据集（视觉特征，imu 数据）接入我们的 VINS 代码，并运行出轨迹结果。
   - 仿真数据集无噪声
   - 仿真数据集有噪声（不同噪声设定时，需要配置 vins 中 imu noise 大小。）



源码结构简述

源码主要有三个线程：

IMU：读取 IMU 数据

Tracking：读取 Image 数据，光流追踪特征点并补充检测特征点

Estimator：后端紧耦合 VIO 优化

实现思路简述

所需要用到的来自于手写 VIO 第二讲的仿真数据：

imu_pose.txt：带时间戳的无噪声的 IMU 数据

imu_pose_noise.txt：带时间戳的有噪声的 IMU 数据

cam_pose.txt：带时间戳的相机位姿

all_points.txt：所有特征点的全局位置

all_points_xx.txt：所有特征点在对应相机归一化平面的投影坐标

源码修改 —— IMU 读取

修改 test/run_euroc.cpp 中的 void PubImuData() 函数。

此函数的功能是从 Euroc 数据集的 imu 文件中读取数据。

需要修改为读取手写 VIO 课程第二讲中给出的 txt 文件中的数据。

源码修改——IMU 读取

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```
void PubImuData()
{
    string sImu_data_file = sConfig_path + "MH_05_imu0.txt";
    cout << "1 PubImuData start sImu_data_filea: " << sImu_data_file << endl;
    ifstream fsImu;
    fsImu.open(sImu_data_file.c_str());
    if (!fsImu.is_open())
    {
        cerr << "Failed to open imu file! " << sImu_data_file << endl;
        return;
    }
    std::string sImu_line;
    double dStampNSec = 0.0;
    Vector3d vAcc;
    Vector3d vGyr;
    while (std::getline(fsImu, sImu_line) && !sImu_line.empty()) // read imu data
    {
        std::istringstream ssImuData(sImu_line);
        ssImuData >> dStampNSec >> vGyr.x() >> vGyr.y() >> vGyr.z() >> vAcc.x() >> vAc
        // cout << "Imu t: " << fixed << dStampNSec << " gyr: " << vGyr.transpose() <<
        pSystem->PubImuData(dStampNSec / 1e9, vGyr, vAcc);
        usleep(5000*nDelayTimes);
    }
```

```
void PubImuData()
{
    string sImu_data_file = sConfig_path + "imu_pose.txt";
    cout << "1 PubImuData start sImu_data_filea: " << sImu_data_file << endl;
    ifstream fsImu;
    fsImu.open(sImu_data_file.c_str());
    if (!fsImu.is_open())
    {
        cerr << "Failed to open imu file! " << sImu_data_file << endl;
        return;
    }
    std::string sImu_line;
    double dStampNSec = 0.0;
    Vector3d vAcc;
    Vector3d vGyr;
    while (std::getline(fsImu, sImu_line) && !sImu_line.empty()) // read imu data
    {
        std::istringstream ssImuData(sImu_line);
        ssImuData >> dStampNSec;
        double tmp;
        for(int i = 0; i < 7 ; i++)
        {
            ssImuData >> tmp;
        }
        ssImuData >> vGyr.x() >> vGyr.y() >> vGyr.z() >> vAcc.x() >> vAcc.y() >> vAcc
        // cout << "Imu t: " << fixed << dStampNSec << " gyr: " << vGyr.transpose() <
        pSystem->PubImuData(dStampNSec, vGyr, vAcc);
        usleep(5000*nDelayTimes);
    }
```

源码修改——图像输入

修改 test/run_euroc.cpp 中的 void PubImageData() 函数。

此函数的功能是从 Euroc 数据集的图片文件中读取数据，再通过 pSystem->PubImageData() 方法提取和跟踪特征点。

需要修改为直接读取 txt 格式的特征点归一化平面坐标，交付给 pSystem->PubImageData() 方法，因此进一步要求对 void PubImageData() 函数进行重载，满足 std::vector<cv::Point2f> 形参输入。

源码修改——图像输入

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```
void PubImageData()
{
    string sImage_file = sConfig_path + "MH_05_cam0.txt";
    cout << "1 PubImageData start sImage_file: " << sImage_file << endl;

    ⋮

        Mat img = imread(imagePath.c_str(), 0);
        if (img.empty())

        {
            cerr << "image is empty! path: " << imagePath << endl;

            return;

        }
        pSystem->PubImageData(dStampNSec / 1e9, img);
```

```
void PubImageData()
{
    string sImage_file = sConfig_path + "cam_pose.txt";
    cout << "1 PubImageData start sImage_file: " << sImage_file << endl;

    ⋮

        //Mat img = imread(imagePath.c_str(), 0);
        //if (img.empty())
        //  cerr << "image is empty! path: " << imagePath << endl;
        //  return;
        //}
        vector<cv::Point2f> FeaturePoints;
        std::ifstream f;
        f.open(imagePath);
        while(!f.eof())
        {
            std::string s;
            std::getline(f,s);
            if(!s.empty())
            {
            std:: stringstream ss;
            ss << s;
            double tmp;
            for(int i = 0; i < 4; i++)
            {
                ss>>tmp;
            }
            float px, py;
            ss >> px;
            ss >> py;
            cv::Point2f pt(px, py);
            cout << "cx cy "<< px << py << endl;
            FeaturePoints.push_back(pt);
            }
        }
        //f.close();
        //pSystem->PubImageData(dStampNSec / 1e9, img);
        pSystem->PubImageData(dStampNSec, FeaturePoints);
```

源码修改——图像处理

修改 test/System.cpp 中的 void PubImageData(double …) 函数。

此函数的功能是调用特征点追踪器 trackData[0].readImage() 方法来实现对图像特征点的光流追踪、筛选、去畸变、补充检测等操作。

因为在这之前，我们输入的就已经是特征点了，所以不需要再调用特征点追踪器，而只需要将结果直接交给下一步就行。光流速度可以始终设置为零，也可以根据相同 ID 的特征点的前后归一化平面坐标差来决定。

源码修改——图像处理

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```
void System::PubImageData(double dStampSec, Mat &img)
{
    if (!init_feature)
    {
        cout << "1 PubImageData skip the first detected feature, which doesn't contain
    ⋮
    if (PUB_THIS_FRAME)
    {
        pub_count++;
        shared_ptr<IMG_MSG> feature_points(new IMG_MSG());
        feature_points->header = dStampSec;
        vector<set<int>> hash_ids(NUM_OF_CAM);
        for (int i = 0; i < NUM_OF_CAM; i++)
        {
            auto &un_pts = trackerData[i].cur_un_pts;
            auto &cur_pts = trackerData[i].cur_pts;
            auto &ids = trackerData[i].ids;
            auto &pts_velocity = trackerData[i].pts_velocity;
            for (unsigned int j = 0; j < ids.size(); j++)
            {
                if (trackerData[i].track_cnt[j] > 1)
                {
                    int p_id = ids[j];
                    hash_ids[i].insert(p_id);
                    double x = un_pts[j].x;
                    double y = un_pts[j].y;
                    double z = 1;
                    feature_points->points.push_back(Vector3d(x, y, z));
                    feature_points->id_of_point.push_back(p_id * NUM_OF_CAM + i);
                    feature_points->u_of_point.push_back(cur_pts[j].x);
                    feature_points->v_of_point.push_back(cur_pts[j].y);
                    feature_points->velocity_x_of_point.push_back(pts_velocity[j].x);
                    feature_points->velocity_y_of_point.push_back(pts_velocity[j].y);
                }
            }
        }
```

```
void System::PubImageData(double dStampSec, const vector<cv::Point2f> &FeaturePoints)
{
    if (!init_feature)
    {
        cout << "1 PubImageData skip the first detected feature, which doesn't contai
    ⋮
    if (PUB_THIS_FRAME)
    {
        pub_count++;
        shared_ptr<IMG_MSG> feature_points(new IMG_MSG());
        feature_points->header = dStampSec;
        vector<set<int>> hash_ids(NUM_OF_CAM);
        for (int i = 0; i < NUM_OF_CAM; i++)
        {
            auto &un_pts = trackerData[i].cur_un_pts;
            auto &cur_pts = trackerData[i].cur_pts;
            auto &ids = trackerData[i].ids;
            auto &pts_velocity = trackerData[i].pts_velocity;
            for (unsigned int j = 0; j < FeaturePoints.size(); j++)
            {
                //if (trackerData[i].track_cnt[j] > 1)
                {
                    int p_id = j;
                    hash_ids[i].insert(p_id);
                    double x = FeaturePoints[j].x;
                    double y = FeaturePoints[j].y;
                    double z = 1;
                    feature_points->points.push_back(Vector3d(x, y, z));
                    feature_points->id_of_point.push_back(p_id * NUM_OF_CAM + i);
                    feature_points->u_of_point.push_back(460 * x + 255);
                    feature_points->v_of_point.push_back(460 * y + 255);
                    feature_points->velocity_x_of_point.push_back(0);
                    feature_points->velocity_y_of_point.push_back(0);
                }
            }
        }
```

源码修改——参数配置

修改 config/euroc_config.yaml 中相关参数。

此配置文件中设置了相机和 IMU 之间的相对位姿，以及 IMU 的四个噪声参数。这些参数需要和手写 VIO 第二讲中生成的数据集对应的配置参数保持一致。

需要修改参数，使之与第二讲中的数据集对应参数一致。

源码修改 —— 参数配置

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```
#If you choose 0 or 1, you should write down the following matrix.
#Rotation from camera frame to imu frame, imu^R_cam
extrinsicRotation: !!opencv-matrix
   rows: 3
   cols: 3
   dt: d
   data: [0.0148655429818, -0.999880929698, 0.00414029679422,
          0.999557249008, 0.0149672133247, 0.025715529948,
          -0.0257744366974, 0.00375618835797, 0.999660727178]
#Translation from camera frame to imu frame, imu^T_cam
extrinsicTranslation: !!opencv-matrix
   rows: 3
   cols: 1
   dt: d
   data: [-0.0216401454975,-0.064676986768, 0.00981073058949]
```

⋮

```
max_num_iterations: 8   # max solver itrations, to guarantee real time
keyframe_parallax: 10.0 # keyframe selection threshold (pixel)

#imu parameters       The more accurate parameters you provide, the better performance
acc_n: 0.08          # accelerometer measurement noise standard deviation. #0.2   0.04
gyr_n: 0.004         # gyroscope measurement noise standard deviation.     #0.05  0.00
acc_w: 0.00004         # accelerometer bias random work noise standard deviation.  #0.
gyr_w: 2.0e-6       # gyroscope bias random work noise standard deviation.     #4.0e-5
g_norm: 9.81007     # gravity magnitude
```

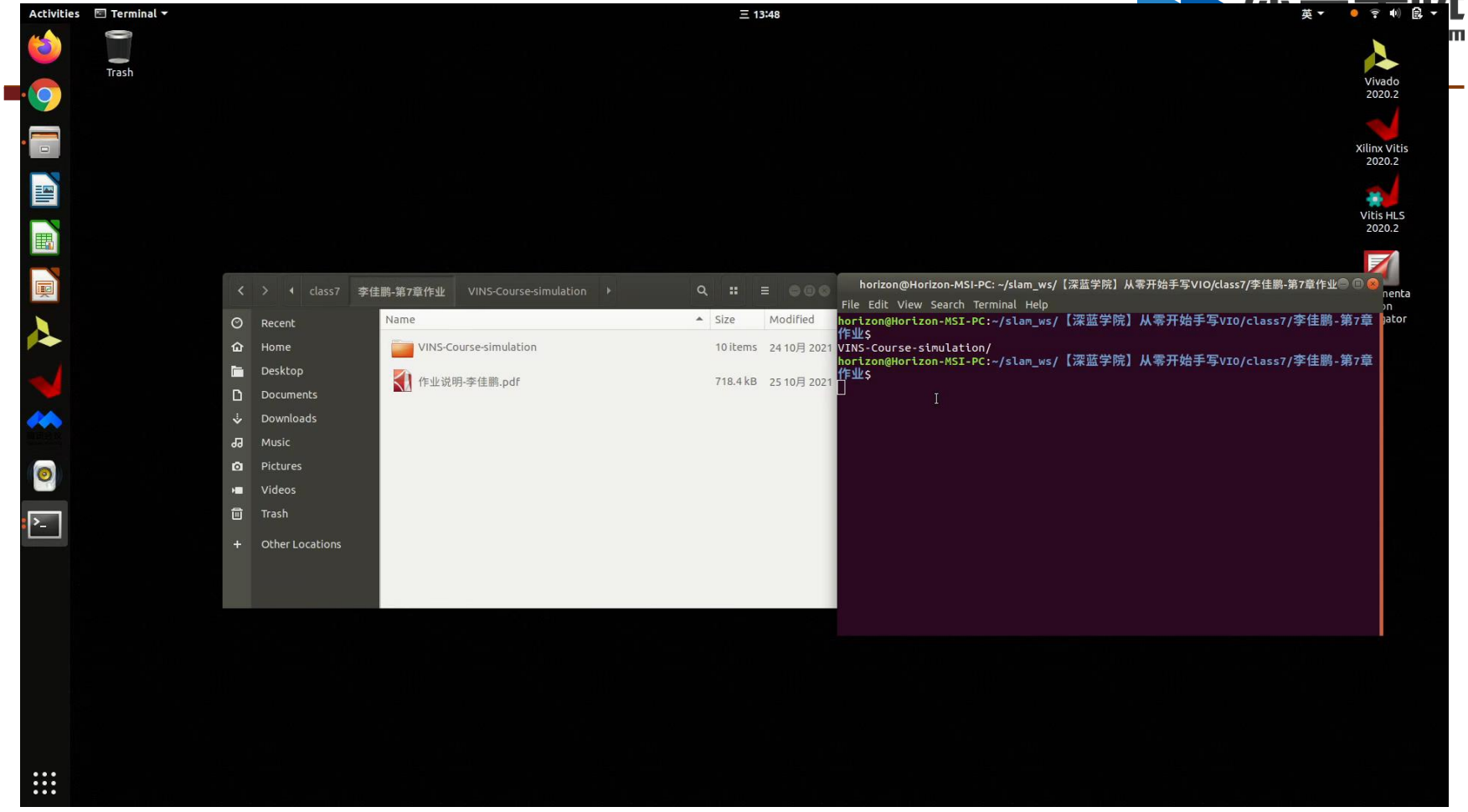
```
#If you choose 0 or 1, you should write down the following matrix.
#Rotation from camera frame to imu frame, imu^R_cam
extrinsicRotation: !!opencv-matrix
   rows: 3
   cols: 3
   dt: d
   data: [0, 0, -1,
          -1, 0, 0,
           0, 1, 0]
#Translation from camera frame to imu frame, imu^T_cam
extrinsicTranslation: !!opencv-matrix
   rows: 3
   cols: 1
   dt: d
   data: [-0.05,-0.04, 0.03]
```

⋮

```
max_num_iterations: 8   # max solver itrations, to guarantee real time
keyframe_parallax: 10.0 # keyframe selection threshold (pixel)

#imu parameters       The more accurate parameters you provide, the better performance
acc_n: 0.019          # accelerometer measurement noise standard deviation.  #0.2   0.0
gyr_n: 0.015         # gyroscope measurement noise standard deviation.     #0.05  0.00
acc_w: 0.0005         # accelerometer bias random work noise standard deviation.  #0.0
gyr_w: 5.0e-5       # gyroscope bias random work noise standard deviation.     #4.0e-5
g_norm: 9.81007     # gravity magnitude
```

作业效果演示


Activities
Terminal
13:48
英
Trash
Vivado 2020.2
Xilinx Vitis 2020.2
Vitis HLS 2020.2
class7
李佳鹏-第7章作业
VINS-Course-simulation
Recent
Home
Desktop
Documents
Downloads
Music
Pictures
Videos
Trash
Other Locations
Name
Size
Modified
VINS-Course-simulation
10 items
24 10月 2021
作业说明-李佳鹏.pdf
718.4 kB
25 10月 2021
horizon@Horizon-MSI-PC: ~/slam_ws/【深蓝学院】从零开始手写VIO/class7/李佳鹏-第7章作业
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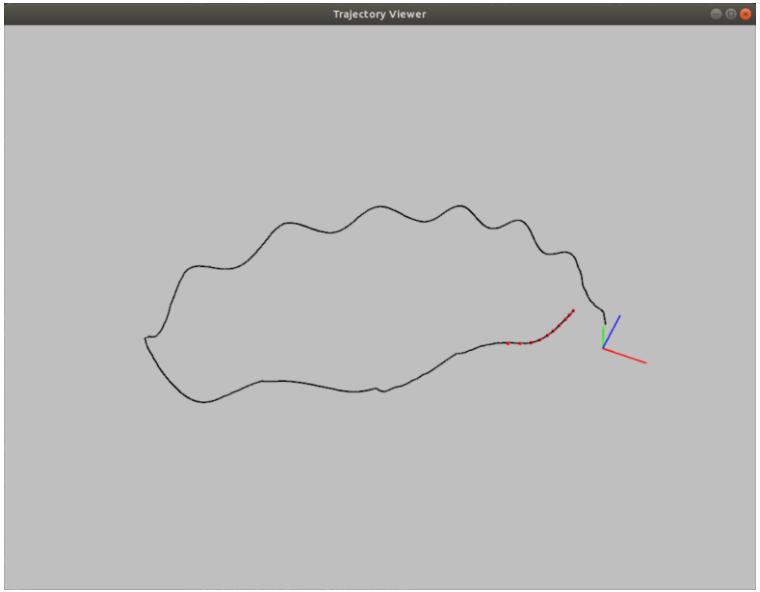
VINS-Course-simulation/
horizon@Horizon-MSI-PC:~/slam_ws/【深蓝学院】从零开始手写VIO/class7/李佳鹏-第7章作业$

作业效果演示

较小噪声



较大噪声

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感谢各位聆听！

Thanks for Listening