Monocular, software-synchronized, Camera-IMU Localization

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CS 491

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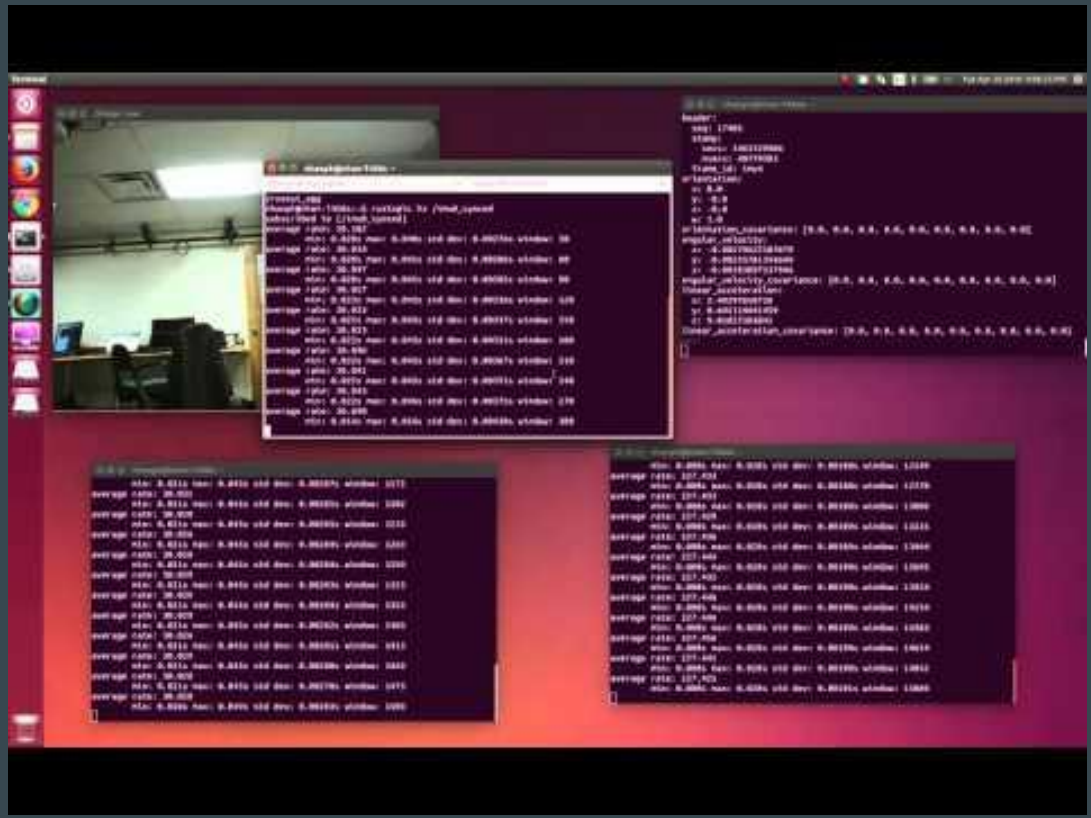
Team 4

Preparation

- Learned how to work with ROS for simulating data gathered by Cameras and IMUs
- Spent time researching rovio, which runs a SLAM algorithm on data collected by a camera and IMU
- From our research we learned that for rovio to work with our data the information gathered would need to be synchronized in some way.

Software Syncing Camera

- cam_imu_sync node
  - Subscribe:
    - /imu0 ~ 200 Hz
    - /image_raw ~ 30 - 60 Hz
  - Publish:
    - /imu0_synced ~ camera rate
    - /image_synced ~ original rate



Future

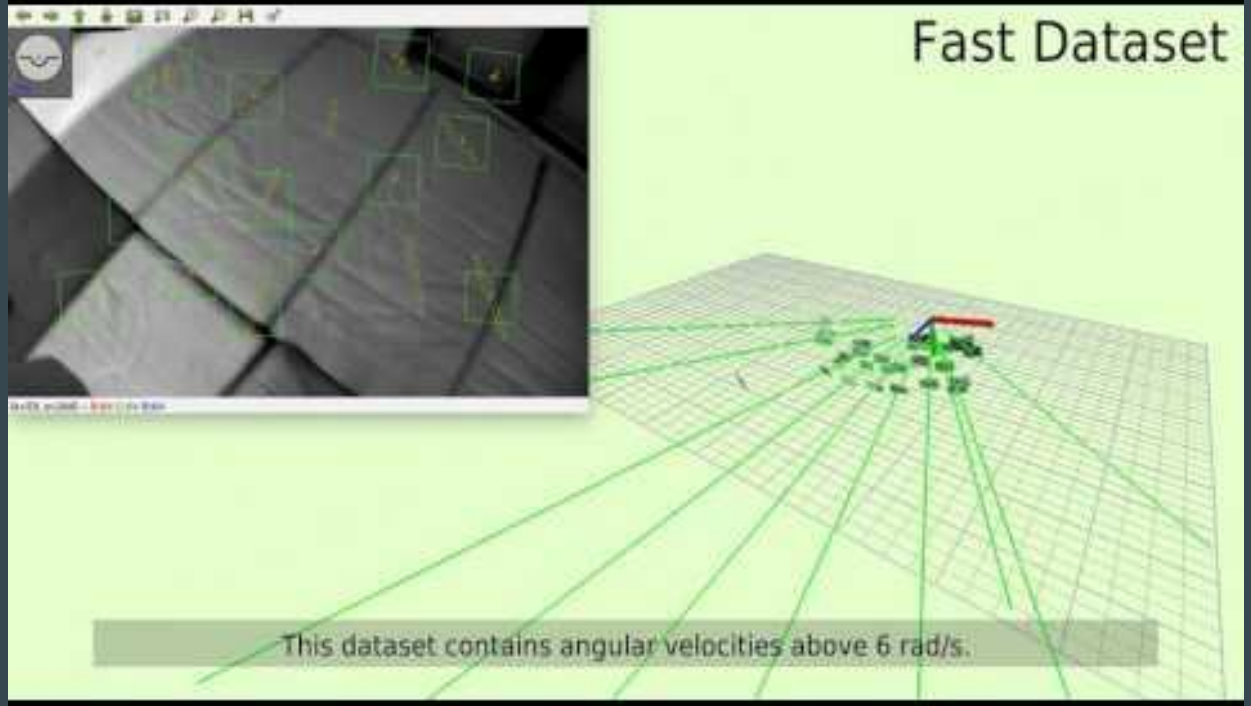
Camera and IMU Initialization Variables: These are used to set up the relation between the IMU and the Camera. This allows the IMU data to be proportioned correctly for localization and mapping.

Camera and IMU Covariance Initialization Variables: These are used to

```
Camera0
        {
        CalibrationFile ; Camera-Calibration file for intrinsics
        qCM_x -0.00666398307551; X-entry of IMU to Camera quaterion (JPL)
        qCM_y 0.0079168224269; Y-entry of IMU to Camera quaterion (JPL)
        qCM_z 0.701985972528; Z-entry of IMU to Camera quaterion (JPL)
        qCM_w 0.712115587266; W-entry of IMU to Camera quaterion (JPL)
        MrMC_x -0.0111674199187; X-entry of IMU to Camera vector (expressed in IMU CF) [m]
        MrMC_y -0.0574640920022; Y-entry of IMU to Camera vector (expressed in IMU CF) [m]
        MrMC_z 0.0207586947896; Z-entry of IMU to Camera vector (expressed in IMU CF) [m]
        }
```

```
Covariance
        {
        pos_0 0.0001; X-Covariance of initial position [m^2]
        pos_1 0.0001; Y-Covariance of initial position [m^2]
        pos_2 0.0001; Z-Covariance of initial position [m^2]
        vel_0 1.0; X-Covariance of initial velocity [m^2/s^2]
        vel_1 1.0; Y-Covariance of initial velocity [m^2/s^2]
        vel_2 1.0; Z-Covariance of initial velocity [m^2/s^2]
        acb_0 4e-4; X-Covariance of initial accelerometer bias [m^2/s^4]
        acb_1 4e-4; Y-Covariance of initial accelerometer bias [m^2/s^4]
        acb_2 4e-4; Z-Covariance of initial accelerometer bias [m^2/s^4]
        gyb_0 3e-4; X-Covariance of initial gyroscope bias [rad^2/s^2]
        gyb_1 3e-4; Y-Covariance of initial gyroscope bias [rad^2/s^2]
        gyb_2 3e-4; Z-Covariance of initial gyroscope bias [rad^2/s^2]
        vep 0.0001; Covariance of initial linear camera-IMU extrinsics, same for all entries
        [m^2]
        att_0 0.1; X-Covariance of initial attitude [rad^2]
        att_1 0.1; Y-Covariance of initial attitude [rad^2]
        att_2 0.1; Z-Covariance of initial attitude [rad^2]
        vea 0.01; Covariance of initial rotational camera-IMU extrinsics, same for all entries
        [rad^2]
        }
```

Fast Dataset



This dataset contains angular velocities above 6 rad/s.

Results

- A basic understanding of ROS
  - Subscribing
  - Topics
  - Rosbags
- A better grasp on how the concepts of localization and mapping work
  - All about the timing
  - Camera Initialization Variables
  - Covariances Variables

- Now we know what software synchronizing easily achievable, but takes exhaustive testing to refine