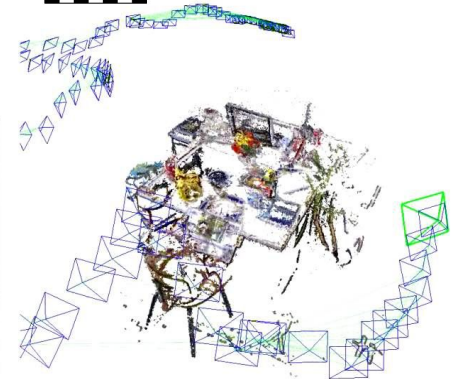
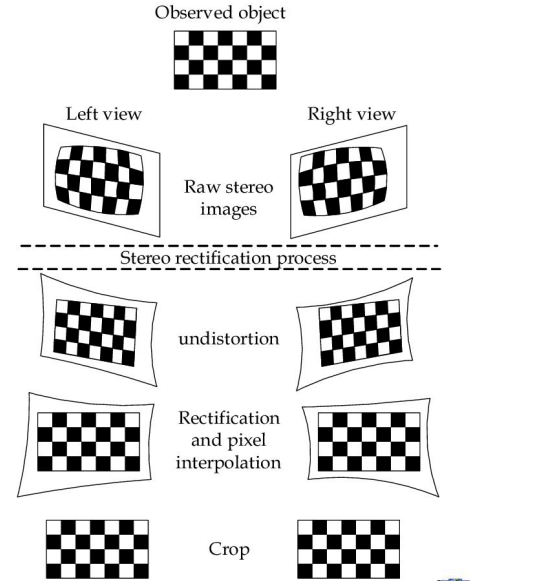
An abstract background featuring a collage of colorful, textured rectangular blocks in shades of blue, green, yellow, and red. A yellow ladder is visible on the right side, leaning against the blocks. The overall effect is a vibrant, pixelated or mosaic-like pattern.

EECE5554 Robotics Sensing and Navigation Final Project Presentation - Visual SLAM

Group 8: Yao Zhou, Shuchong Wang, Zhiyu Zhu, Tianrun Yan, Qiming Huang

Overview

- Motivation and problem statement
- Brief introduction to ORB-SLAM algorithm
- ORB-SLAM installation and configuration
- Error encounter while installing the ORB-SLAM
- Public dataset EuRoC
- Result
- Analysis
- Conclusion
- Future work for us until the deadline

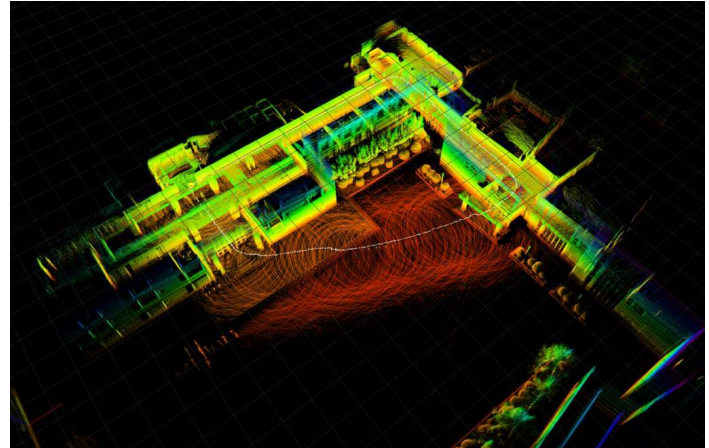


Motivation

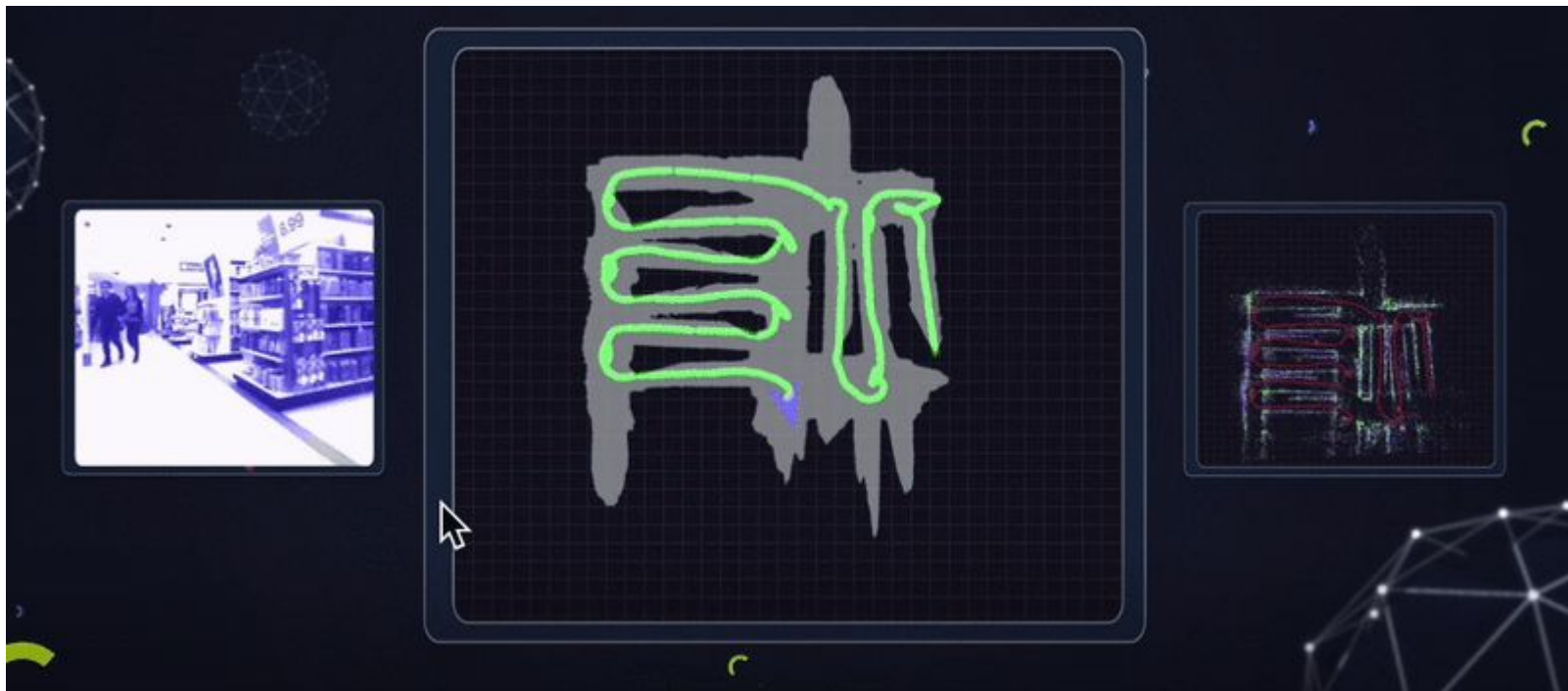


- Covid-19 or other disease.

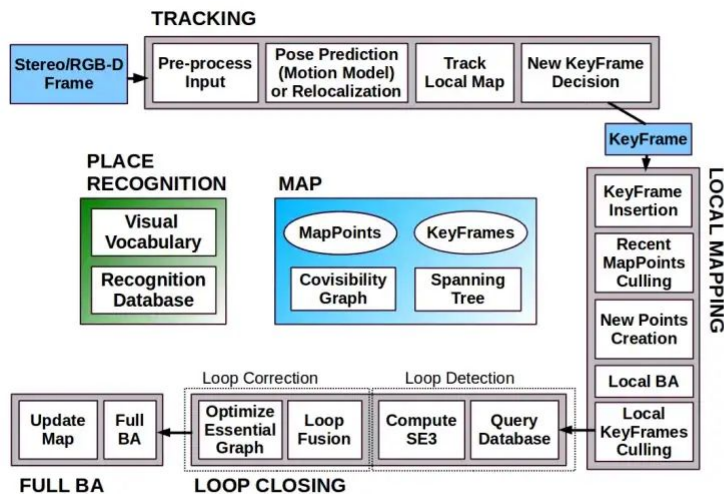
Avoiding intensive contact.



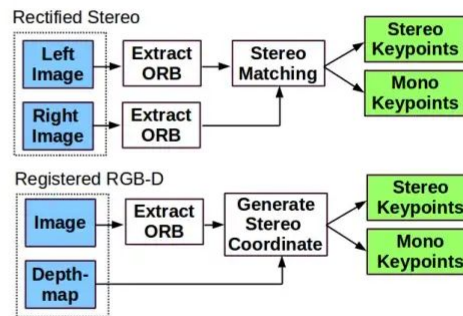
Example:



Brief Introduction to ORB-SLAM

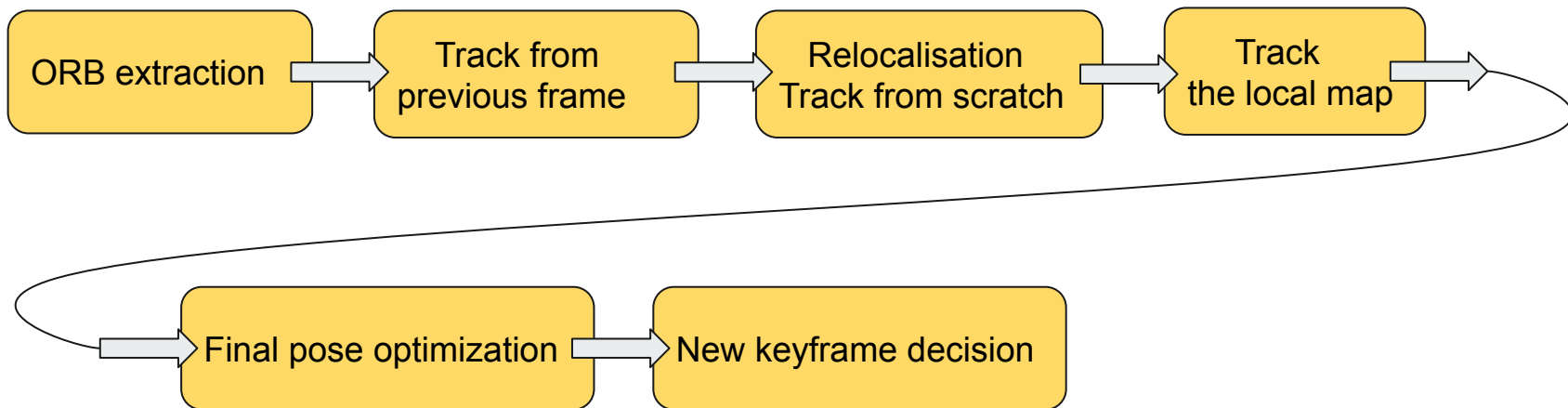


(a) System Threads and Modules.



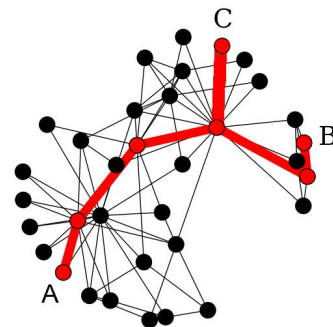
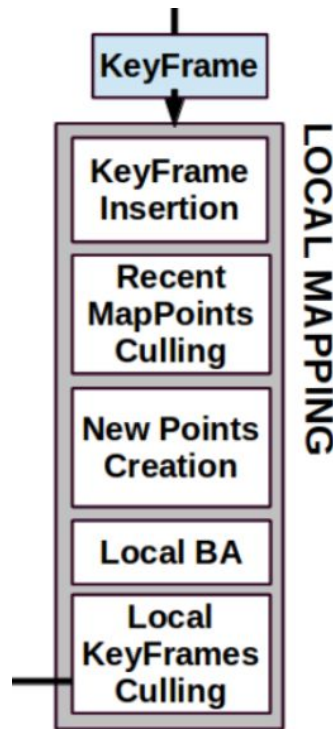
(b) Input pre-processing

Tracking

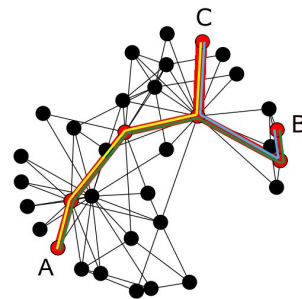


Local Mapping

Save the coordinates of the keyframes, but not every coordinate of the environment objects in a system were collected. In stead, the points are collected in every 10 - 20 frames.

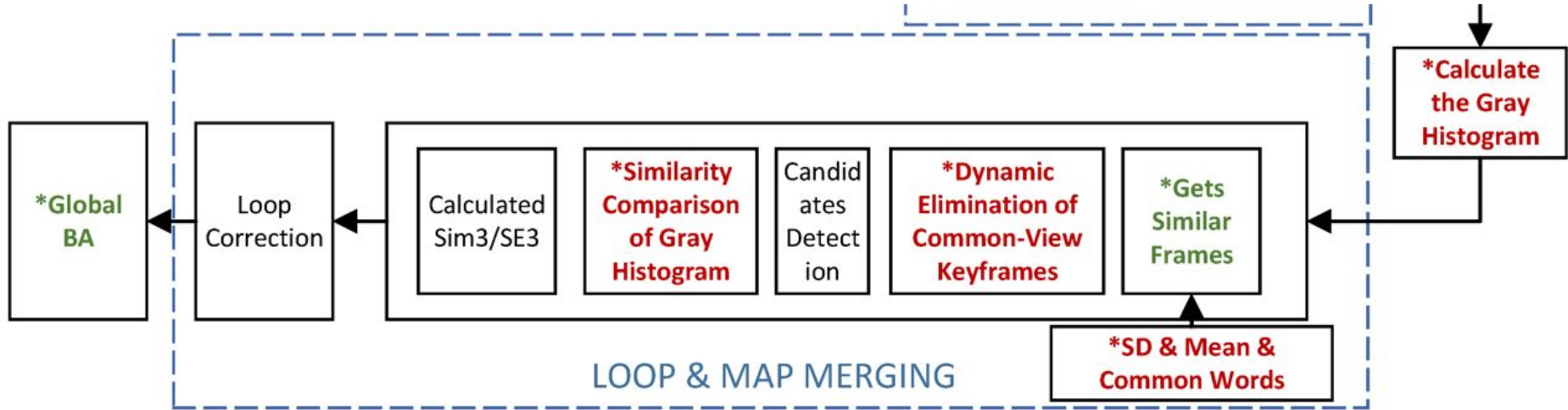


Intersection of paths



A successful merging of maps moving alongside a path

Loop Closing





Software and Library Requirements

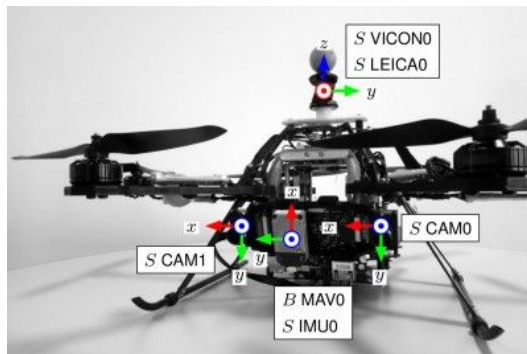
- Ubuntu 18.04
- OpenCV 4.4.0
- Pangolin
- ORB-SLAM3
- Matplotlib
- Numpy

Dataset we used - EuRoC

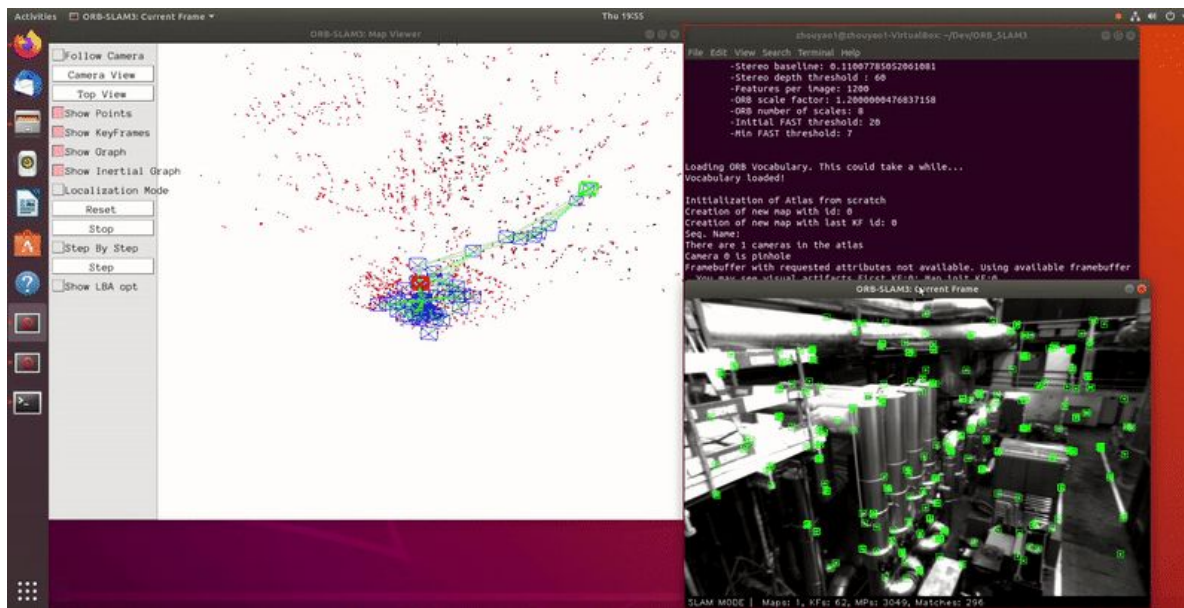
- A visual-inertial datasets collected on-board a Micro Aerial Vehicle (MAV).
- Contains stereo images, synchronized IMU measurements, accurate motion and structure ground-truth.
- Recorded with two pinhole cameras and an inertial sensor.

Available Data

Visual-Inertial Sensor Unit
Ground-Truth
Calibration



EuRoC Dataset Demo

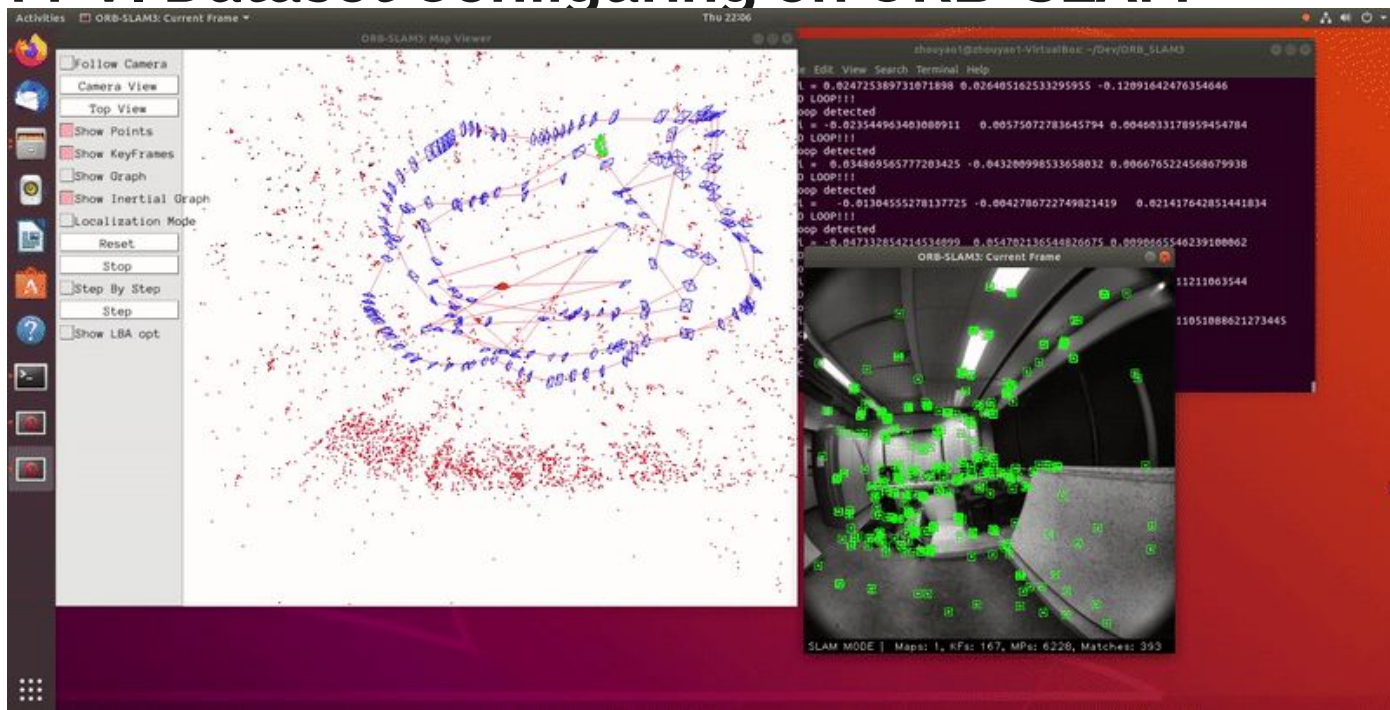




TUM Dataset

- An RGB-D dataset.
- Contains color and depth images of a Microsoft Kinect sensor along the ground-truth trajectory of the sensor.
- Was recorded with two fisheye cameras and an inertial sensor.

TUM-VI Dataset Configuring on ORB-SLAM



Error Encountered while Installing ORB-SLAM

1. 'slots_reference' was not declared in this scope

```
var(const T&, const pangolin::VarMeta&) [with T = bool]
/usr/local/include/pangolin/var/var.h:88:35:   required from 'pangolin::Var<T>::
Var(const string&, const T&) [with T = bool; std::string = std::__cxx11::basic_s
tring<char>]
/usr/local/include/pangolin/display/widgets.h:153:50:   required from here
/usr/local/include/signal/signal.hpp:1180:65: error: 'slots_reference' was not
declared in this scope
1180 |         cow_copy_type<list_type, Lockable> ref = slots_reference();
      |
```

Compiling error using C++11

-- sed -i 's/++11/++14/g' CMakeLists.txt

Error Encountered while Installing ORB-SLAM

1. collect2: error: ld returned 1 exit status
2. CMakeFiles/ORB_SLAM.dir/build.make:1587: recipe for target './bin/ORB_SLAM' failed
3. make[2]: *** [./bin/ORB_SLAM] Error 1
4. CMakeFiles/Makefile2:419: recipe for target 'CMakeFiles/ORB_SLAM.dir/all' failed
5. make[1]: *** [CMakeFiles/ORB_SLAM.dir/all] Error 2
6. Makefile:129: recipe for target 'all' failed
7. make: *** [all] Error 2

1. - sudo apt-get install libglew-dev libboost-all-dev libssl-dev
2. Change CMakeList.txt under ORB_SLAM3 root, and

```
1 target_link_libraries(${PROJECT_NAME}
2   ${OpenCV_LIBS}
3   ${EIGEN3_LIBS}
4   ${PROJECT_SOURCE_DIR}/Thirdparty/DBow2/lib/libDBow2.so
5   ${PROJECT_SOURCE_DIR}/Thirdparty/g2o/lib/libg2o.so
6 )
```

```
1 target_link_libraries(${PROJECT_NAME}
2   ${OpenCV_LIBS}
3   ${EIGEN3_LIBS}
4   ${PROJECT_SOURCE_DIR}/Thirdparty/DBow2/lib/libDBow2.so
5   ${PROJECT_SOURCE_DIR}/Thirdparty/g2o/lib/libg2o.so
6   -lboost_system
7 )
```

Error Encountered while Installing ORB-SLAM

The function is not implemented. Rebuild the library with [...] GTK+ 2.x [...] support. If you are on Ubuntu or Debian, install libgtk2.0-dev and pkg-config, then re-run cmake or configure script If you are not using Ubuntu or Debian

```
File Edit View Search Terminal Help
Loading ORB Vocabulary. This could take a while...
Vocabulary loaded!

Initialization of Atlas from scratch
Creation of new map with id: 0
Creation of new map with last KF id: 0
Seq. Name:
There are 1 cameras in the atlas
Camera 0 is pinhole
Framebuffer with requested attributes not available. Using available framebuffer
. You may see visual artifacts. terminate called after throwing an instance of 'cv::Exception'
what():  OpenCV(4.5.1) /home/zhouyao1/opencv/modules/highgui/src/window.cpp:63:
4: error: (-2:Unspecified error) The function is not implemented. Rebuild the library with Windows, GTK+ 2.x or Cocoa support. If you are on Ubuntu or Debian, install libgtk2.0-dev and pkg-config, then re-run cmake or configure script in function 'cvNamedWindow'

Aborted (core dumped)
zhouyao1@zhouyao1-VirtualBox: ~/Dev/ORB_SLAM3$ cd
```

1. sudo apt-get install cmake git libgtk2.0-dev pkg-config
2. Re- install opencv
- git -C opencv checkout 4.4.0

OpenCV

We use [OpenCV](http://opencv.org) to manipulate images and features. Download and install instructions can be found at: <http://opencv.org>. Required at least 3.0. Tested with OpenCV 3.2.0 and 4.4.0.



Milestone and Conclusion so far

- The ORB-SLAM3 has been successfully installed and configured.
- In the demo video, the datasets are successfully loaded into the algorithm.
- The algorithm did well in two public datasets, can see the loop closure.
- The algorithm can successfully read the interest points in the dataset and follow the trajectory.
- The ORB-SLAM3 algorithm shows the great performance on public datasets. It is also an outstanding open-source algorithm.



Future work

- **Our Progress**
 - EuRoC & Tum
- **Kitti Visual Odometry**
- **Self Camera**
- **On-device SLAM**

Future work - Kitti Dataset



- Founded by (KIT) Karlsruhe Institute of Technology and (TTIC) Toyota Technological Institute at Chicago
- Aimed for automatic pilot model training
- Contains 22 stereo sequences in png format, 11 of them has ground truth trajectories, 11 of them does not
- Scenes include urban, rural and highway areas
- Scenes are dynamic with occlusions and truncations



Future work - Camera Video

Calibration Tutorial for ORB-SLAM3 v1.0

Juan J. Gómez Rodríguez, Carlos Campos, Juan D. Tardós

December 22, 2021

- Using our own video for SLAM algorithm
- Camera calibration, follow the instructions of ORB-SLAM3 on github
- Convert our video into ROS bag format
- Compare results of indoor and outdoor



Future work - On-device SLAM

- Explore possibility and efficiency
- Install SLAM on mobile phone, sdk & app
- Could be really rough but really fun
- Applications include spatial orientation and AR



Reference

<https://paperswithcode.com/dataset/euroc-mav>

<https://projects.asl.ethz.ch/datasets/doku.php?id=kmavvisualinertialdatasets>

<https://paperswithcode.com/dataset/tum-rgb-d>

https://github.com/UZ-SLAMLab/ORB_SLAM3

https://github.com/shanpenghui/ORB_SLAM3_Fixed



Thank you

Any questions for us?