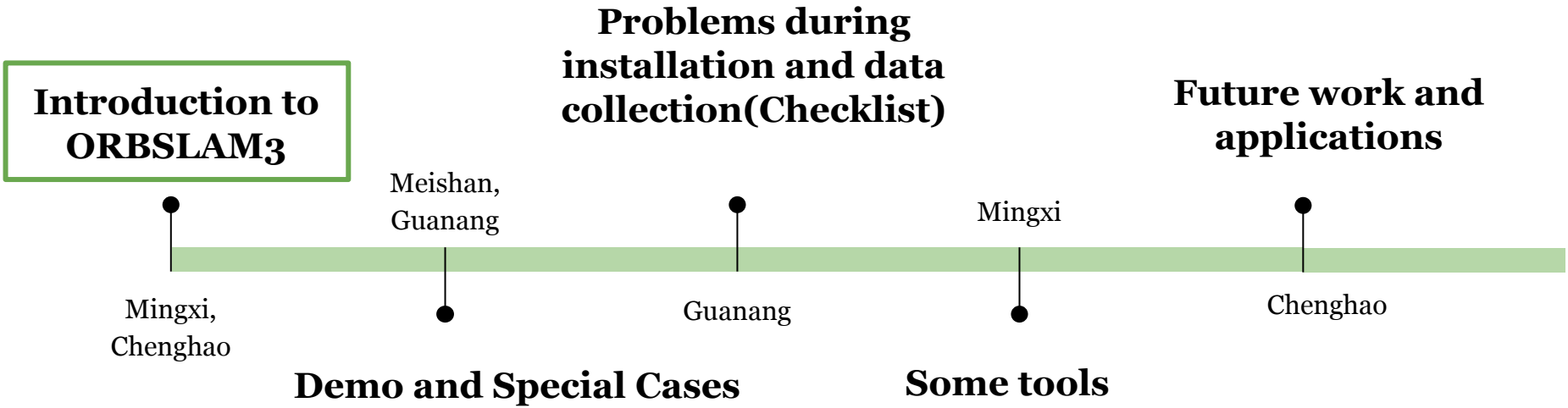
ORB-SLAM3

on iPhone

Team9: Guanang Su, Meishan Li,
Mingxi Jia, Chenghao Wang

Topics


Introduction to ORBSLAM3
Mingxi, Chenghao
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Demo and Special Cases
Public dataset
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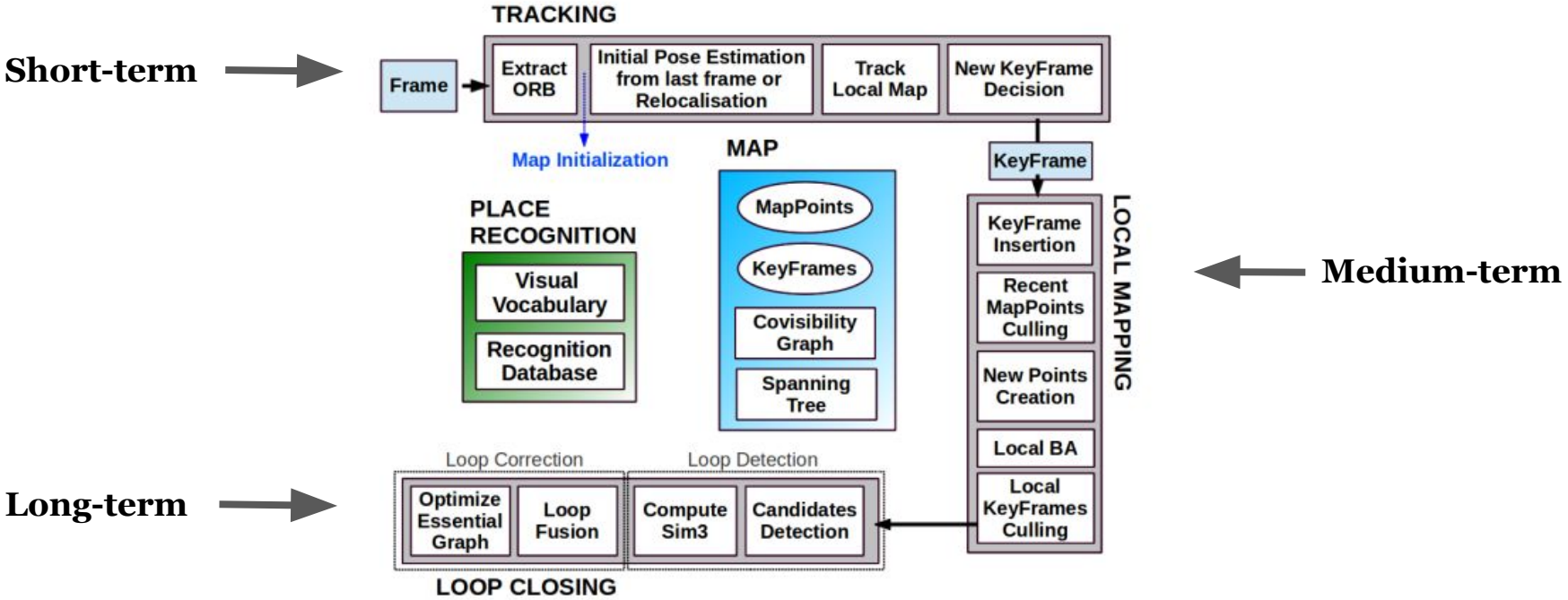
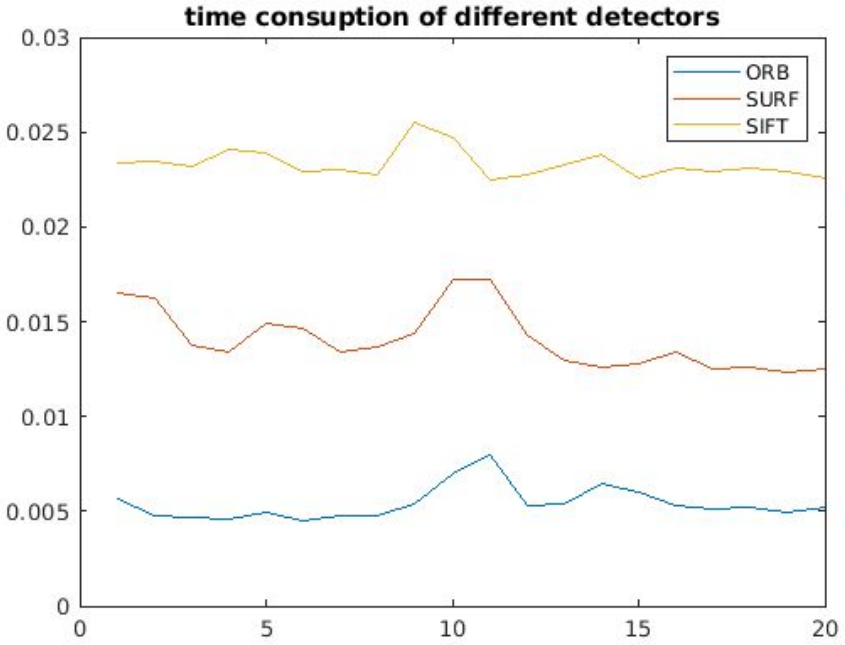
Guanang
Mingxi
Some tools
Future work and applications
Chenghao

Intro to ORB-SLAM3: **Overview**

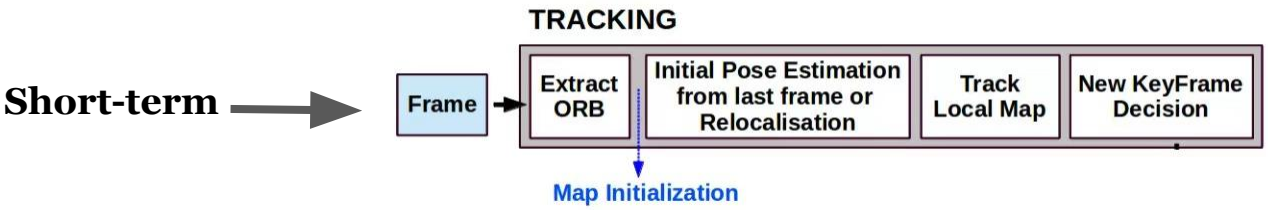


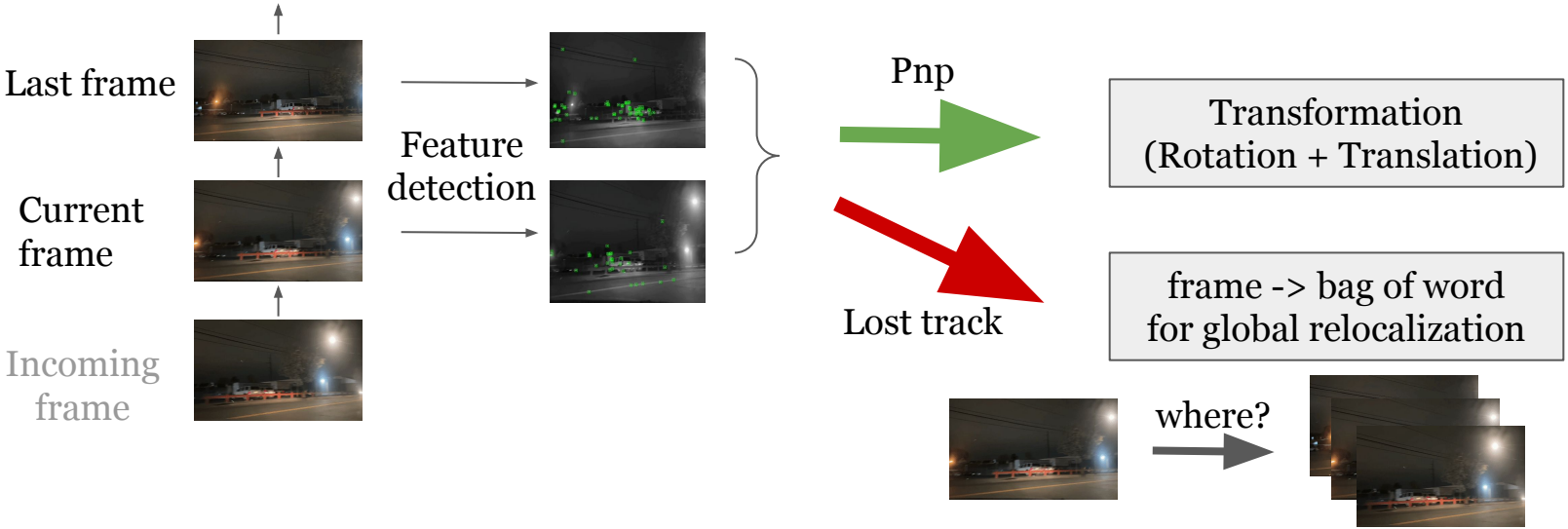
Why ORB feature

- Rotation invariant
  - Intensity Centroid
- Scale invariant
  - Scale pyramid
- Viewpoint and illumination invariance
  - FAST corner detector
- Fast!
  - Binary feature

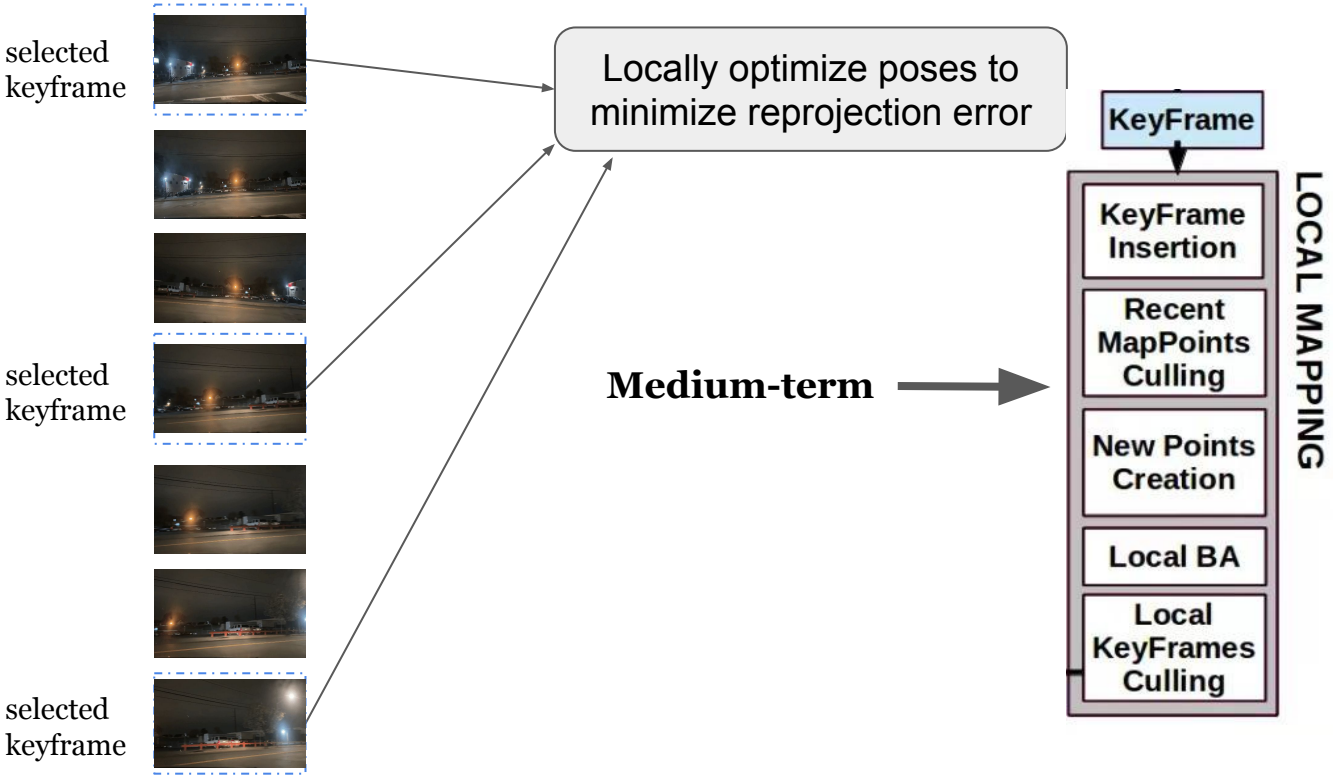


Intro to ORB-SLAM3: **Short-term**



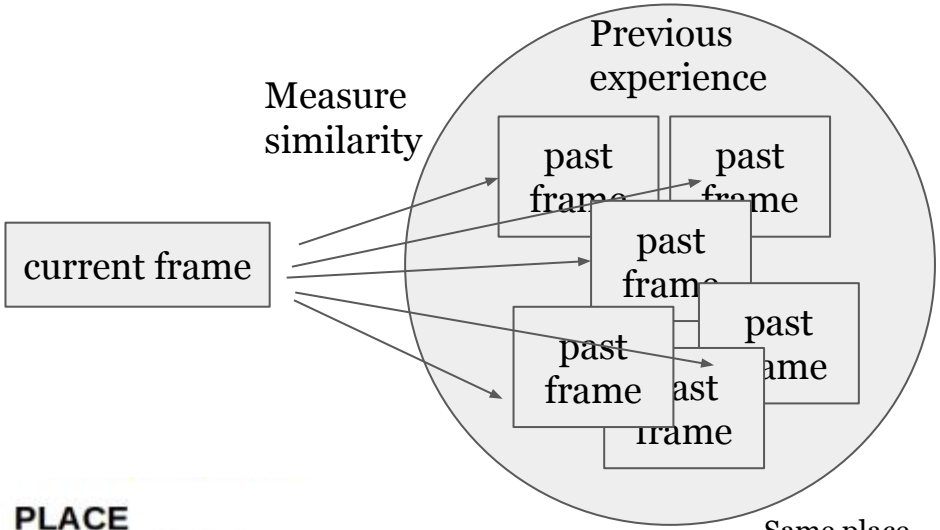


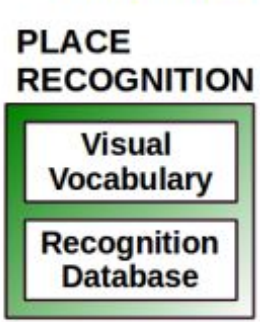
Intro to ORB-SLAM3: **Medium-term**

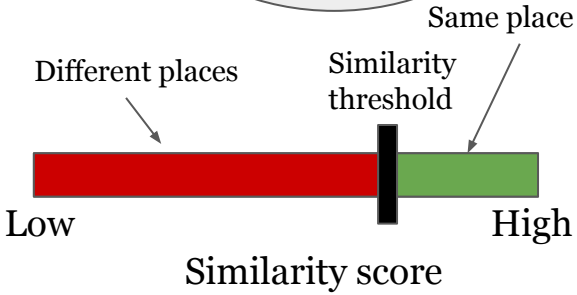


Intro to ORB-SLAM3: **Place recognition**

To perform loop detection and relocalization







Good!

Look similar and YES!

Confusing

Look similar but NO

Confusing

Look different but YES

Intro to ORB-SLAM3: **Long-term**

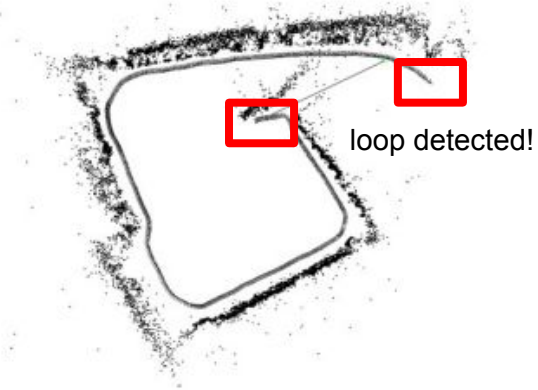
Global optimization

relative transformation error

$$\mathbf{e}_{rel}(i,j) = \mathrm{Log}_{\mathrm{SE}(3)}\left(\hat{\mathbf{T}}^{ij}_{\mathtt{CC}}\mathbf{T}^{j}_{\mathtt{CW}}\mathbf{T}^{i\,-1}_{\mathtt{CW}}\right)$$

pose graph optimization

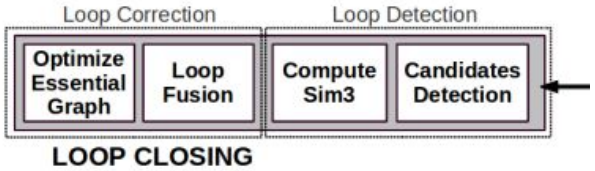
$$\mathrm{C} = \sum_{(i,j)\in\mathcal{X}} \rho\left(\|\mathbf{e}_{rel}(i,j)\|^2_{\mathbf{\Sigma}_{ij}}\right)$$



(a) before optimisation

(b) 6 DoF optimisation

Long-term →



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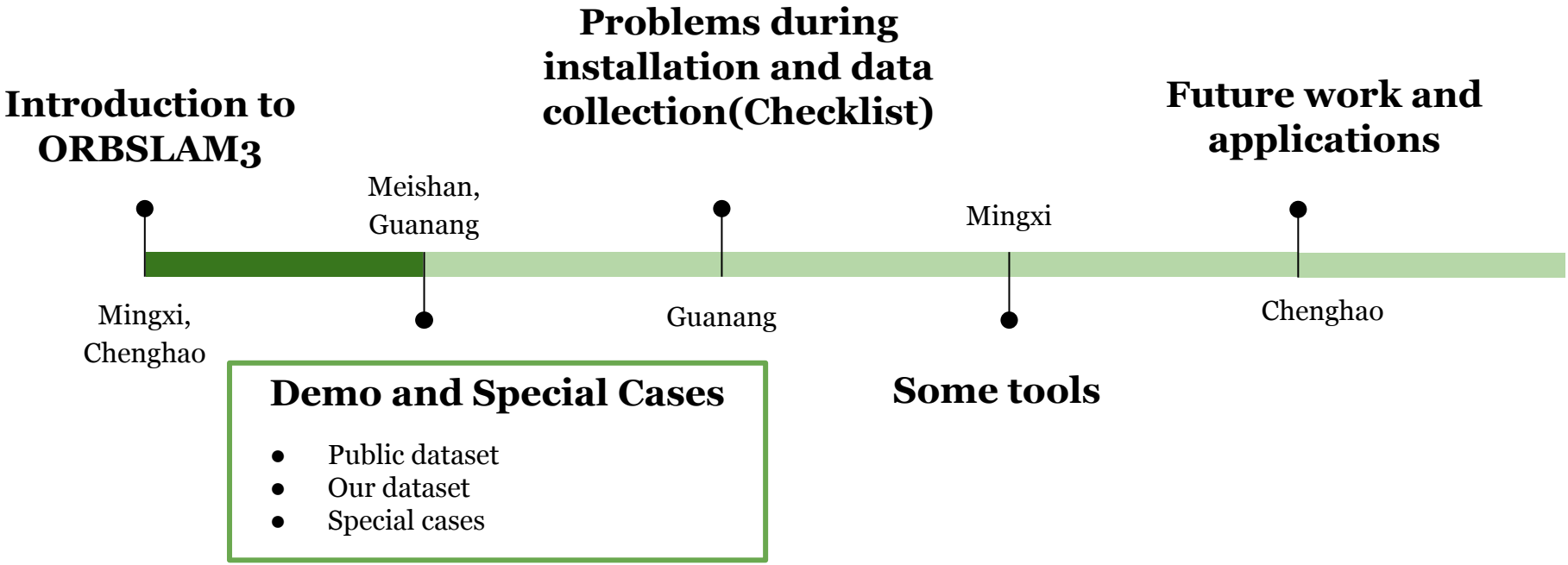
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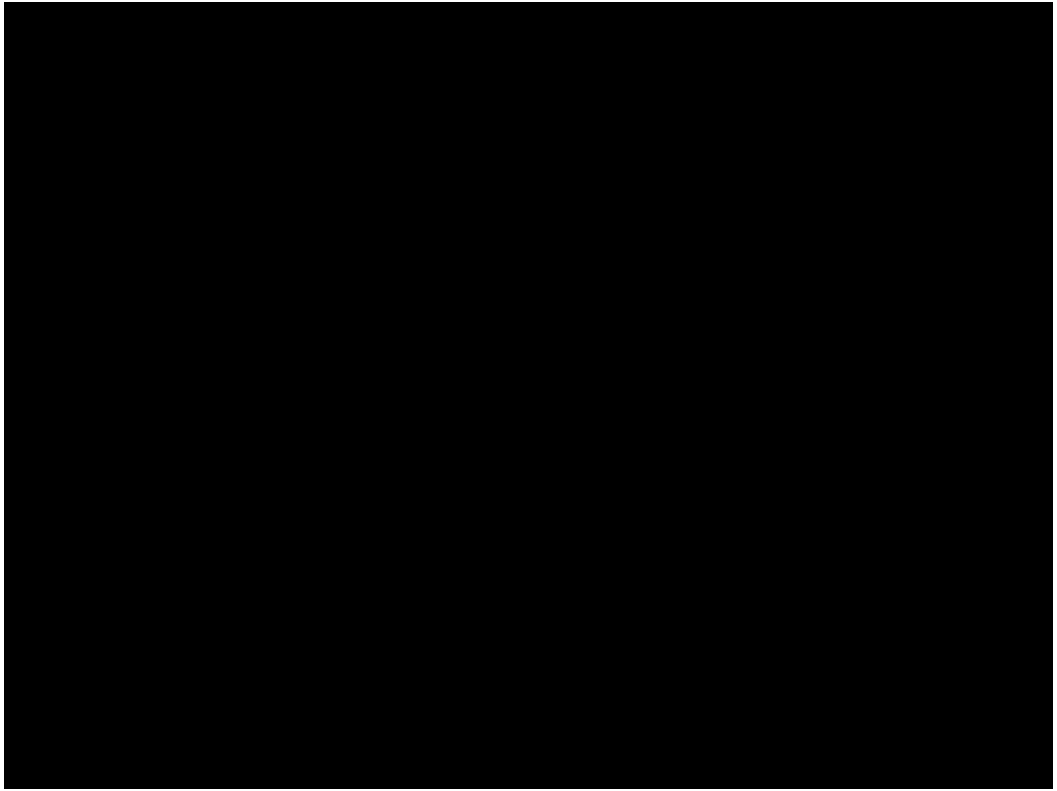
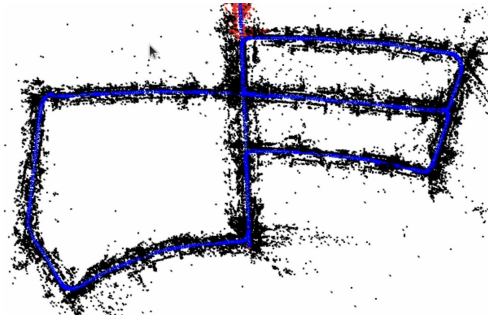
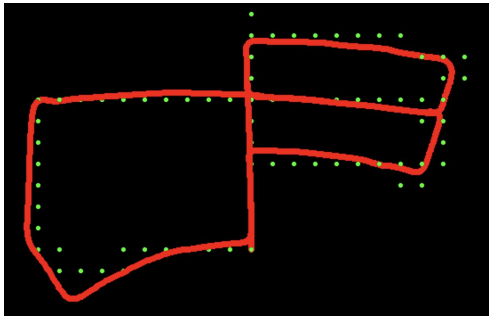
Experiments on public dataset (KITTI)



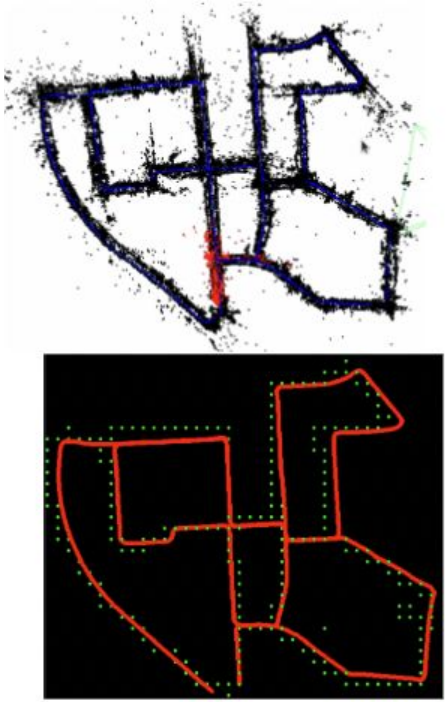
dataset 5





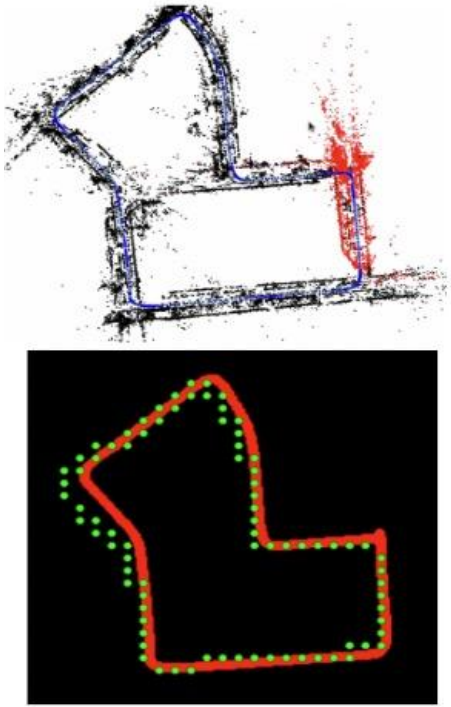
Experiments on public dataset (KITTI)

dataset 0



Red line:
ground truth
Green dot:
Orb slam3 Algo

dataset 7



Red line:
ground truth
Green dot:
Orb slam3 Algo

more details: https://github.com/xxs90/monoVO-python

Motivation

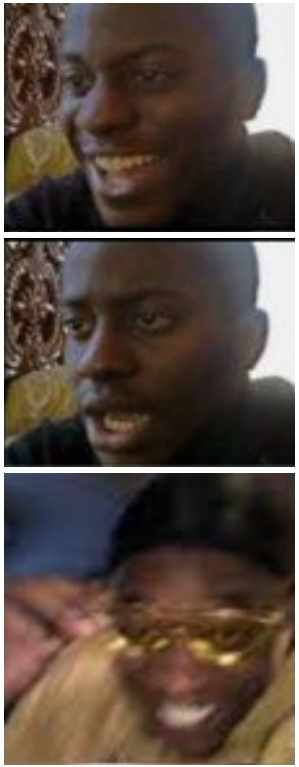
What are we talking about perception sensor of a robot?

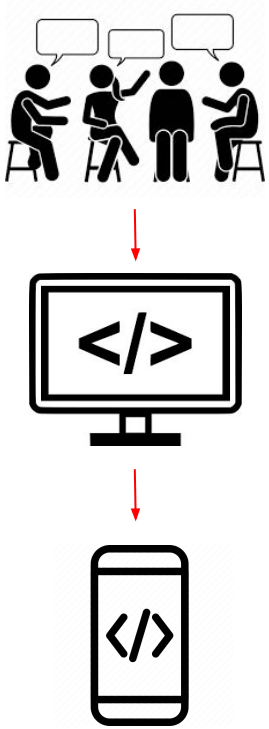
How about playing SLAM on iPhone?

State-of-the-art
SLAM

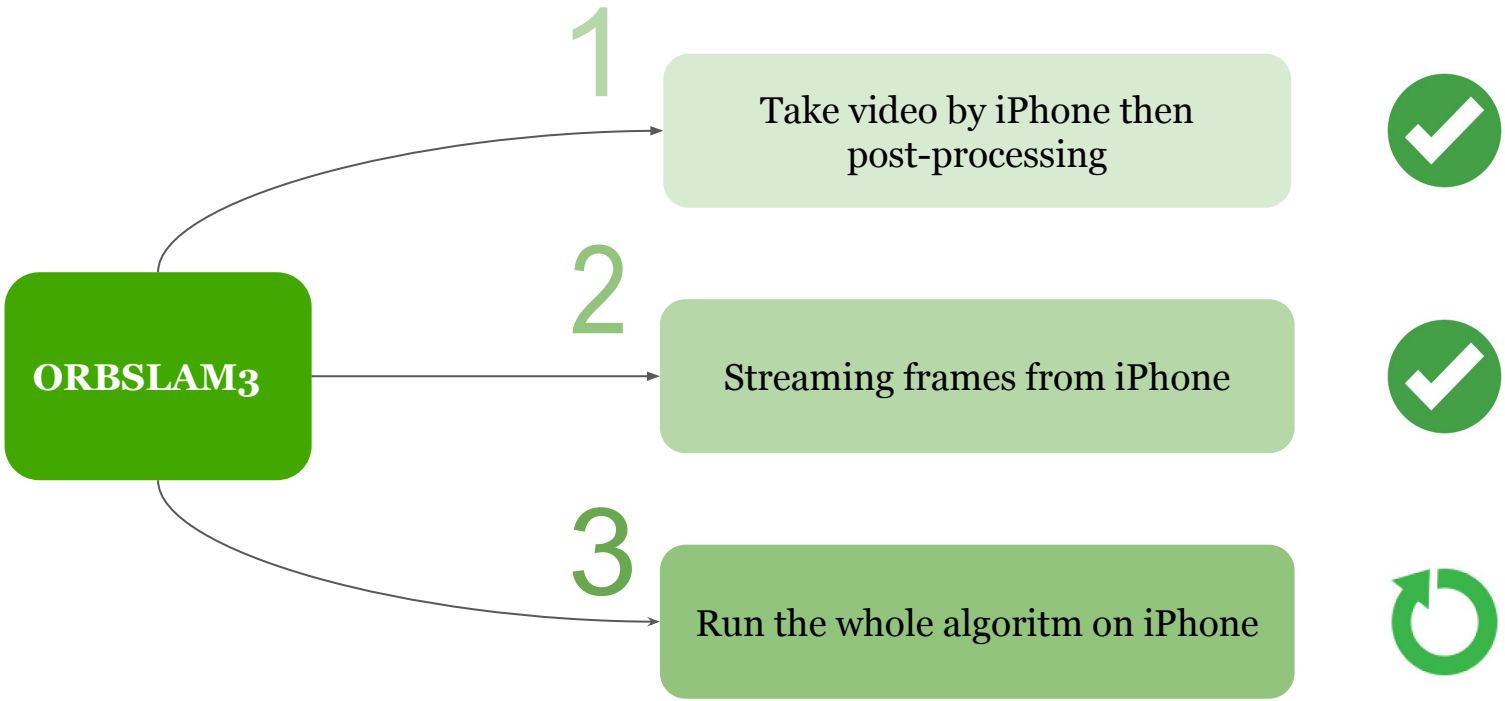
- On Ubuntu
- Dependencies
- Realsense camera
- Calibration

SLAM on iPhone

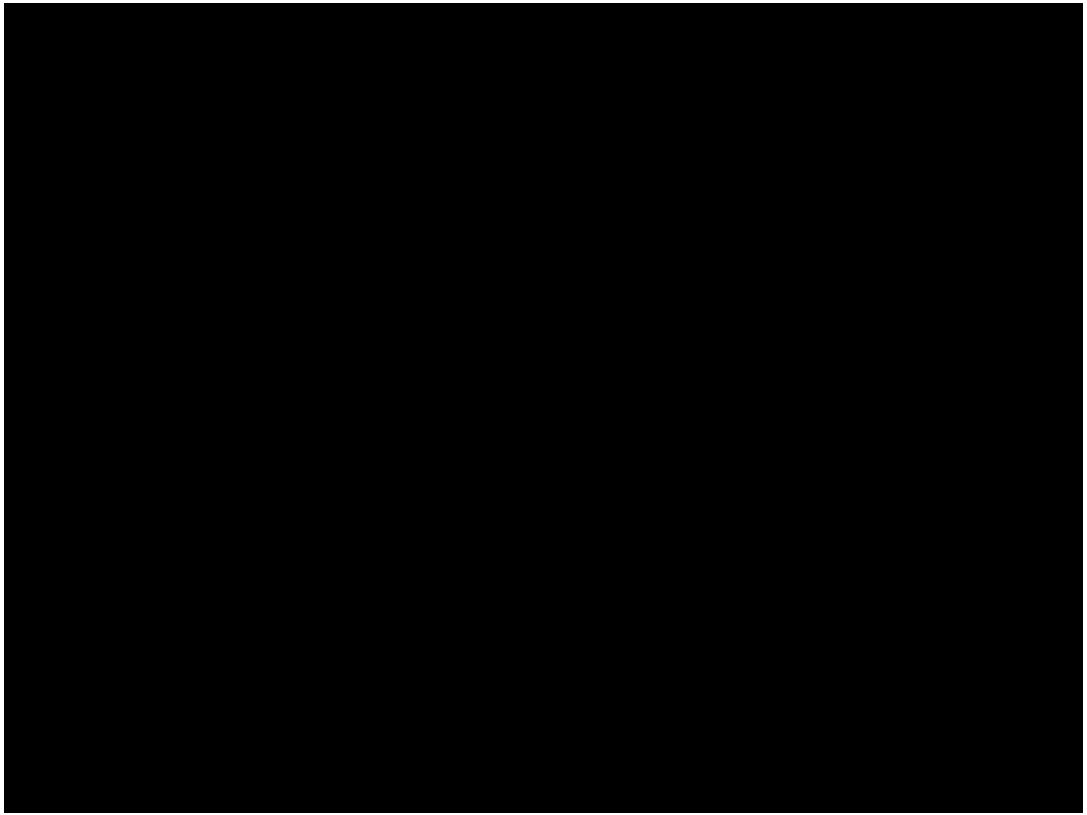


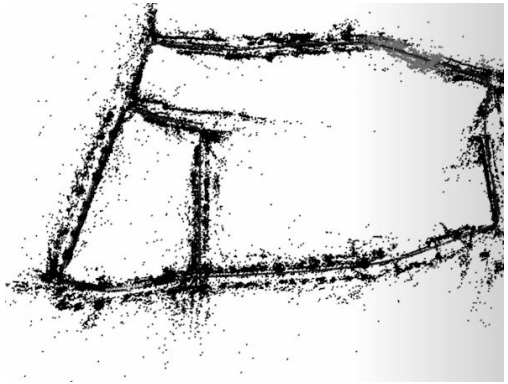


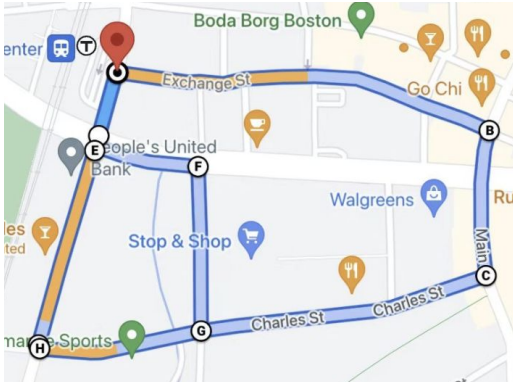
How to run SLAM on iPhone?



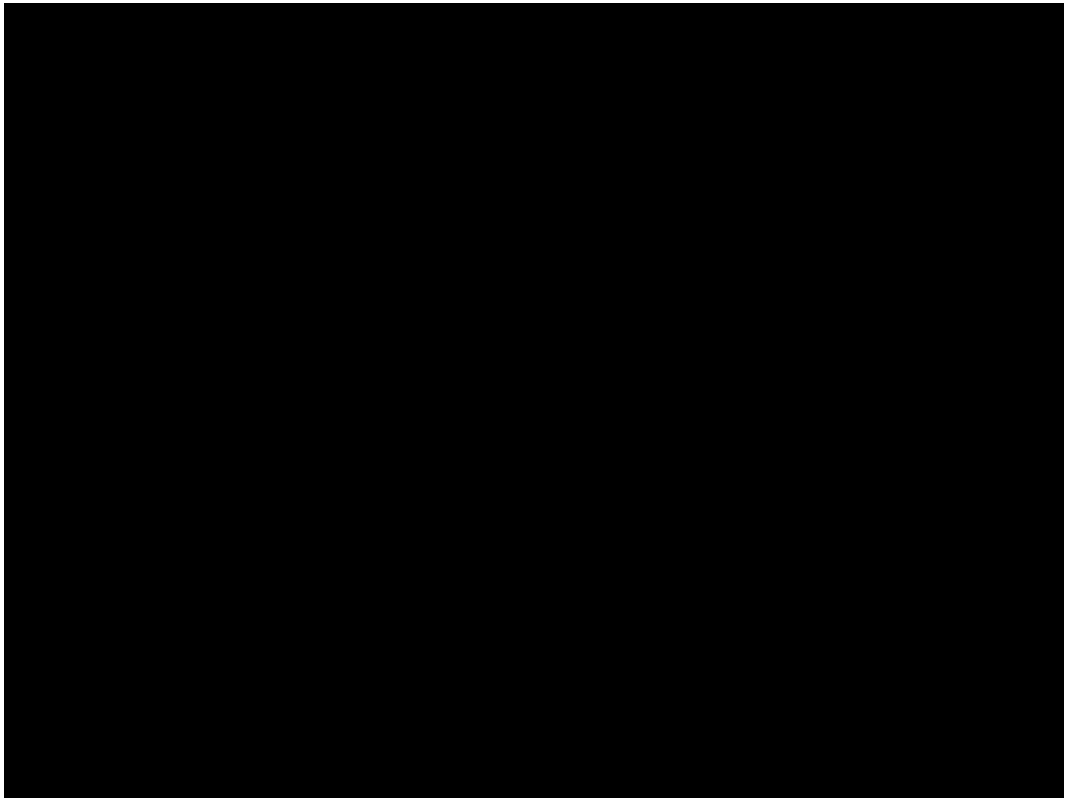
1 Post-process demo





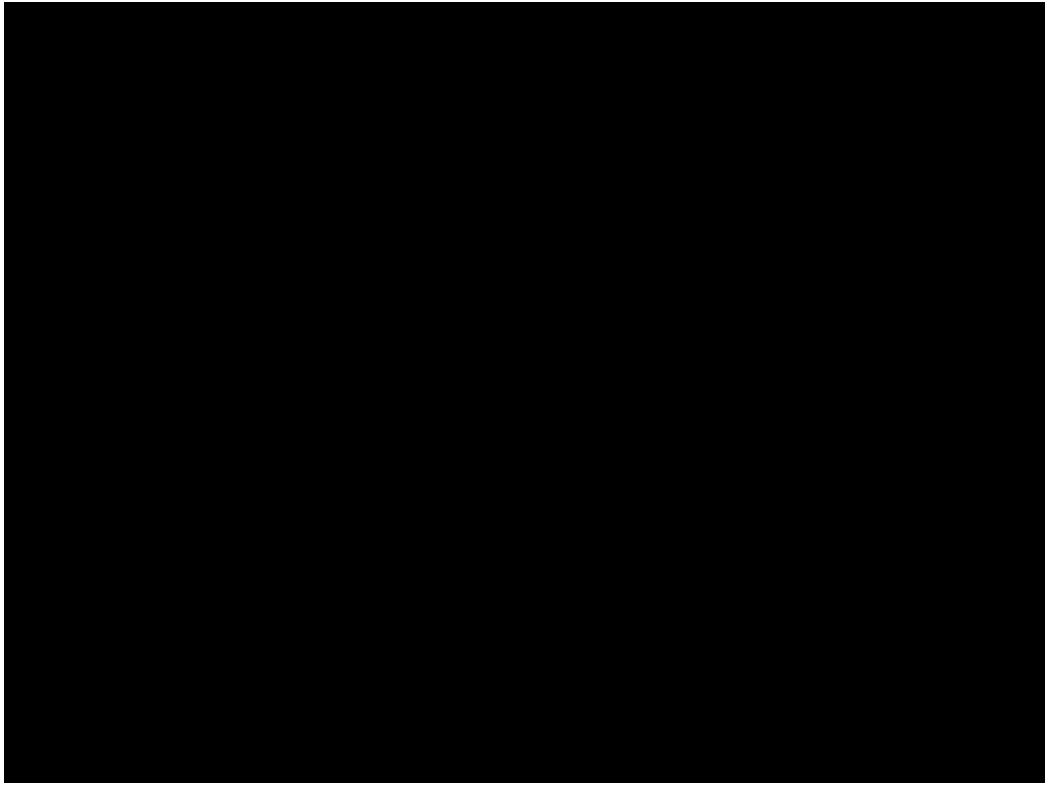


2 Streaming demo



- Video streaming through WiFi
- Real-time
- Run on any iPhone
- Remote control
- High quality
- Stable
- High accuracy

3 On-device ORBSLAM demo



Done:

- Fully functional feature detection
- Run on low frequency capture mode

Todo:

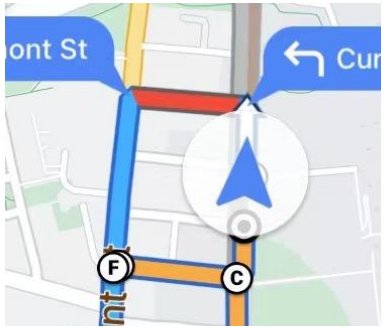
- Not useable for some library (Pangolin ….)

Limitations:

- CPU & Memory
- Multithread

Special cases 1: Loop Closure

Shot in the streets near isec



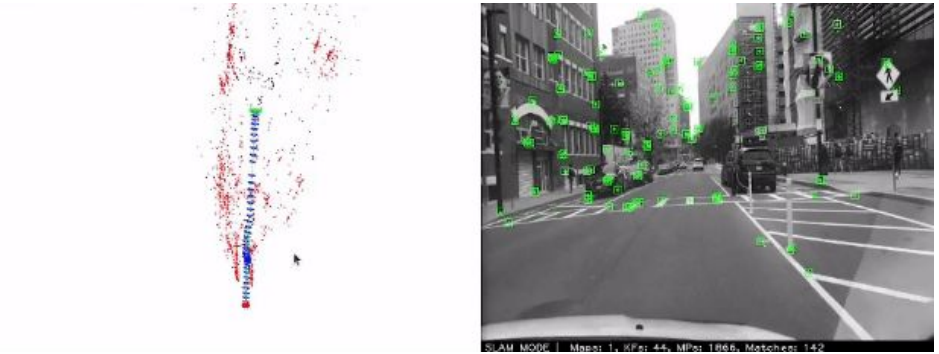
ORBSLAM3 can detecte turns accurately but not distances
Automatically correct map using previous detected features.

Special case 2: Camera Frequency

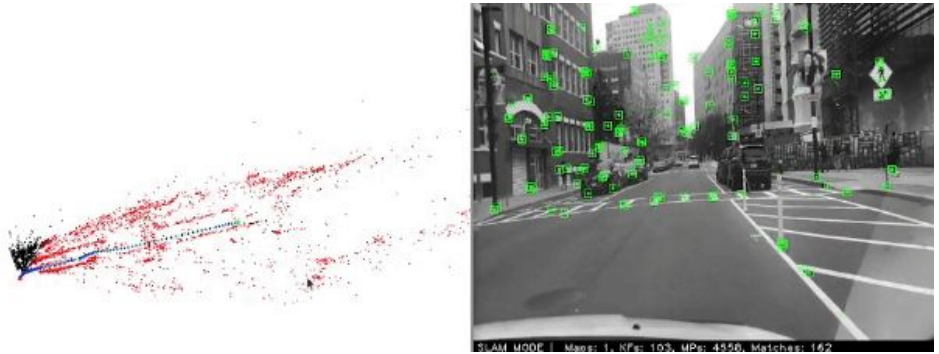
Shot in the streets near isec

Frequency - 2hz
Failure at turn

Can’t detected enough features!

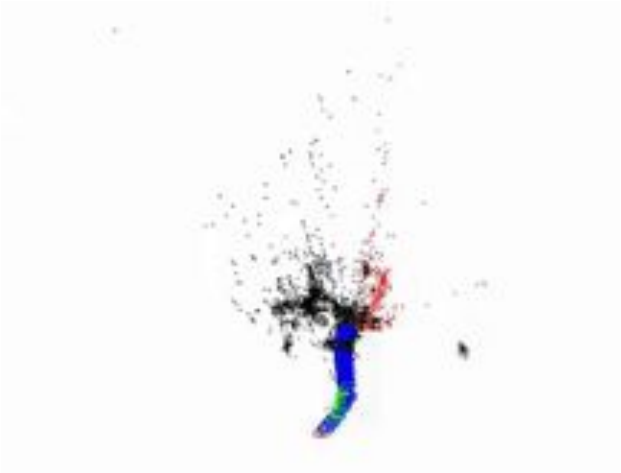


Frequency - 10hz
Successful turn



Special case 3: Blurred Lens

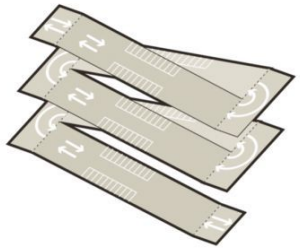
Shot at night in the streets near Malden with unsuccessful focus.

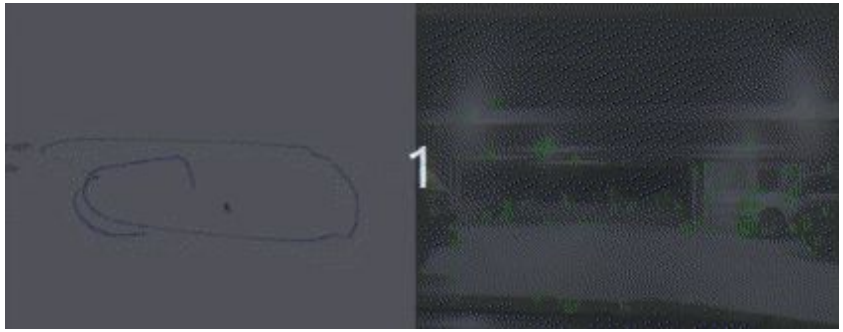


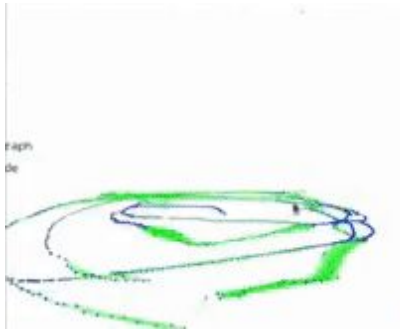
Poor mapping results

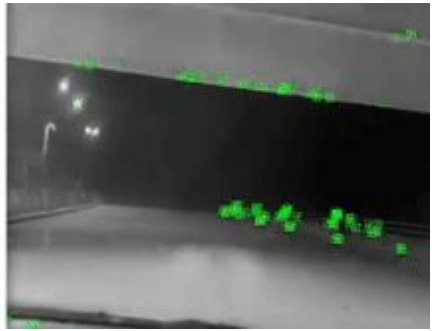
Special case 4: Parking

Shot at night in a Parking Garage near Malden







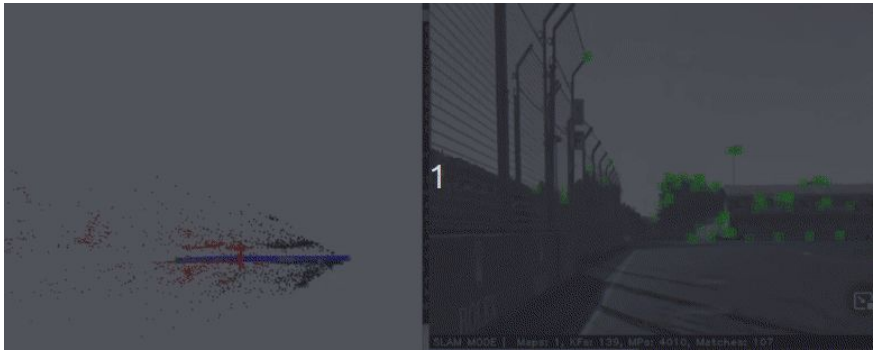


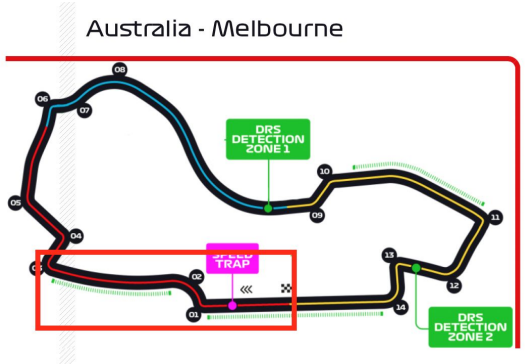
Single helix structure parking garage

Tough to draw accurate maps!

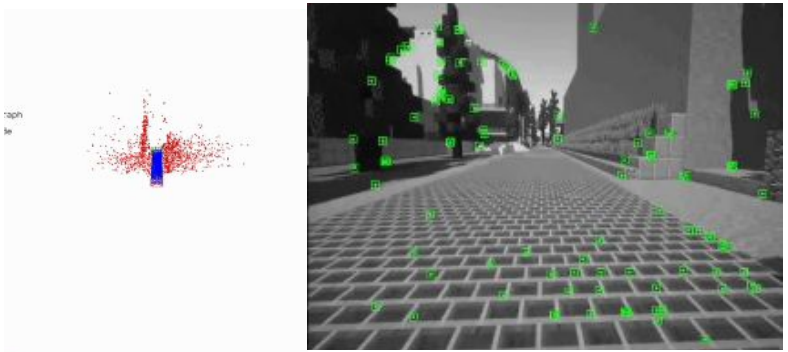
Special case 5: Gaming

Racing game video found on YouTube





Minecraft game video found on YouTube



What a surprise!!!
ORBSLAM3 can run in games!!!

Topics

Problems during installation and data collection(Checklist)

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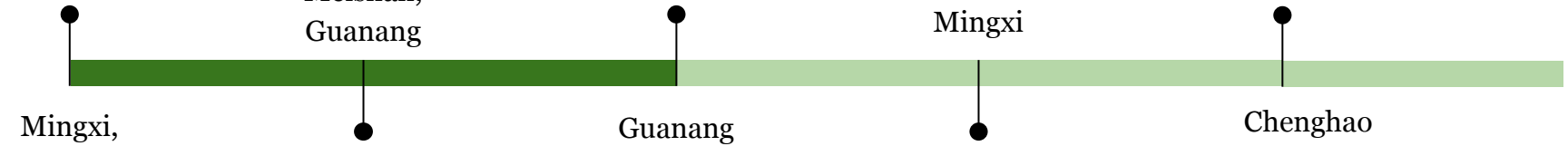


Problems during installation

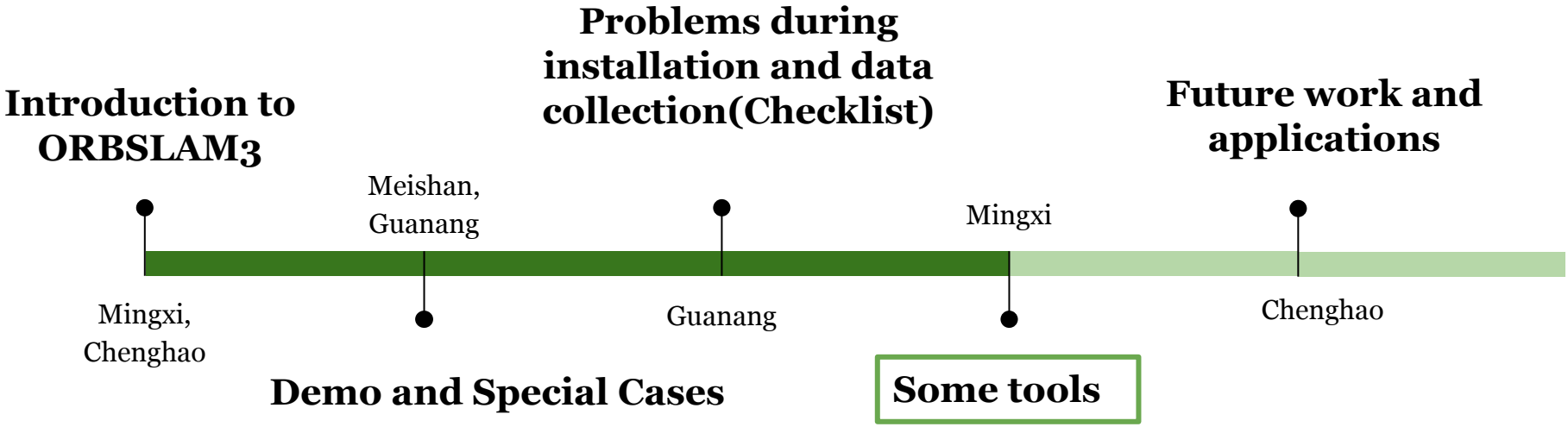
	Problem	Solution
ORB_SLAM	Pangolin Visualization not showing	"ORB_SLAM3::System SLAM(argv[1],argv[2],ORB_SLAM3::System::MONOCULAR, true); (line 83)
	ORI_SLAM3 setup issues with OpenCV	Need python2 with numpy by: sudo apt install python-numpy
	Compiling error using C++11	Change C++11 to C++14
iPhone streaming	Error in droidcam-client	Install gstreamer and atlas library
KITTI Dataset	Questions with parameters	http://20sep1995.blogspot.com/2019/02/how-to-run-orb-slam-with-kitti-dataset.html
XCode	No member named 'end' in 'std::map<ORB_SLAM2::KeyFrame *...'	In include/LoopClosing.h, change lines 49 and 50 to: typedef map<KeyFrame*,g2o::Sim3,std::less<KeyFrame*>,...

More References: gitlab.com/saulbatman/eece5554/readME.md

Checklist for data collection

1. Do not go with low battery
2. Clean the camera
3. Please bring a selfie stick
4. Do not use hotpot on iPhone to do streaming
5. Not recording data with traffic jam

Topics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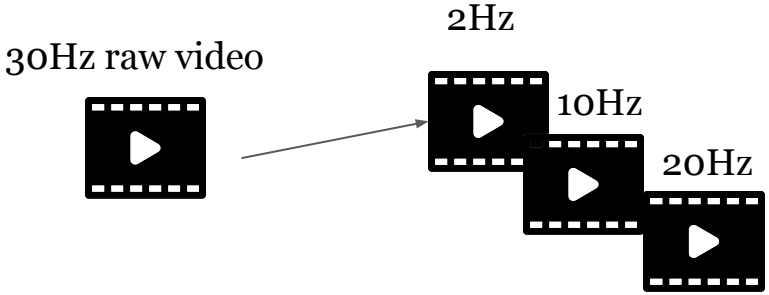
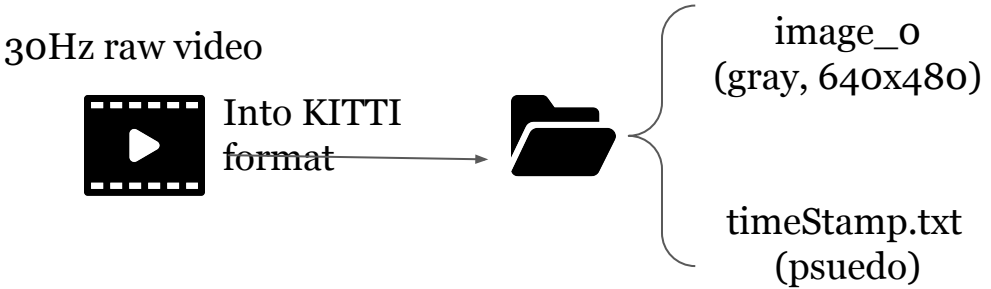
We made some tools

Video processing tools based on OpenCV

- Convert videos into different sample frequency
- Convert videos into RGB/gray frames
- Split video to frames in KITTI format
  - Organizing folders
  - Psuedo time stamps





https://github.com/SaulBatman/monoVO-python

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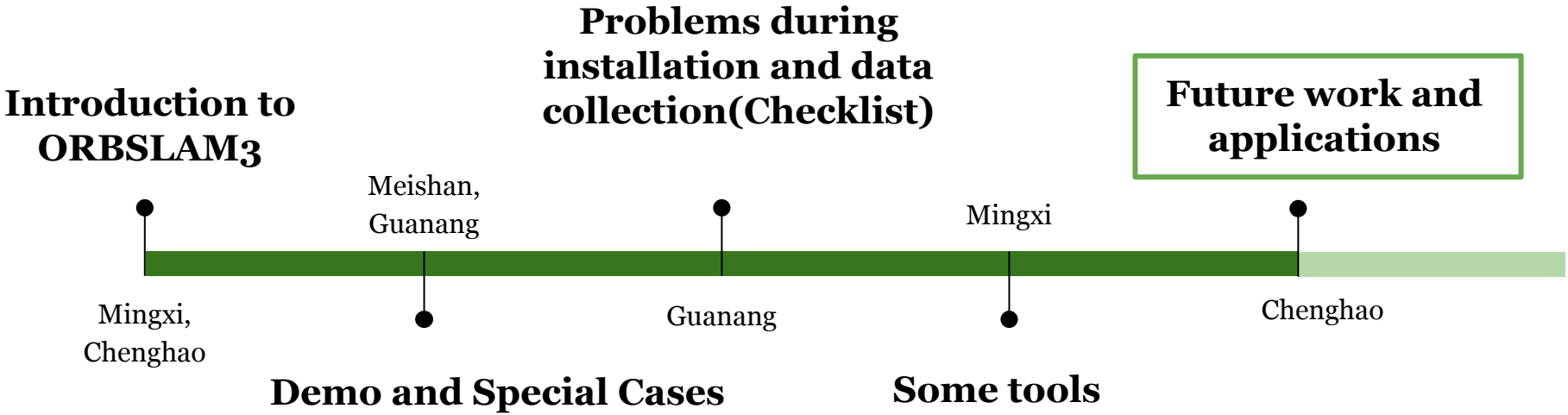
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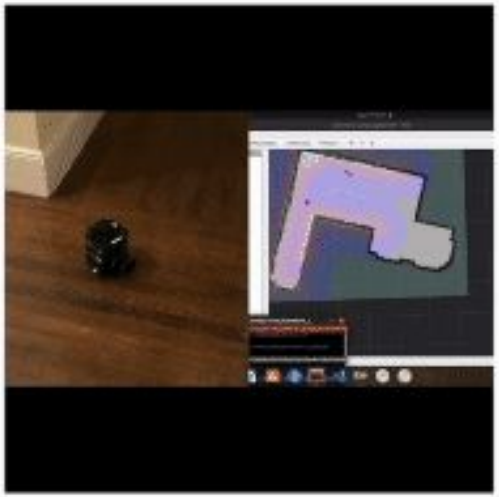
Future Work

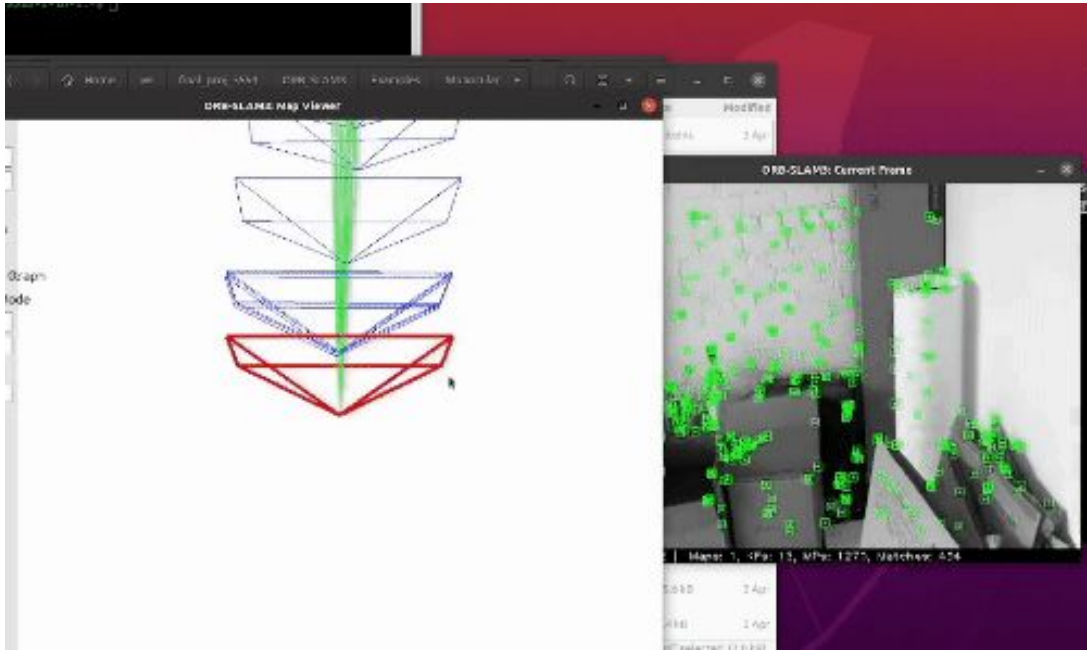


Applications - Low cost “metaverse”

VR Display

perception & computation

Applications - Low cost “metaverse”



Reference

ORB-SLAM:

[1] Campos, Carlos, et al. "Orb-slam3: An accurate open-source library for visual, visual–inertial, and multimap slam." *IEEE Transactions on Robotics* 37.6 (2021): 1874-1890.

[2] Mur-Artal, Raúl, and Juan Domingo Tardós Solano. "Real-Time Accurate Visual SLAM with Place Recognition." *Ph. D Thesis* (2017).

[3] Strasdat, Hauke, J. Montiel, and Andrew J. Davison. "Scale drift-aware large scale monocular SLAM." *Robotics: Science and Systems VI* 2.3 (2010): 7.

[4] Geiger, Andreas, et al. "Vision meets robotics: The kitti dataset." *The International Journal of Robotics Research* 32.11 (2013): 1231-1237.

[5] https://zhuanlan.zhihu.com/p/266229144

Descriptor and detector:

https://dsp.stackexchange.com/questions/24346/what-is-the-difference-between-feature-detectors-and-feature-descriptors

Icons:

https://www.flaticon.com/