ORB-SLAM 3 PROJECT REPORT

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Abstract:

This report outlines the implementation of ORB-SLAM3, a state-of-the-art SLAM (Simultaneous Localization and Mapping) system, on various datasets, including the EuRoC MAV Dataset , NUance datasets, and the data captured using a Samsung S23 Ultra camera. The aim is to assess the performance and accuracy of ORB-SLAM3 in different scenarios.

Introduction:

Background of SLAM and Visual SLAM

Simultaneous Localization and Mapping (SLAM) is crucial in robotics and autonomous systems, enabling devices to map unknown environments while pinpointing their location within them. Visual SLAM (VSLAM), a subset of SLAM, leverages visual data from cameras, offering cost-effectiveness, rich environmental information, and versatility across various settings.

Choice of ORB-SLAM3:

ORB-SLAM3 was selected for its superior capabilities in VSLAM technology. It stands out due to:

1. **Accuracy**: High precision in localization and mapping.
2. **Efficiency**: Utilizes ORB features for real-time operation, even on standard hardware.
3. **Versatility**: Compatible with monocular, stereo, and RGB-D data, suitable for diverse applications.
4. **Robustness**: Performs well in outdoor as well as indoor environments.
5. **Strong Community Suppor**t: Benefits from active development and a broad user base.

These attributes make ORB-SLAM3 an ideal choice for this project, particularly given its adaptability to different datasets and its proven reliability in navigation and mapping tasks.

Phase 1: Testing with EuRoC Dataset

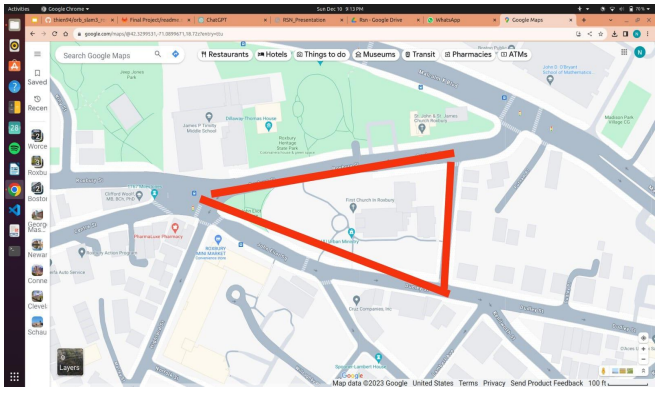
- **Dataset Overview**: Introduction to the EuRoC MAV Dataset, including its components and relevance.
- **Implementation on Easy and Hard Sequences**: Detailed account of how ORB-SLAM3 was implemented on both easy and hard sequences of the EuRoC dataset. This was done to find out how ORB-SLAM3 works in different situations, like dealing with rapid motion or a dark environment.

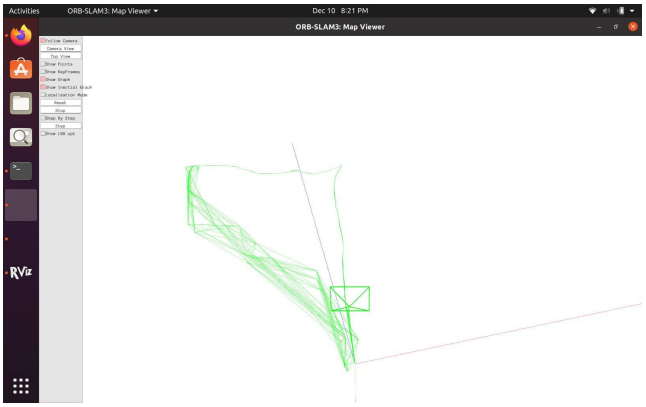
Phase 2: NUance Dataset

- **Dataset Description**: Characteristics of the dataset provided by the professor, including RGB, IMU, and GPS data.
- **Parameter Tuning**: Adjusting settings for camera calibration, IMU noise characteristics, and GPS accuracy to optimise performance.
- **Running the Dataset**: Inputting the dataset into ORB-SLAM3 for SLAM processing, using RGB for feature extraction and IMU/GPS for motion and positional information.
- **Challenges and Solutions**: The biggest challenge was parameter tuning in which the camera was not perfectly calibrated and we needed to fine tune the calibration parameters to try and get the best possible result. By the end we managed to get a video feed that ran the mapping smoothly but wasn't capturing the complete image from top to bottom.

Phase 3: Application on our camera

- We used a mobile camera to record our own datasets, which included both outside and inside recordings.
- To compare the compatibility of Orb Slam3, we tried it in three different environments: the Roxbury region, Northeastern campus, and Snell ground floor.
- We tried the loop closure in every situation, and for the most part, it performed as expected.
- If there are fewer features recognised, Orb Slam3 struggles and the path mapping can break. For example, walls and other plain, featureless surfaces are challenging for orb slam3.
- Another area where orb slam3 has high chances of failure are turns, which, if taken very fast, does not produce enough features for the slam3 to capture.
- For loop closure to be successful, we need to walk some distance more from our original start point
- Orb slam3 is computationally heavy and requires high computing power.





The outdoor dataset was mapped by Orb Slam3, producing the desired results.

References

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