

Detailed Project Proposal (DPP)

Leveraging Deep Features for ORB-SLAM3 (DXSLAM-ORB3)

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Aim of the project

The aim of this project is to enhance ORB-SLAM3 by integrating HF-Net as the feature extractor, thereby improving its robustness and accuracy in complex environments. This will enable more reliable and efficient SLAM performance in diverse and challenging scenarios.

Short Description of the idea

Simultaneous Localisation and Mapping (SLAM) is a problem that has made great improvements over the last decade. In the world of robotic, feature-based visual SLAM algorithms reign supreme. They're efficient, allowing robots to navigate smoothly, and adaptable, making them perfect for long-term missions. But the existing visual SLAM algorithms use handcrafted visual features like SIFT (Lowe, 2004), Shi-Tomasi (J. Shi and Tomasi, 1994) and ORB (Ethan, 2011) which fails to extract features in complex environments. Several studies (Mur-Artal and Tardós, 2017; X. Shi et al., 2020) have identified limitations in ORB-SLAM2's ability to re-localize in environments with significant scene or viewpoint changes.

Recent developments in deep learning has seen great results with pixel-wise feature extractors (DeTone, Malisiewicz, and Rabinovich, 2018; Dusmanu et al., 2019; Tang et al., 2019) which are more robust in extracting features even in complex conditions. While ORB-SLAM3 (Campos et al., 2021) represents a state-of-the-art visual SLAM algorithm, it utilizes the aforementioned ORB feature extraction, leading to limitations in complex scenarios.

This project proposes an improvement to ORB-SLAM3 by integrating HF-Net (Sarlin et al., 2019), a deep learning-based feature extractor. Li et al. (2020) demonstrated improved performance over ORB-SLAM2 by utilizing HF-Net. This project aims to replicate and potentially surpass those results by integrating HF-Net into ORB-SLAM3.

Research Questions

- Can replacing the handcrafted feature extraction in ORB-SLAM3 with the deep learning-based HF-Net lead to improved performance in terms of accuracy, robustness, and efficiency?
- How does the performance of ORB-SLAM3 integrated with HF-Net compare to the original ORB-SLAM3?

Project Objective

- Integrate HF-Net as the primary feature extractor in ORB-SLAM3 to improve robustness in complex environments.
- Validate the improvement through a series of benchmark tests comparing the enhanced ORB-SLAM3 with the original version.

Project Plan

Tasks:

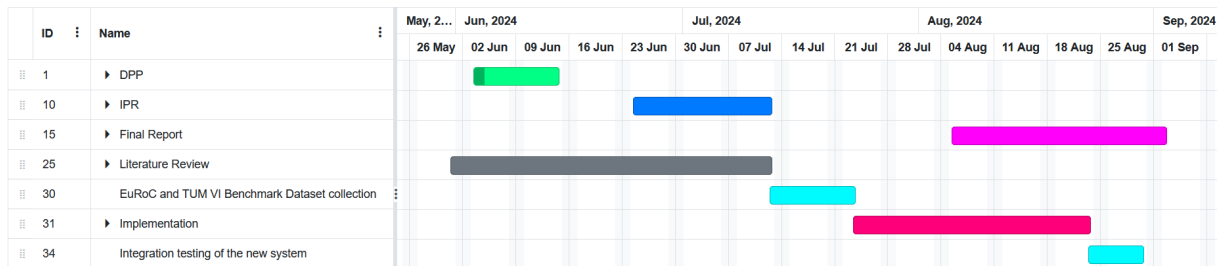


Figure 1: Gantt chat of project plan

1. Literature Review (31-05-2024:12-07-2024)
 - (a) Understanding SLAM and Monocular SLAM (31-05-2024:04-06-2024)
 - (b) Understanding ORB SLAM 1,2,3 (04-06-2024:06-06-2024)
 - (c) Understanding SP SLAM, DX SLAM (06-06-2024:14-06-2024)
 - (d) Understand ORB SLAM 3 code base (14-06-2024:02-07-2024)
 - (e) Understand HF-Net (03-07-2024:12-07-2024)
2. EuRoC and TUM VI Benchmark Dataset collection (12-07-2024:23-07-2024)
3. Implementation (23-07-2024:23-08-2024)
 - (a) Serialising the HF-Net (23-07-2024:31-07-2024)
 - (b) writing the wrapper for serialised model in C++ (31-07-2024:08-08-2024)
 - (c) Unit Testing HF-Net (09-08-2024:12-08-2024)
 - (d) Intergrate the Model with ORB slam 3 (12-08-2024:23-08-2024)
4. Integration testing of the new system (23-08-2024:26-08-2024)
5. Validation of the new system with benchmark datasets (26-08-2024:30-08-2024)

Milestones:

- Serialising the HF-Net
- Integrating HF-Net to ORB-SLAM3
- Validation of the new system with benchmark datasets

References

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