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Comparative Analysis of SLAM With Laser and Camera on Sensor Efficiency & Tuning in GAZEBO
Jose Otto Ranier, Prof. Drs. Agus Harjoko, M.Sc., Ph.D; Oskar Natan, S.ST., M.Tr.T., Ph.D.
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CHAPTER I

INTRODUCTION

A. Research Background

The rapid advancements in technology have revolutionized the way data is collected and processed, especially in the field of robotics, autonomous navigation, and environmental monitoring. Light Detection and Ranging (LiDAR) have emerged as a critical tool for mapping and spatial analysis due to their ability to provide precise distance measurements and detailed environmental data. Their applications range from urban planning to autonomous vehicle navigation and real-time disaster mitigation systems, emphasizing the need of importance on accuracy and efficiency in data collection.

However, a problem arises which is that as the complexity of map/environments increases, traditional mapping algorithms face limitations in terms of real-time processing, noise reduction method, and capabilities to adapt to dynamic or complex terrains. Addressing these challenges entails the development rate of an optimized algorithm set/tuned to the capabilities and constraints of LiDAR. A refined algorithm would then enhance the accuracy of mapping but also ensure reliability in diverse applications. (X. Wang et al., 2020)

The research that is being proposed focuses on designing and evaluating an optimal algorithm for mapping methods using LiDAR, aiming to improve the data collection accuracy in both controlled and uncontrolled environments. By combining foundational knowledge from several studies that have been cited in the next chapter. This thesis seeks to address existing gaps in laser-based mapping systems. Additionally, insights from comparative analyses of mapping algorithms and adaptive techniques will guide the algorithm’s development and validation.

This following study holds the potential to significantly contribute to the field of data collection by offering a strong, scalable, and efficient solution for high-concentrated mapping. Its implications extend to several factors such as environmental conservation and industrial automation.

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B. Research Problem

Based on the research program described above, the formulation of problems in this research are prescribed as follows:

1. What are the metrics that can prove that L-SLAM is better than ORBSLAM2?
2. Are there any performance limitations that appear in the L-SLAM method?

C. Research Objective

The objective of this research is as the following:

1. To compare & analyze the mapping accuracy of proposed L-SLAM against ORBSLAM2 system.
2. To evaluate the efficiency of GPU utilization during the process.

D. Research Scope

The scope of this research is the following:

1. Utilization of a widely accessible variety of programming codes specifically used for L-SLAM gazebo simulation in github.
2. Tuning of existing codes to be enhanced & optimized further for LSLAM for a singular terrain.

E. Research Advantage

The proposed research topic on an efficient LSLAM mapping technique that will produce the generated image in comparison to the given image, x and y error rate in centimeters. This technique offers several advantages in this research such as a wide area of view that could reach up to 240° in one direction, better performance in low light conditions, optimal handling of dynamic environments, advanced long range mapping, consistent in complex terrains, and less computational load. Furthermore, this approach supports the development of practical use in the world, creating a more advanced and critical autonomous mapping system.

F. Research Schematic

1. CHAPTER 1: INTRODUCTION

   This chapter presents the general background, overview, problem, and main objective of the research study proposed.

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2. CHAPTER 2: LITERATURE REVIEW

   This chapter provides a summary of the papers and journals related to laser-based SLAM system.

3. CHAPTER 3: RESEARCH METHODOLOGY

   This chapter contains the proposed research implementation and detailing the entire research procedure, including research schedule, starting from the variables used to perform benchmark.

4. CHAPTER 4: IMPLEMENTATION

   This chapter provides the majority of the ROS2 humble codes for implementing the research.

5. CHAPTER 5: RESULTS & DISCUSSION

   This chapter discusses results found after multiple running simulations to gather average value & also deep and comparative analysis from proposed L-SLAM to ORBSLAM2

6. CHAPTER 6: CONCLUSION AND FUTURE WORK

   This chapter discusses the conclusion of all findings & suggestions for future work so the research can be more thorough & concrete in different environments & technicalities.