УДК 004.896

РОБАСТНОЕ КОМПЛЕКСИРОВАНИЕ СТЕРЕОЗРЕНИЯ, ИНС И ЭНКОДЕРОВ КОЛЁС ДЛЯ НАВИГАЦИИ МОБИЛЬНЫХ РОБОТОВ

ROBUST FUSION OF STEREO VISION, IMU AND WHEEL ENCODERS FOR MOBILE ROBOTS' NAVIGATION

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Abstract. This work states a simultaneous localization and mapping system for mobile robots. It utilizes fusion between different sources of data (Optical, Inertial, Odometric), and provides robustness and accuracy in real-world environments.

Introduction. Mobile Robots need to navigate autonomously in unknown environments (Indoors / Outdoors). Simultaneous localization and mapping (SLAM) systems provide the required feedback for a navigation system of a robot. SLAM is designed by fusing the data of sensors (camera, IMU, encoders, etc..) for the pose estimation and then performing optimization for minimizing the estimation error. Robustness and accuracy are factors for such systems to make the robot navigate efficiently.

Main Part. Cameras, IMU, and wheel encoders are considered inexpensive hardware for the robot. The fusion between these data can provide a localization accuracy within centimeters. We used the optimization-based approach for the fusion process, which minimizes the multi-modal error of the robot's pose estimation.

The work is based on the ORB-SLAM system which is a Visual-Inertial SLAM system. The main contributions can be stated as:

- Wheel Encoders fusion with VINS (Visual-Inertial SLAM) algorithm.
- Introducing Planar Constraints for better accuracy.
- Robust Adaptive Kernel based on error measurements and semantic data about the environment.
- Hardware testing on KUKA Youbot mobile robot with software implementation for ROS.

Results. The evaluation of our system can be divided into two steps:

a. Testing on open-source datasets for mobile robots (OpenLoris, NCLT dataset).
b. Experimental evaluation using KUKA Youbot mobile robot, operating autonomously in indoor environment (ZED2 Camera, Omni-directional wheels, embedded IMU).

The results show that our system provides better results than the best known solution on the OpenLoris dataset. Also, the real-world evaluation depicts the robustness and accuracy of using our system for navigation in hard conditions, such as low texture, lighting conditions and high dynamic environment.

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