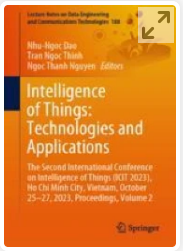

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Bayesian Approach for Static Object Detection and Localization in Unmanned Ground Vehicles

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Abstract

This paper introduces a statistical and probabilistic framework in approaching for an automatic search and estimation of static object's location in an unmanned ground vehicle setting. It relies on the probabilistic nature of the Bayesian approach in statistical inference and decision-making. In Bayesian

statistic, probabilities are assigned to model parameters, hypotheses, and predictions, making them inherently probabilistic. In the context of machine learning, the Bayesian approach plays a crucial role in addressing various challenges, particularly in the realm of uncertainty estimation, parameter optimization, and decision-making. Bayesian method permits a more comprehensive exploration of the parameter space. In this paper, the proposed approach utilized a lidar sensor and a pan/tilt camera as the primary hardware components. The lidar sensor, with its wide angle of view and high 2D accuracy, first detected the object in the 2D plane. Subsequently, the camera captured and analyzed object features to confirm its presence before guiding the robot to the precise position and orientation. The Recursive Bayesian Estimation (RBE) algorithm was leveraged to continuously track and determine the target's location, ensuring accurate and reliable updates throughout the process. A confidence level was assigned to each detection technique, and the lidar sensor enables continuous detection by incrementally increasing the probability of detection in a generalized manner. The approach was evaluated through the detection of a static object with specific features, and the results were demonstrated using a multi-space Bayesian approach and the lidar detection method.

Keywords

Bayesian **Unmanned Ground Vehicle (UGV)**

Static Object Detection **Localization**

Lidar sensor **Pan/Tilt camera**

References

1. Miura, H., et al.: Plant inspection by using a ground vehicle and an aerial robot: lessons learned from plant disaster prevention challenge

in world robot summit 2018. Adv. Robot. **34**(2), 104–118 (2020)

2. Štibinger, P., et al.: Mobile manipulator for autonomous localization, grasping and precise placement of construction material in a semi-structured environment. IEEE Robot. Autom. Lett. **6**(2), 2595–2602 (2021)

3. Qin, H., et al.: Autonomous exploration and mapping system using heterogeneous UAVs and UGVs in GPS-denied environments. IEEE Trans. Veh. Technol. **68**(2), 1339–1350 (2019)

4. Ocando, M.G., et al.: Autonomous 2D SLAM and 3D mapping of an environment using a single 2D LIDAR and ROS. In: 2017 Latin American Robotics Symposium (LARS) and 2017 Brazilian Symposium on Robotics (SBR), pp. 1-6 (2017)

5. Lee, S., et al.: Accuracy–power controllable LiDAR sensor system with 3D object recognition for autonomous vehicle. Sensors **20**(19), 5706 (2020)

6. Alizadeh, P.: Object distance measurement using a single camera for robotic applications. Laurentian University of Sudbury (2015)

7. Zhao, X., et al.: Fusion of 3D LIDAR and camera data for object detection in autonomous vehicle applications. IEEE Sens. J. **20**(9), 4901–4913 (2020)

8. Beltrán, J., et al.: Automatic extrinsic calibration method for LiDAR and camera sensor setups. IEEE Trans. Intell. Transp. Syst. **23**(10), 17677–17689 (2022)

9. Huang, H., et al.: A novel nonlinear algorithm for non-gaussian noises and measurement information loss in underwater navigation. IEEE Access **8**, 118472–118484 (2020)

10. Bergman, N.: Recursive Bayesian Estimation: Navigation and Tracking Applications. Linköping University (1999)

11. Chen, Z.J.S.: Bayesian filtering: From Kalman filters to particle filters, and beyond. Statistics **182**(1), 1–69 (2003

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