УДК 004.896

A REVIEW AND COMPARISON BETWEEN CONVENTIONAL AND NEURAL SLAM ALGORITHMS

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Introduction. SLAM (Simultaneous Localization and Mapping) is a complex problem in robotics that involves building a map of an unknown environment while simultaneously localizing a robot within that environment [1]. Both conventional and neural methods have been used for SLAM, and the choice between the two approaches depends on various factors, such as the specific application, the available computational resources, and the required level of accuracy. Conventional methods in SLAM have been used successfully for many years, particularly in applications such as robotics and autonomous vehicles. However, neural methods in SLAM are gaining popularity due to their ability to handle uncertainty and learn from data.

Main Part. Conventional methods for SLAM typically use probabilistic models, such as Extended Kalman Filters (EKF) or Factor graphs, to estimate the robot's pose and the map of the environment. These methods rely on a set of assumptions about the environment and the robot's motion, and they require tuning of many parameters [2]. However, conventional methods are often computationally efficient and can provide accurate results for many SLAM problems.
On the other hand, neural methods for SLAM use deep learning techniques, such as Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs), to learn the mapping and localization tasks directly from sensor data. Neural methods can potentially provide better accuracy and robustness in challenging environments with complex sensor data, such as outdoor environments or environments with dynamic obstacles [3]. However, neural methods may require more computational resources and may be challenging to train and tune.
In this work, the author provides a comparison between both methods:

1. Representation of Information: Conventional methods in SLAM represent the environment using feature-based methods, such as point clouds or keypoint extraction, while neural methods in SLAM represent the environment using learned representations, such as occupancy grids or learned feature maps.
2. Robustness to Noise and Uncertainty: Conventional methods in SLAM rely on heuristics and assumptions about the environment, which can lead to poor performance in noisy or uncertain environments. In contrast, neural methods in SLAM can learn to deal with these uncertainties and can be more robust to noise [3].
3. Generalization: Conventional methods in SLAM can be generalized easily to new environments as it independent to the environment. Neural methods in SLAM can generalize to new environments, only if they are trained on a wide range of environments.

Results. In summary, both conventional and neural methods have their strengths and weaknesses in SLAM, and the choice between the two approaches depends on the specific problem at hand. For some applications, conventional methods may be more suitable, while for others, neural methods may be more effective. The study shows that the best results recently are achieved by using hybrid approaches for both, by considering strengths and weaknesses for each approach.

Literature

1. Cadena C, Carlone L, Carrillo H, Latif Y, Scaramuzza D, Neira J, Reid I, Leonard JJ. “Past, present, and future of simultaneous localization and mapping: Toward the robust-perception age” IEEE Transactions on robotics. 2016 Dec ; 32(6):1309–32.

2. Grisetti G, Kummerle R, Stachniss C, Burgard W. “A tutorial on graph-based SLAM”. IEEE Intelligent Transportation Systems Magazine. 2010;2(4):31–43.
3. Chen, C., Wang, B., Lu, C., Trigoni, N., & Markham, A.. (2020). A Survey on Deep Learning for Localization and Mapping: Towards the Age of Spatial Machine Intelligence.

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