LiDAR-based Object Localization in Real-Time Sensor Networks

Abstract

Camera-based object tracking systems in closed spaces compromise privacy and confidentiality [1, 2]. This study proposes a novel approach utilizing light detection and ranging (LiDAR) technology for object tracking, ensuring privacy while maintaining confidentiality. In Scenario I, the capability to detect objects on a flat surface is demonstrated by analyzing LiDAR data from multiple locations within the environment. In Scenario II, the effectiveness of tracking multiple objects from a single fixed LiDAR position is demonstrated in real-time experiments involving human subjects. Results exhibit the adeptness of strategically positioned LiDAR in dynamically tracking objects. Additionally, the study compares deep learning with the classical machine learning algorithms of the Gaussian process and kernel smoothing regression with the error obtained using test data. It is observed that Gaussian process regression outperforms the deep learning technique (convolutional neural networks). The study is done using lidar data for object/human detection applications (Link to refer). Furthermore, the hyperparameters tuned using the Particle swarm optimization technique for better performance of Gaussian process regression (Link to refer).

keywords: Data acquisition, Bounding box, Gaussian process regression, kernel smoothing, CNN, Particle swarm optimization (PSO).

Journal publications

1. **Vinodha K** and **E. S. Gopi**, "Analyzing the performance improvement of hierarchical binary classifiers using ACO through Monte Carlo simulation and multiclass engine vibration data".*Expert Systems with Applications*, Elsevier Journal (Impact factor:8.665, Cite Score:12.20 (released in June 2022), ISSN: 0957-4174), Science Citation Index Expanded , Volume 238, Part B, 2024, doi: 10.1016/j.eswa.2023.121730

2. **Vinodha K**, **E. S. Gopi** and **Tushar Agnibhoj**, "LiDAR-based estimation of bounding box coordinates using Gaussian process regression and particle swarm optimization". *Biomimetic*

Intelligence and Robotics, Elsevier Journal, Scopus, Volume 4, Issue 1, 2024, doi: 10.1016/j.birob.2023.100140

Book chapter

1. **Vinodha K**, and **E. S. Gopi**, "High-Resolution Remote Sensing Image Classification with Kernel Linear Discriminant Analysis". Handbook of Formal Optimization (Google scholar). Springer, Singapore, https://doi.org/10.1007/978-981-19-8851-$6_9 - 1$

Conference

1. **Vinodha K**, **E. S. Gopi** and **Bapeswar Vinnakota**, "Experimental Analysis for Sensor Reduction to Depict Real-Time Applications through Regression Techniques". presented at the 5th International Conference on Deep Learning, Artificial Intelligence, and Robotics (ICDLAIR 2023), held on December 8, 2023, in NIT Kurukshetra(online mode), will be published in Scopu indexed Springer.

Dataset publication

1. **Vinodha K**, **E. S. Gopi** and **Tushar Agnibhoj**, "Lidar dataset for object localization"., IEEE DataPort (Standard dataset), doi: 10.21227/zrq0-xm93

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[2] Kiwon Sohn, Andrea Bernardi, and Osama R. Neiroukh. Effects of input resolution on lidar pedestrian localization using deep learning. In *International Conference on Electronics, Information, and Communication (ICEIC)*, 2021.