**P.A.College of Engineering, Mangalore**
**Department of Computer Science & Engineering**
**Technical Seminar Synopsis**

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| **Student Name** | : | Muhammad Muhsin Shareef P L |
| **USN** | : | 4PA21CS085 |
| **Title of the Paper** | : | An Intelligent Navigation Control Approach for Autonomous Unmanned Vehicles via Deep Learning-Enhanced Visual SLAM Framework |
| **Year of Publish** | : | 2023 |
| **Authors** | : | Lu Chen, Yapeng Liu,Panpan Dong, Jianwei Liang, Aibing Wang |

**Objective of the Paper (150 Words) :** The objective of this research is to develop Autonomous Unmanned Vehicles (AUVs). It require precise navigation systems to operate efficiently in dynamic environments. Traditional SLAM (Simultaneous Localization and Mapping) methods have been widely utilized, but they lack the ability to perceive and interpret complex visual scenarios. This paper introduces a deep learning-enhanced Visual SLAM framework that integrates artificial intelligence techniques for more accurate navigation control. The framework includes a high-accuracy up-convex curve model for lane detection and a yaw angle guidance-based imitation learning module for decision-making. By leveraging deep reinforcement learning, the proposed system optimizes navigation performance, achieving a 5% improvement in accuracy. Experimental validation through urban road simulations confirms the efficacy of the approach. The findings contribute to the advancement of AUV technology, enabling safer and more efficient autonomous navigation in complex and unpredictable environments.

**Introduction (500 Words) :** Autonomous vehicles have gained significant attention due to their potential to reduce traffic accidents, enhance road safety, and mitigate environmental pollution caused by vehicle emissions. The integration of artificial intelligence into vehicle navigation systems has revolutionized autonomous driving technology. The core components of an autonomous navigation system include global planning, decision-making, local planning, and control modules. Traditionally, autonomous vehicles have relied on high-precision maps, perception modules, and decision-making frameworks to navigate efficiently.

However, existing approaches face challenges when deployed in large-scale, complex road conditions. The increasing engineering costs and inability to handle extreme situations necessitate the development of more advanced AI-driven methodologies. Reinforcement learning has emerged as a promising solution, enabling vehicles to optimize decision-making by interacting with their environments. Recent advances in deep learning have enhanced reinforcement learning by addressing scalability issues and improving learning capabilities.

Deep reinforcement learning (DRL) extends traditional reinforcement learning to handle high-dimensional decision problems. By integrating DRL with Visual SLAM techniques, autonomous vehicles can achieve real-time decision-making and adaptive navigation. This paper explores the application of SLAM technology and adaptive Monte Carlo localization to enhance autonomous vehicle navigation. By combining Extended Kalman Filter (EKF)-SLAM and Rao-Blackwellized Particle Filter (RBPF)-SLAM, the proposed approach improves localization accuracy and environmental mapping efficiency.

This study aims to address the limitations of traditional navigation methods by developing an AI-enhanced SLAM framework for AUVs. The approach is validated through extensive simulations, demonstrating its potential for improving navigation precision and decision-making capabilities.

**Literature Reviews (Minimum 4 Papers):**

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| **Title of the Paper #1** | **:** | Mixed Graph Neural Network-Based Fake News Detection for Sustainable Vehicular Social Networks |
| **Year of Publish** | **:** | 2023 |
| **Authors** | **:** | Z. Guo, K. Yu, A. Jolfaei, G. Li, F. Ding, A. Beheshti |
| **Objective(50 Words)** | **:** | The primary objective of this research is to develop This paper presents a Mixed Graph Neural Network (MGNN)-based approach for detecting fake news in vehicular social networks. The goal is to enhance information security and |

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| | | reliability in smart transportation systems by leveraging machine learning models to filter misinformation effectively. |
| **Methodology(100 Words)** | : | The study proposes a hybrid MGNN model that integrates graph convolutional networks (GCNs) with attention mechanisms to analyze and verify vehicular social network data. The system employs real-time data mining techniques to extract relevant information, classify news as genuine or fake, and improve decision-making accuracy. The authors use a large dataset comprising real-world vehicular communication logs to train and test the model. The framework also incorporates a reinforcement learning-based optimization algorithm to refine classification accuracy dynamically. |
| **Advantages** | : | Enhances information reliability in vehicular networks.<br>Uses attention mechanisms for improved feature extraction.<br>Provides real-time detection of misinformation. |
| **Drawbacks** | : | Requires high computational resources.<br>Performance depends on data quality and diversity. |
| **Conclusion & Future Scope ( 50 Words)** | : | The MGNN-based system significantly improves fake news detection accuracy in vehicular social networks. Future research can explore integrating federated learning for decentralized model training, reducing dependency on centralized servers, and improving data privacy. Enhancements in scalability and adaptability to new misinformation trends are also suggested. |

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| **Title of the Paper #2** | : | Autonomous Pilot of Unmanned Surface Vehicles: Bridging Path Planning and Tracking |
| **Year of Publish** | : | 2022 |
| **Authors** | : | N. Wang, Y. Zhang, C. K. Ahn, Q. Xu |
| **Objective(50 Words)** | : | The primary objective of this research is to develop the integration of path planning and tracking control for |

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| | | autonomous Unmanned Surface Vehicles (USVs). The objective is to design an efficient algorithm that ensures real-time collision-free navigation while maintaining stability in complex maritime environments. |
| **Methodology(100 Words)** | **:** | The study presents a hybrid path-planning framework combining Artificial Potential Fields (APF) with Reinforcement Learning (RL) to enhance navigation performance. The proposed system first uses an APF-based method for global path planning while incorporating RL-based local optimization for obstacle avoidance. The tracking control mechanism is based on Model Predictive Control (MPC), ensuring real-time adaptability. The framework is tested on a USV prototype under various sea conditions, demonstrating improved maneuverability and robustness. |
| **Advantages** | **:** | Real-time adaptive control for obstacle avoidance.<br>Enhances USV stability in dynamic environments.<br>Hybrid planning optimizes both global and local navigation. |
| **Drawbacks** | **:** | Computationally expensive due to RL integration.<br>Struggles with unpredictable marine disturbances. |
| **Conclusion & Future Scope ( 50 Words)** | **:** | In conclusion, the framework effectively bridges path planning and tracking for autonomous USVs. Future work should focus on improving adaptability to extreme maritime conditions and incorporating multi-agent coordination for swarm-based USV operations. Enhancing onboard computational efficiency is also a potential research direction. |

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| **Title of the Paper #3** | : | Cooperative Path Planning for Heterogeneous Unmanned Vehicles in a Search-and-Track Mission |
| **Year of Publish** | : | August 2020 |
| **Authors** | : | Y. Wu, K. H. Low, C. Lv |
| **Objective(50 Words)** | : | The primary objective of this research is a cooperative path-planning approach for heterogeneous Unmanned Vehicles (UVs) engaged in search-and-track missions. The objective is to optimize multi-vehicle coordination, improve target detection, and enhance mission efficiency by minimizing travel distances and maximizing coverage. |
| **Methodology(100 Words)** | : | The proposed framework utilizes a hybrid approach that integrates Ant Colony Optimization (ACO) with Particle Swarm Optimization (PSO) for dynamic path planning. The ACO algorithm facilitates real-time decision-making for local path adjustments, while PSO optimizes the overall mission trajectory. The system is tested using heterogeneous UVs, including Unmanned Aerial Vehicles (UAVs) and Unmanned Ground Vehicles (UGVs), in simulation environments mimicking real-world search-and-track missions. The algorithm dynamically adapts to environmental constraints, such as obstacles and target movement patterns. |
| **Advantages** | : | Enhances search efficiency with optimized path planning.<br>Supports multi-vehicle coordination.<br>Adaptive to dynamic mission environments. |
| **Drawbacks** | : | Increased computational complexity.<br>Requires precise inter-vehicle communication. |
| **Conclusion & Future Scope ( 50 Words)** | : | The proposed hybrid planning method significantly improves multi-vehicle coordination in search-and-track missions. Future research should focus on real-world deployment, integrating machine learning models for autonomous |

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| | | decision-making, and refining inter-vehicle communication for enhanced scalability. |

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| **Title of the Paper #4** | **:** | Cooperative Path Planning of Multiple Unmanned Surface Vehicles for Search and Coverage Task |
| **Year of Publish** | **:** | 2022 |
| **Authors** | **:** | Z. Zhao, B. Zhu, Y. Zhou, P. Yao, J. Yu |
| **Objective(50 Words)** | **:** | The primary objective of this research is to develop a cooperative path-planning algorithm for multiple Unmanned Surface Vehicles (USVs) performing search-and-coverage tasks in marine environments. The goal is to enhance efficiency, minimize redundancy, and optimize resource utilization. |
| **Methodology(100 Words)** | **:** | The research introduces a multi-agent deep reinforcement learning (MADRL)-based framework for cooperative path planning. The algorithm enables USVs to dynamically adapt their paths based on real-time environmental data, including ocean currents and obstacles. The method integrates Deep Q-Networks (DQN) with an attention mechanism to improve decision-making. Experiments conducted in simulated maritime environments demonstrate improved task efficiency and reduced energy consumption. |
| **Advantages** | **:** | Optimized coordination among multiple USVs.<br>Real-time adaptability to environmental changes.<br>Improved coverage efficiency. |
| **Drawbacks** | **:** | Requires extensive training datasets.<br>Computational overhead due to deep learning integration. |

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| **Conclusion & Future Scope ( 50 Words)** | **:** | The study presents an efficient cooperative path-planning solution for USVs. Future work should explore real-world validation, integration of advanced oceanographic models, and scalability enhancements for large-scale fleet coordination in complex maritime operations. |

**Proposed Methodology (250 Words): ROS-Based Autonomous Navigation Framework**

The proposed framework is built on the Robot Operating System (ROS), which facilitates efficient communication between different navigation modules. The main components of the system include:

- **Sensor Data Acquisition:** Utilizes LiDAR and odometer data for real-time navigation.
- **Coordinate Conversion:** Ensures uniformity in data representation within the global coordinate system.
- **SLAM Module:** Constructs and updates the environment map while localizing the vehicle.
- **Path Planning Module:** Implements global and local path planning for smooth navigation.

**Motion Model for AUVs**

The motion of AUVs is modeled using velocity-based and odometer-based kinematic equations. The vehicle dynamics are described using:

- **Velocity-based models:** Define movement based on speed and yaw rate.
- **Odometer-based models:** Use wheel rotation data to estimate position.

An optimized particle filtering algorithm is employed to enhance localization accuracy, combining the advantages of EKF-SLAM and RBPF-SLAM. The framework ensures real-time map updates and precise trajectory planning.

**Result & Analysis:**

The proposed approach was evaluated using Carla simulation experiments under varying traffic conditions. The key findings include:

- **Enhanced Navigation Accuracy:** The deep learning-enhanced SLAM framework improved localization precision by approximately 5%.
- **Improved Path Tracking:** The up-convex curve model demonstrated superior lane detection performance compared to traditional methods.

- **Adaptability to Dynamic Environments:** The yaw angle guidance-based imitation learning method facilitated adaptive navigation in changing traffic conditions.

Experimental results validate the effectiveness of the proposed framework in real-world autonomous driving scenarios.

**Future Enhancement (100 Words):** Future advancements in AUV navigation systems can focus on integrating:

- **Multi-sensor fusion** to enhance environmental perception and improve obstacle detection accuracy.
- **Advanced reinforcement learning techniques** for more efficient and adaptive decision-making.
- **Real-world implementation and testing** to validate system performance under diverse conditions.
- **Edge computing and cloud-based solutions** to facilitate real-time data processing and remote control.
- **Enhanced SLAM algorithms** with improved localization capabilities in highly dynamic and unstructured environments.

By incorporating these improvements, the proposed framework can further enhance navigation efficiency, safety, and adaptability in real-world scenarios.

**Conclusion (100 Words):** In summary, this paper presents a deep learning-enhanced Visual SLAM framework for AUV navigation control. By integrating AI-driven lane detection, imitation learning-based guidance, and an optimized SLAM approach, the proposed system improves navigation accuracy and adaptability. Experimental validation through Carla simulations demonstrates the effectiveness of the method, achieving a 5% improvement in localization accuracy. Future research will focus on real-world applications and further optimization of deep learning-based navigation strategies.

**References (Minimum 15 References since 2020 in descending Order):**

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**Student Signature:**

**Technical Seminar Staff In charge:**

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