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References: [1] Joseph Azeta. (2019). Obstacle Detection Using Ultrasonic Sensor For A Mobile Robot. IOP Conference Series:

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Related articles:

[1] **Computer Vision-Based Environmental Perception for a Collaborative Robot**

Strongly related

Abstract: The recent advancements in Artificial Intelligence and robotics have highlighted the need for human-centered systems in industrial automation. As research and application of Collaborative Robots become more prevalent, it is increasingly important to ensure their ability to safely and efficiently navigate dynamic environments. This publication presents a modular ROS-based system that leverages 3D computer vision to enhance obstacle detection and avoidance. The integration of depth sensing and 3D object detection facilitates enhanced autonomy and safety in Collaborative Robot applications. The results of the tests demonstrate that the system is capable of achieving promising outcomes with low-budget sensing hardware. This provides a solid foundation for future enhancements in accuracy and flexibility, as well as the integration into other robotic systems.

DOI: 10.1007/978-3-032-03515-8_38

View paper

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[2] **Obstacle Detection and Enhanced Safety for Self-driving Automobiles (ODESSA)**

Strongly related

Abstract: As autonomous driving technology evolves, ensuring car dependability and safety is crucial. The versatile Quanser Car (Q-car) platform provides an ideal testing ground for driverless vehicles. This research focuses on enhancing self-driving car safety

by implementing an effective obstacle detection system. The study aims to improve obstacle recognition in self-driving Q-Cars by integrating depth cameras with MATLAB Simulink. Depth cameras offer advantages over yolo v5, providing vital three-dimensional environmental data essential for accurate obstacle detection and distance measurement. The research explores depth camera usage in driverless cars, detailing their integration into the Q-Car platform via Simulink. Additionally, it investigates how depth cameras can enhance safety features, especially collision avoidance. By leveraging depth cameras and MATLAB Simulink, the project aims to significantly boost autonomous vehicle safety and reliability on the Q-car platform, potentially advancing autonomous driving technology and fostering the development of safer self-driving cars.

DOI: 10.1007/978-3-031-93688-3_26

View paper

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[3] **Robot Learning**

Strongly related

Abstract: This chapter introduces the research on robot learning, with a focus on Robot Online Learning (ROL) frameworks. It begins by defining ROL and motivating its necessity for robots operating in dynamic environments. Two prominent ROL frameworks are then presented: one based on Positive–Negative (P–N) learning and the other leveraging knowledge transfer. A comparative analysis highlights the strengths and weaknesses of each approach. Specifically, while P–N learning operates autonomously, it is susceptible to self-bias. Conversely, knowledge transfer can mitigate self-bias but requires external guidance and must address potential conflicts between internal and external knowledge sources. The chapter further explores strategies for mitigating catastrophic forgetting, a critical challenge in long-term ROL. Finally, it demonstrates how ROL can be applied to enhance

socially-compliant robot navigation in extended, cross-environment deployments.

DOI: 10.1007/978-981-96-7094-9_4

View paper

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[4] **A Non-geographical Approach to the Study of Culture-Mediated Acceptance of Social Robots**

Strongly related

Abstract: Culture plays a fundamental role in shaping how individuals perceive and accept technology, influencing their willingness to adopt it. Social robots, as interactive agents, are subject to cultural variations in acceptance, yet existing Human-Robot Interaction (HRI) literature predominantly equates culture with nationality, overlooking more nuanced frameworks. This paper advocates for a non-geographical approach to culture, grounded in Hofstede's model, specifically focusing on Uncertainty Avoidance (UA). The proposed model posits that UA exerts a moderating influence on the relationship between Perceived Control (PC) and social robot acceptance, such that the positive effect of PC is more pronounced for low-UA individuals and less so for high-UA individuals. This speculative analysis introduces novel perspectives for future empirical research, challenging conventional methodologies in the domain of cultural HRI studies.

DOI: 10.1007/978-3-031-94748-3_17

View paper

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[5] **Enhancing Robotic Interaction and Navigation with Pick and Place Operations and Visual SLAM Techniques**

Strongly related

Abstract: In this paper, we introduce a mobile robotic system with a 7-Degrees of Freedom Robotic Arm designed for executing various pick-and-place operations and autonomous navigation within indoor environments. This system integrates vision-based object recognition and localization to facilitate precise grasping actions. A visual simultaneous localization and mapping (SLAM) algorithm is utilized to enable the robot's autonomous navigation in unfamiliar indoor settings. Additionally, we employed the YOLOv3 algorithm which enhances object detection and tracking capabilities, which is crucial for responding to any sudden positional changes in the target object. The process begins with YOLOv3 identifying and locating the object, followed by monitoring the next frame to detect any immediate shifts before the robotic arm's movement to grasp the object. Once the object to be picked up is decided by the Robot, we employ a Countour-based Object boundary detection technique that gives us both, the objects' coordinates in 3D space and the orientation at which the object is placed. Subsequently, a coordinate transformation is performed, converting the coordinates of the target object from the camera's frame of reference to that of the robotic arm's base frame, thereby facilitating accurate grasping operations. Furthermore, the robot is equipped with a human-following algorithm, enabling it to track and transport payloads to a human target efficiently, placing the payload in proximity to the person. Experimental results highlight a significant grasping success rate of 94%, underscoring the system's efficacy in autonomous robotic navigation and pick-and-place operations. This advancement holds substantial promise for enhancing robotic autonomy and operational efficiency in real-world scenarios.

DOI: 10.1007/978-3-031-93688-3_22

View paper

[6] **Enhancing Minimarket Customer Experience Through YOLOv8-Powered Checkout Systems**

Maybe related

Abstract: In Lima, Peru, minimarkets are vital, providing essential goods to a growing population. However, slow payment processes lead to long lines and frustrated customers, impacting satisfaction and profitability. The main issue is the slow, error-prone manual item scanning at the checkout. Addressing this inefficiency can enhance economic impact, customer satisfaction, and operational efficiency. Despite the benefits, implementing object detection technology faces challenges such as technological complexity, integration issues, diverse product ranges, and high costs. Previous solutions failed due to inadequate technology, high costs, poor integration, and user resistance. This paper proposes using YOLOv8, a state-of-the-art object detection model, for its precision, real-time processing, cost-effectiveness, and easy integration. This work includes custom hardware, an integration layer, and a user interface, with the aim of reducing checkout times, achieving over 94% product recognition accuracy, and improving customer satisfaction. Initial tests show promising results in speed, accuracy, and customer feedback.

DOI: 10.1007/978-981-96-8889-0_43

View paper

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[7] **Adaptive Positioning of a Mobile Robot for Precise Workstation Operation**

Maybe related

Abstract: This study presents an adaptive positioning method for mobile cobots using a vision-based correction system integrated into a UR10 robotic arm. The approach involves two-stage positioning: the AMR (MiR100) docks at an initial location, then the

vision system detects a reference marker to establish a local coordinate frame for precise task execution. This compensates for global positioning errors, enhancing repeatability and accuracy. Experimental validation on a CNC workstation confirmed improved alignment precision over standard AMR methods. The results highlight the potential of vision-based adaptive positioning for high-precision mobile cobot applications in dynamic industrial environments.

DOI: 10.1007/978-3-032-01517-4_26

View paper

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[8] **A New Semi-Automatic Strategy for Teleoperating Mobile Manipulators Using a Haptic Device**

Maybe related

Abstract: When teleoperating wheeled mobile manipulator robots using haptic devices, users usually use rate control for navigation and position control for manipulation. Manually switching between those two modes (for example, via a push button) while relying on visual feedback is often challenging, as using a single camera significantly reduces depth perception, making contact-based tasks difficult due to reduced spatial awareness and depth cues. Adding proximity sensors or auditory cues for distance detection requires processing more data, raising both the cognitive load and associated costs. On the other hand, typical automatic hybrid switching schemes employ restoring forces in navigation mode to assist the human operator. However, performing contact-based tasks in navigation mode deteriorates transparency due to interference between environmental and restoring forces while impairing fine-manipulation capabilities. Therefore, to overcome these challenges, we propose a new hybrid scheme that detects interaction with the environment via a force sensor to facilitate the automatic transition from navigation to manipulation mode. We use constrained task-space controllers to address obstacle

avoidance directly in the control law and enable safe interaction. We conducted an ethically approved study involving nine humans to assess the proposed scheme and used task completion time (TCT) and NASA Task Load Index (TLX) to assess human operator workload. Paired t-tests indicate a reduction of 23.3% ($p = 0.0058$ p = 0.0058) in TCT and mental demand by 57.1% 57.1 % ($p = 0.0021$ p = 0.0021), highlighting the advantages of the proposed semi-automatic switching scheme over the manual one.

DOI: 10.1007/978-3-032-01486-3_2

View paper

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[9] **AI-Driven Multisensor Quality Inspection: A Focus on Robotic Wire Harness Assembly**

Maybe related

Abstract: The rapid evolution of electric, connected, autonomous, and shared (ECAS) vehicles is transforming automotive architectures and driving demand for complex, scalable, and efficient wiring systems, even as harness assembly remains a predominantly manual and ergonomically challenging process. However, reliable verification of electrical connector mating, traditionally performed by human operators via auditory and tactile feedback, remains challenging for full automation. This study introduces a multimodal sensing approach integrating acoustic, force, and kinematic data for robust, real-time detection of successful electrical connector mating. High-frequency acoustic signals capturing mechanical click signatures, combined with simultaneous force sensor data and robot end-effector motion profiles, provide complementary information to resolve ambiguous events. Various supervised learning algorithms, including convolutional neural networks (CNNs), multilayer perceptrons (MLPs), and random forest classifiers, are evaluated using a dataset including diverse connector types and ambient noise levels. Feature extraction techniques and dynamic thresholding mechanisms

isolate critical signal features, enhancing performance under low signal-to-noise conditions. Designed for seamless robotic integration, the system delivers immediate feedback for downstream assembly processes. Achieving up to 96.8% accuracy with the deployed CNN, the approach demonstrates the viability of AI-driven multisensor fusion for reliable connector verification, facilitating agile, sustainable, and digitally integrated manufacturing systems.

DOI: 10.1007/978-3-032-03538-7_25

View paper

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[10] **Sonochemistry in Chemical Engineering**

Maybe related

Abstract: Sonochemistry, specifically dependent on acoustic cavitation, has transformed chemical engineering through its possibilities of provocation of localized temperature and pressure. This chapter will discuss sonochemical technology, specifically ultrasonic reactors, which include ultrasonic baths, horns, and multiple-frequency flow cell reactors. Bubble dynamics are modeled according to the Rayleigh-Plesset equation together with the role of frequency, temperature, pressure, liquid, reactor geometry, and the transducer's position. It has been used in nanoparticle preparation, nanoemulsion process, filtration process, ultrasonic atomization, and improvement of reaction rates in polymerization process, catalysis process, and enzymatic process. The chapter also discusses mass transfer modeling, namely the diffusion-limited model for vapor transport, ultrasound generation methods, piezoelectric and magnetostrictive transducers. Comparisons of sonochemistry with other hybrid technologies in controlling air contamination and biological wastewater treatment are also provided to highlight the importance of sonochemistry in developing more sustainable and innovative chemical engineering methods.

DOI: 10.1007/978-3-031-91656-4_3

View paper

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[11] **Introduction to the DDDAS2024 Conference Infosymbiotics/DDDAS and AI: Towards Reliable AI**

Maybe related

Abstract: The 5^th International DDDAS 2022 Conference, convened on November 6–8, 2024, featured presentations on Dynamic Data Driven Applications Systems (DDDAS)-based approaches in conjunction with artificial intelligence (AI) methods, for new capabilities in a wide set of areas and systems, in the context ofthe overarching theme ofenabling reliable AI. The scope of the conference covered foundational and applications' methods in materials, aerospace mechanics and space systems, networked communications and autonomy, biomedical and environmental systems, and featured DDDAS-based, system-cognizant modeling combined with Machine Learning methods, and enabling new capabilities including reliable AI and Dynamic Digital Twins. Capturing the tenets of the DDDAS paradigm across these areas, solutions were presented to address challenges in systems-of-systems' approaches providing analysis, assessments and enhanced capabilities in the presence of complex and big data. The conference comprised of a main track that featured 43 plenary presentations of peer reviewed papers, fourkeynotes, an invited talk, and a panel on S&T Advances through DDDAS, Reliable AI, and Digital Twins Approaches . In conjunction with the main track of the DDDAS conference, a session of three tutorials preceded the commencement of the main track. In addition to the papers of the plenary presentations in the main track of the conference, the DDDAS2024 Proceedings include this introduction, as an overview of the conference with synopsis of the main-track papers, followed by two subsequent parts: one presenting summaries of the keynotes, the panel discussions, and the tutorials; and the other

listing the conference Agenda. Additional information and archival materials, including the presentations' slides and recordings, are available in the DDDAS website: www.1dddas.org .

DOI: 10.1007/978-3-031-94895-4_1

View paper

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[12] **FISHER: An Efficient Sim2sim Training Framework Dedicated in Multi-AUV Target Tracking via Learning from Demonstrations**

Maybe related

Abstract: Multiple autonomous underwater vehicles (AUVs) target tracking problem is a significant challenge for AUV swarm control, which is crucial to the growth of the marine industry. To emphasize the great adaptability while tackling the limitations of reinforcement learning (RL) methods in Multi-AUV target tracking tasks, we propose an efficient two-stage learning from demonstrations (LfD) training framework, FISHER, based on few-shot expert demonstration, featuring imitation learning (IL) and offline reinforcement learning (ORL). In the first stage, we develop a sample-efficient algorithm, multi-agent discriminator actor-critic (MADAC), to facilitate the imitation of expert policy and the generation of offline datasets. In the second stage, based on the decision transformer (DT), the reward function-independent algorithm, multi-agent independent generalized decision transformer (MAIGDT) is utilized for further policy improvement. Simultaneously, we propose a simulation to simulation (sim2sim) method to facilitate the generation of expert trajectories, which is compatible with traditional methods like artificial potential field (APF). Through comparative experiments, we verify the improvement of the proposed MADAC and MAIGDT algorithms. Finally, full target tracking simulation processes show that FISHER can achkmieve performance comparable to expert demonstrations, thereby further demonstrating the strong practicality of FISHER

framework. To accelerate relevant research in this direction, the code for simulation will be released as open-source.

DOI: 10.1007/978-981-96-7036-9_5

View paper

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[13] **Embodied Intelligence Robotics Technology for Safety Operation and Maintenance in Large-Scale Energy Storage Stations**

Maybe related

Abstract: This paper systematically explores the application and technological advancements of embodied intelligence robotics in safety operation and maintenance of large-scale energy storage stations. With energy transition and power system modernization, energy storage stations as critical power infrastructure face numerous operational challenges. The paper analyzes the technical systems of three types of embodied intelligent devices—quadruped robots, wheeled robots, and unmanned aerial vehicles (UAVs)—including environmental perception, state estimation, motion control, gait planning, path optimization, fault detection, and recovery. Through multi-sensor fusion, deep reinforcement learning, improved object detection algorithms, and intelligent control strategies, these robotic systems can achieve efficient and safe autonomous inspection and maintenance in complex and changing energy storage station environments. The study demonstrates that embodied intelligence-based maintenance systems significantly improve station safety operation levels, reduce personnel risks, and enhance fault warning and handling capabilities, providing technical support for the long-term stable operation of energy storage stations. This research has important theoretical and practical value for promoting the application of intelligent robots in power system safety operation and maintenance.

DOI: 10.1007/978-981-95-1337-6_36

View paper

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[14] **Fully Distributed Cooperative Multi-agent Underwater Obstacle Avoidance**

Maybe related

Abstract: Navigation in cluttered underwater environments is challenging, especially when there are constraints on communication and self-localisation, and there is clutter in the environment. In this paper, we first studied the connection between everyday activity of dog walking and the cooperative underwater obstacle avoidance problem. Inspired by this analogy, we propose a novel dog walking paradigm and implement it in a multi-agent underwater system. Simulations were conducted across various scenarios, with performance benchmarked against traditional methods utilising Image-Based Visual Servoing in a multi-agent setup. The results indicate that our dog-walking-inspired paradigm significantly enhances cooperative behavior between agents and outperforms the existing approach in navigating through obstacles.

DOI: 10.1007/978-3-032-01486-3_28

View paper

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[15] **Control Design and Validation of Gait Analysis with the Robogait Mobile Robotic Platform**

Maybe related

Abstract: The integration of mobile robotic platforms with depth sensors could led to a major advance in human gait analysis. However, the lack of dedicated technologies designed specifically

for corridor-based gait analysis limits the availability of comprehensive tools to accurately and efficiently capture and analyze gait data in this specific context. In this study, control algorithms for person following and lane keeping of a mobile robotic platform named Robogait were applied and validated experimentally. The validity of using an Azure Kinect sensor for gait analysis was also examined using gait data collected from 10 participants and comparing its accuracy in gait signals and gait parameters with respect to a Vicon photogrammetric system. Results in controller design demonstrated a path following error of only 0.0446 m was measured on average, with a maximum deviation of 0.1420 m. The person tracking presented slight oscillations, however it did not affect the performance of the system in the gait analysis. An RMSE error of 12.68 $^{\circ}$ ∘ was obtained for knee flex./ext., 5.54 $^{\circ}$ ∘ for hip flex./ext., and just 0.06 m for the inter-ankle distance. Regarding gait descriptors analyzed, the Azure Kinect system provides reliable gait event measurements, though some discrepancies exist compared to Vicon. This study validates the use of the Azure Kinect sensor in gait analysis with mobile platforms. This offers a low-cost solution in real environments such as hospital corridors, contrary to in-lab gait analysis where the influence of equipment and the controlled environment could alter the gait pattern. The robot setup errors were comparable to static treadmill systems and similar to those of Vicon systems, which highlights its potential in clinical and rehabilitation applications.

DOI: 10.1007/978-3-031-98290-3_1

View paper

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[16] **Introduction**

Maybe related

Abstract: Implanted medical devices (IMDs) are developed to monitor and record biological data from the units implanted inside the body or brain and send it to an external unit. The need for IMDs

has considerably increased in recent years [1 , 2] to be used for diagnostic purposes. The applications of these implantable biomedical devices include cardioverter defibrillators, cochlear implants, and deep brain stimulators. Wirelessly powered implants are a subset of IMDs that employ wireless power transmission techniques to avoid using batteries or wired powering. This method enables the design of compact and long-lasting IMDs for biomedical applications. In neural applications, IMDs are used for neural recording and brain stimulation. For instance, brain implants are utilized for Parkinson's disease and epilepsy, by providing targeted open- or closed-loop stimulation to certain areas of the brain [2 – 4]. Ultrasonic, capacitive, optical, radio frequency (RF), and inductive links are the most commonly used platforms employed as a wireless power transmission technique. Inductive power transfer (IPT) is widely developed in IMDs because it is robust, straightforward, and safe. It also enables simultaneous wireless power and data communication. This book presents an implantable system that employs inductive links and CMOS electronics to develop a fully implantable wirelessly powered closed-loop multisite implant.

DOI: 10.1007/978-3-031-90839-2_1

View paper

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[17] **Enhanced Agricultural Crop Monitoring Using Autonomous Navigation Technologies**

Maybe related

Abstract: This paper discloses the potentials of obstacle avoiding robots in crop monitoring for precision agriculture. Such robots, empowered by advanced sensing modalities like ultrasonic, infrared, and LIDAR, are capable of self-navigation through a field, avoiding obstacles. The results show that navigation efficiency, data collection precision, and real-time monitoring capabilities are greatly improved. These robots give better resource management,

reduce dependence on manual labor, and timely decision-making in crop management. Although the high up-front costs of investment and the challenges in maintenance are inbuilt, the potential benefits in the reduction of labor, cost-effectiveness, and increased crop yield are enormous. Future improvement in AI, sensor technology, and cost reduction will drive further adoption and improve the impact of the technology on agriculture.

DOI: 10.1007/978-3-031-98138-8_2

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[18] **Enhanced Agricultural Crop Monitoring Using Autonomous Navigation Technologies**

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DOI: 10.1007/978-3-031-98138-8_2

View paper

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[19] **Rectification of Accumulated Proprioception Errors in Evolutionary Robotics**

Maybe related

Abstract: The augmentation of robotic controllers with proprioceptive inputs in Evolutionary Robotics have been shown to drastically improve controller performance on complex tasks. Previous research used a neural network to produce approximate location information as proprioceptive inputs to a robot controller which do not have other access to location information. This software-only technique produced controllers that were significantly more effective. However, it was found that for the approach to be used for an extended period of time, it becomes necessary to periodically reset and correct the approximate location information. Resetting has that drawback that it may not be possible in all situations and may require hardware intervention. This paper presents an alternative approach to correcting location information which makes use of a task-specific rectification neural network. Two real-world experiments are conducted to evaluate the approach and to identify limitations. Experimental results show clear performance benefits of using the rectification network.

DOI: 10.1007/978-3-031-96262-2_18

View paper

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[20] **Information Fusion of Ultrasonic Waves and Low-Frequency Vibrations: Leveraging Probabilistic Machine Learning and Stochastic Time Series Models for Structural Awareness**

Maybe related

Abstract: In this work, a unified framework integrating global and local SHM methods for structural health monitoring (SHM) of aerospace structures is proposed. This framework integrates both

“local” ultrasonic-guided wave-based and “global” vibration-based SHM schemes for tackling damage detection, identification, and quantification under uncertainty. To achieve that, two modeling methods are applied including (i) the variational auto-encoder (VAE) latent space to represent the ultrasonic guided wave (GW) propagation, and (ii) auto-regressive models with exogenous excitation (ARX) models to capture low-frequency vibrations. Subsequent damage identification and quantification are performed based on a feed-forward neural network (FFNN) mapping the AE latent space representation and structural dynamics extracted by ARX models to the damage state. The complete experimental evaluation and assessment of the proposed framework are presented for an Airbus H125 helicopter blade under both low-frequency vibrations and ultrasonic guided-waves for SHM. Estimation results are compared with previous publications with single source of vibration or GW data.

DOI: 10.1007/978-3-031-94895-4_6

View paper

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[21] **SCALOFT: An Initial Approach for Situation Coverage-Based Safety Analysis of an Autonomous Aerial Drone in a Mine Environment**

Maybe related

Abstract: The safety of autonomous systems in dynamic and hazardous environments poses significant challenges. This paper presents a testing approach named SCALOFT for systematically assessing the safety of an autonomous uncrewed aerial vehicle in a mine. SCALOFT provides a framework for developing diverse test cases, real-time monitoring of system behaviour, and detection of safety violations. Detected violations are then logged with unique identifiers for detailed analysis and future improvement. SCALOFT helps build a safety argument by monitoring situation coverage and calculating a final coverage measure. We have evaluated the

performance of this approach by deliberately introducing seeded faults into the system and assessing whether SCALOFT is able to detect those faults. For a small set of plausible faults, we show that SCALOFT is successful in this.

DOI: 10.1007/978-3-032-02018-5_21

View paper

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[22] **The Evolution of Connected Vehicles: Innovations, Integration Complexities, and Security Imperatives**

Maybe related

Abstract: The transformative potential of IVN in the automotive industry is being realized through the enablement of real-time data exchange between vehicles and infrastructure. This study examines recent IVN advancements while addressing persistent challenges in technology integration and security. Key communication protocols including V2V, V2I, and V2X are analyzed as foundational elements for advanced traffic management, enhanced safety systems, and innovative transport applications. The capabilities enabled by IVN are explored, encompassing improved situational awareness for autonomous driving, personalized infotainment, and predictive maintenance. Despite these advancements, widespread IVN adoption is impeded by cost considerations, lack of standardization, privacy concerns, and connectivity reliability issues. As IVN transmission capacities are expanded through 5G technology integration, securing safety-critical data against interference and falsification is identified as a paramount concern. Additionally, the challenge of overcoming proprietary data silos is highlighted, with the integration of insights from diverse sources recognized as crucial for maximizing IVN's collective intelligence. This multidisciplinary analysis maps IVN's expanding attack surface while proposing policies and design strategies to guide its development. By addressing these interconnected challenges, this research aims to contribute to the responsible advancement of

connected vehicle technologies, ensuring a balance between innovation, security, and public interest, thereby providing a roadmap for navigating the complexities of IVN implementation in the rapidly evolving landscape of connected vehicles.

DOI: 10.1007/978-981-95-1334-5_17

View paper

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[23] **Real-Time Monitoring and Active Control of Autonomous Agricultural Robot Trajectories Using an Edge-Fog Architecture**

Maybe related

Abstract: Smart farming concerns the usage of autonomous robots and sensors in the field to implement agro-ecology practices. Agriculture stake-holders are supported by supervision and control systems that allow for monitoring real-time data by means of Data Stream Management Systems (DSMSs), and remotely control robots in the field. However, processing in real-time streaming trajectory data that come from autonomous robots presents significant challenges due to the large volume of data generated by robots, and their bad quality since communication networks deployed in rural area can present several problems (e.g., instability and congestion). Furthermore, existing lightweight DSMSs do not support spatial data, and the proposed supervision systems are based on cloud-fog architectures, which do not provide effective solutions for trajectory data stream analysis within bad quality communication network. Therefore, in this paper, we extend [14], by proposing a hybrid edge-fog architecture and computation framework for robotic trajectory data analysis, which combines distributed and non-distributed DSMSs to manage trajectory data more efficiently. In particular, we extend the lightweight DSMS Esper with spatial operators, and dynamic frequency mechanism, at the edge level to process complex queries over trajectory data stream of the robots. Our architecture uses Geoflink at the fog, i.e., in the farm. A distributed computation approach for complex queries has

therefore been implemented to split queries over the edge and the fog. We validate our proposals using experiment in real-life conditions.

DOI: 10.1007/978-3-031-97606-3_18

View paper

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[24] **Web of Things Based Advanced Smart Parking Management Solution**

Maybe related

Abstract: Urbanization and increasing vehicle ownership have exacerbated parking challenges in cities worldwide, necessitating innovative solutions for efficient space utilization. Smart Parking Management Systems, integrating the Internet of Things (IoT), Web of Things (WoT), machine learning, and digital twins, offer a data-driven approach to optimizing parking infrastructure. This paper presents an advanced Smart Parking Management System developed using Snap4City, an open-source framework designed for real-time urban mobility monitoring. The proposed solution enables real-time parking occupancy tracking, predictive analytics, and automated enforcement, improving overall efficiency, sustainability, and user experience. Through dynamic pricing models, integration with Mobility-as-a-Service (MaaS), and AI-driven forecasting, the system enhances urban mobility while reducing traffic congestion and environmental impact. The effectiveness of the solution is validated through simulations and implementation in Florence, demonstrating its capability to streamline parking operations, support municipal policies, and improve user accessibility. The platform has been implemented using data from Florence and is built on the Snap4City Open Source platform for CN MOST, national center on sustainable mobility.

DOI: 10.1007/978-3-031-97654-4_27

View paper

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[25] **Robot Perception**

Maybe related

Abstract: This chapter presents a study on robot perception. It begins by establishing the research motivation: enabling large-scale human detection and tracking in public (non-domestic) environments using embodied sensors and onboard computing. Subsequently, it introduces contemporary 3D lidar technology as an embodied sensor, covering its fundamental operating principles and relevant applications in mobile robotics. The chapter then details the “adaptive clustering” method developed by the author, highlighting its advantages and limitations through a performance comparison with other established methods. Following this, it describes several hand-crafted features extracted from point clouds, proven effective for human model training. Finally, it presents a multi-target tracker optimized for point cloud data.

DOI: 10.1007/978-981-96-7094-9_3

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DOI: 10.1007/978-981-96-7094-9_3

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[27] **A Continuous, Differentiable, Probability-Expressed Harm Risk Estimator for Robot Actions in Dynamic Human-Centric Environments**

Maybe related

Abstract: In environments with unpredictable agent traversal (e.g. Industry 5.0 (I5) workfloors, hospitals, malls), a robot benefits from a harm risk-based criterion that judges whether evasive behaviors are actually necessary. Such an approach ensures safety when plan adjustment is needed, while preserving efficiency and agility when not, rendering the I5 paradigm more practicable and reducing congestion. In this paper, we propose a risk estimator based on mean free path that maps robot actions to probabilities of a harmful outcome. The mapping has a simple underlying construction, and the resulting risk space is continuous and differentiable across actions (if the underlying hazard map is such), making our model easily compatible with both optimization algorithms and Reinforcement Learning (RL) policies. It is expandable beyond accounting merely for visible agents, allowing for the easy inclusion of contributions due to latent hazards, such as blind spots, or even hazard map adjustments due to agent Theory of Mind (ToM) (e.g. awareness of robot). We show via Monte Carlo simulation that, for harm probabilities above 0.1, the accuracy of our method does not fall below a 5% error relative to the Ground Truth (GT) value.

DOI: 10.1007/978-3-031-99565-1_1

View paper

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[28] **Integrating Digitalization into the Process Industry**

Maybe related

Abstract: The implementation of digital technologies in the chemical process industry presents unique challenges and opportunities due to the inherent complexities of chemical processes. Unlike simpler manufacturing systems, chemical processes are governed by intricate thermodynamic, kinetic, and transport phenomena, making their digitalization a highly specialized endeavor. This chapter delves into the underlying concepts and technical nuances involved in embedding digital technologies within the chemical industry, providing a balanced perspective between purely data-driven analysis and physics-based modeling approaches.

DOI: 10.1007/978-3-031-94054-5_7

View paper

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[29] **IoT-Enabled Child Monitoring and Control System via Web Interface**

Maybe related

Abstract: In this fast-paced society, working parents nowadays find it challenging to juggle childcare with their busy schedules. In light of this, a novel infant management system utilizing the Internet of Things has developed. This system functions by using sophisticated technology to automate tasks hence ensuring babies safety and comfort. The major features are sound sensor that results into

automatic rocking cradle; integrated speaker which can play lullabies to a baby. The system is continuously monitored for its temperature and humidity by sensors sending the caregiver a summary notification about their vicinity while motion detectors are present alongside it. While a rain sensor identifies wet diapers, a DC fan keeps the room at a suitable temperature. Components like cradle swing, DC fan operations, or even playing of lullabies can be remotely controlled through web interface. It implies that one can easily control his infant immediate surroundings from anywhere around the world without hassle. The proposed system utilizes ESP32 technology making use of ESP32 camera for detecting children via live streaming. This all-inclusive monitoring has provided a new dimension to childcare technology thus relieving anxiety among workers as well as inexperienced parents.

DOI: 10.1007/978-3-031-94280-8_1

View paper

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[30] **Design of a Downhole Acoustic Emitter for Impact on the Productive Formation and Enhanced Oil Recovery**

Maybe related

Abstract: In this paper deals with the issues of designing a downhole acoustic emitter designed to influence the productive formation in order to intensify oil production. The paper analyses acoustic technologies used in the oil industry, focusing on their impact on physical and chemical processes in the reservoir, such as reducing oil viscosity, improving rock permeability and increasing hydrocarbon production. A new method of impact using acoustic waves generated by a modernized emitter based on the jet-driven Helmholtz oscillator is developed. The experimental study of pressure oscillation generation on the emitter model is presented, and the economic efficiency and prospects of application of this technology in conditions of various geological formations are estimated. The work is of practical importance for optimization of

methods of oil production intensification and development of new technologies to increase the degree of hydrocarbon recovery from the fields.

DOI: 10.1007/978-3-032-04273-6_18

View paper

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[31] **Classify Object Behavior to Enhance the Safety of Autonomous Vehicles**

Maybe related

Abstract: The rapid development of autonomous vehicles (AVs) necessitates advanced safety measures to ensure reliable and secure operation in diverse environments. One crucial aspect of enhancing AV safety is the ability to accurately classify and predict the behavior of surrounding objects, such as other vehicles, pedestrians, cyclists, and static obstacles. This study focuses on developing a robust object behavior classification framework leveraging machine learning and deep learning techniques. By integrating sensor data from LiDAR, radar, and cameras, the proposed system processes real-time environmental information to identify and categorize object behaviors. The framework employs a combination of convolutional neural networks (CNNs) for image data processing and recurrent neural networks (RNNs) for sequential data analysis, ensuring precise behavior prediction. The research highlights the importance of feature extraction, data fusion, and model optimization in achieving high classification accuracy. Furthermore, the study addresses challenges related to dynamic environments, occlusions, and varying weather conditions, providing solutions to enhance the robustness of the classification system. The effectiveness of the proposed approach is validated through extensive simulations. Results demonstrate significant improvements in behavior prediction accuracy and response times, contributing to the overall safety and reliability of autonomous vehicles. This research underscores the critical role of

advanced object behavior classification in the evolution of autonomous driving technologies, paving the way for safer and more efficient transportation systems.

DOI: 10.1007/978-3-031-94283-9_8

View paper

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DOI: 10.1007/978-3-031-94283-9_8

View paper

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[33] **Design and Implementation of an Augmented Reality System for the EPN Museum**

Maybe related

Abstract: Museums worldwide, in response to advances in the Industrial Revolution and artificial intelligence, have adopted digital technologies such as sensors and machine learning to enhance the reconstruction and presentation of ancient objects, environments, and prehistoric animals, offering more enriching experiences for visitors. One such technology is augmented reality (AR), which creates interactive environments allowing users to explore and engage, enhancing the quality and interactivity of visits. This article presents an AR system developed for the “Gustavo Orcés” Natural History Museum at the Escuela Politécnica Nacional. The system uses a camera and computer to process images and detect people using Histogram of Oriented Gradients (HOG) and Support Vector Machines (SVM) techniques, which determine if the image matches a person. During testing, deficiencies in user detection were found due to lighting variations in the installation area, leading to the integration of low-cost presence sensors into the system: one based on PIR sensors and another using ultrasonic sensors, aimed at improving detection and ensuring effective system activation. After testing, it was concluded that the PIR sensor proved more effective. The system includes an application developed in Unity that displays interactive 3D models of dinosaurs, enhancing interactivity and providing an immersive experience for visitors. The combination of software and hardware in person detection achieved 100% effectiveness after resolving lighting-related technical issues. This

technological integration not only enriches learning but also represents an innovative step forward in how museums interact with their audiences.

DOI: 10.1007/978-3-031-98290-3_11

View paper

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[34] **Bio-inspired Electric Field Communication System for Underwater Robot Swarms**

Maybe related

Abstract: Underwater communication is essential for various applications, including oceanographic research, environmental monitoring, and underwater robotics. Traditional communication systems, such as acoustic and optical methods, face significant challenges in the underwater environment, including signal attenuation, multipath propagation, and environmental disturbances. This paper proposes a bio-inspired electric field communication system, drawing inspiration from weakly electric fish, to overcome these limitations. The system uses amplitude-shift keying (ASK) modulation combined with FPGA-based adaptive circuits to provide a low-power, compact, and stable communication solution for underwater robot swarms. Experimental results conducted in a freshwater environment demonstrate that the system achieves a bit error rate of 0% at a communication distance of 2.4 m. The performance is further optimized with a parallel electrode configuration, reducing power consumption by 40% and shrinking the system's size by 30% compared to existing solutions. This bio-inspired communication system offers a promising alternative for real- time, adaptive communication in underwater swarm robotics.

DOI: 10.1007/978-981-95-1331-4_36

View paper

[35] **Realization of Robot Additive Manufacturing**

Maybe related

Abstract: The main goal of this publication is to create a methodology for generating movements for robotic arms with the purpose of realizing Robot Additive Manufacturing (RAM). Additive manufacturing, encompassing a wide range of technologies, is a modern manufacturing method that has seen a rapid increase in popularity in industrial sectors, research, development and even in the everyday consumer sector. Continuous research in the field of additive manufacturing has led to the emergence of new technologies and applications, significantly expanding its use across various industrial sectors. One of these technologies is Robot Additive Manufacturing (RAM). For the successful realization of the desired product through additive manufacturing, a key factor is not only the correct setting of process parameters but above all, precise and efficient movements of the device that will be used for this kind of manufacturing. In conventional 3D printers, the process of generating movements and process parameters is achievable through standardized methods and available software solutions. In the case of additive manufacturing using industrial robots, this process is usually fundamentally different. Generating accurate, smooth, and efficient movements for robotic arms is crucial for the successful realization of RAM. This scientific publication aims to define methods for generating movements for the robotic arm for the purpose of realizing RAM. The goal is to generate movements for various printing methods described in this publication and using a variety of materials for printing such as plastics, concrete, or metal. Subsequently, integrate the generated movements into the robotic arm and verify the proposed methodology at an experimental station with the ABB IRB 120 robotic arm.

DOI: 10.1007/978-3-031-94770-4_8

View paper

[36] **Extension of Industrial and Collaborative Robots for Increased Work Space and Operation in Confined Spaces**

Maybe related

Abstract: Collaborative robots, such as the KUKA LBR iiwa, UR series from Universal Robotics, and many more, have opened new fields of applications in industries through human-robot collaboration. However, despite up to seven rotational degrees of freedom typically offered by commercial collaborative (and industrial) robots, the operational reach is often not sufficient. This prevents these robots from reaching into and operating within confined spaces autonomously or in collaboration with human co-workers. To overcome these limitations, this paper presents a custom-made, open-source, affordable robot arm extension to be mounted on commercial or custom-made robots. The developed solution adds three additional degrees of freedom, including a 0.5 m linear rail. These additional degrees of freedom of the robot extension significantly increase the reach and ability of industrial and collaborative robots to operate in narrow environments. The developed extension is demonstrated by extending a KUKA LBR iiwa 14 collaborative robot operating various insect farming use cases, including tasks such as reaching into crates for insect rearing, operating within caged enclosures, and material handling over a wider workspace. Furthermore, simulations are used to provide insights into the extended reach of the robot. Simulation results show an increase in total operational space by up to 110% 110 %, and a 200% 200 % increase in positions reachable from $\geq 50\%$ ≥ 50 % of tested orientations, compared to a baseline KUKA iiwa.

DOI: 10.1007/978-3-032-01486-3_36

View paper

[37] **Introduction**

Maybe related

Abstract: This chapter establishes the research context of this book: embodied intelligence. It clarifies the research focus: leveraging computer science principles to develop mobile robots as productive tools for human society. Finally, it presents relevant open-source projects related to the content discussed herein.

DOI: 10.1007/978-981-96-7094-9_1

View paper

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[38] **A Secure System to Detect Animal Intrusion and Notify Users in a Farmland**

Maybe related

Abstract: Human-wildlife conflicts are a growing concern in Tamil Nadu, where wild animals frequently damage farmlands, threatening crops and livelihoods. To address this issue, a robust monitoring and alert system is proposed, leveraging a PIR sensor and camera module for wildlife detection. The collected data is processed using a Raspberry Pi, connected via the Virtual Serial Port Emulator (VSPE) for efficient communication. Advanced machine learning (ML) models classify images into “wild animals” or “others,” enabling precise threat identification. On detecting wildlife, encrypted email notifications with images and Base64-encoded decryption keys are sent to forest officials and farm owners. A custom desktop application allows secure decryption and analysis of the images, ensuring prompt response. By integrating real-time monitoring, secure data handling, and effective communication, this system offers a scalable and user-friendly solution to minimize crop damage and improve human-wildlife coexistence.

DOI: 10.1007/978-3-031-98360-3_5

View paper

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[39] **Benchmarking in Mobile Robotics**

Maybe related

Abstract: This chapter presents a study on software engineering for mobile robotics, focusing on benchmarking robot performance, including evaluation methods, metrics, and the construction of testbeds and datasets. It also offers insights into integrating AI into testing tools, benchmarking ethics, and data privacy, aspects increasingly relevant to modern AI development. While these latter topics are not the primary focus of this chapter, sharing the author's experiences and perspectives is nonetheless valuable, given their growing importance in contemporary research. Beginning this book with benchmarking aligns with the software engineering principle of "testing before development", emphasizing the need to establish evaluation methodologies before discussing methods for realizing embodied intelligence. This approach also resonates with the European Commission's emphasis on formulating standards prior to extensive AI development to mitigate the risks of uncontrolled and unregulated advancements, which could lead to detrimental consequences.

DOI: 10.1007/978-981-96-7094-9_2

View paper

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DOI: 10.1007/978-981-96-7094-9_2

View paper

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[41] **Seeing Through the Robot's Eyes: Adaptive Point Cloud Streaming for Immersive Teleoperation**

Maybe related

Abstract: Autonomous Mobile Robots (AMRs) are increasingly deployed in diverse scenarios to automate tedious and hazardous tasks. Nonetheless, challenges such as complex environments, sensor occlusions, and limitations of autonomous navigation systems often require human intervention. Teleoperation offers a viable solution, allowing operators to remotely control AMRs when autonomy fails, without requiring physical presence. A key requirement for effective teleoperation is the real-time delivery of rich sensory information to the operator. Head-Mounted Displays (HMDs), combined with volumetric videos, provide an immersive visualization of the robot's surroundings, enabling natural viewpoint changes and improved spatial awareness compared to

traditional 2D video streams. In this paper, we present a teleoperation framework to stream in real-time volumetric videos in the form of point clouds to an operator wearing a HMD. The system includes a distance-based sampling strategy that dynamically adapts the point cloud bitrate to the estimated time-varying network bandwidth, addressing constraints imposed by limited computational resources on both the robot and the HMD. The framework is implemented on a real mobile robot and evaluated under various network conditions, including a 5G connection, demonstrating its effectiveness and robustness in supporting immersive remote teleoperation. Code is available at our GitHub repository (https://github.com/Diane-Spirit).

DOI: 10.1007/978-3-032-03805-0_1

View paper

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[42] **An Intelligent Mobile Navigation System for Visually Impaired People Using Computer Vision and Deep Learning for Multi-label Classification in Park Environments**

Maybe related

Abstract: Individuals with visual impairments encounter considerable difficulties when navigating outdoor environments, where limited accessible information can lead to accidents or discomfort. To address this issue, an intelligent system is proposed, utilizing deep learning and computer vision to assist users with visual impairments in safely navigating park environments. The system adopts a structured machine learning approach, comprising phases of data preprocessing, model training, and evaluation. The dataset used in this study, though small and self-collected, includes images of common park elements such as benches, trees, and vehicles. This limited dataset presents an opportunity to explore transfer learning and fine-tuning techniques to improve model performance. Several convolutional neural network (CNN) models are evaluated using classification metrics like Hamming Loss, which

is especially important for multi-label classification tasks. Results show promising accuracy and effective performance in real-world applications. Future work will aim to expand the dataset, include additional object categories, and enhance system adaptability by integrating advanced sensory inputs and incorporating user feedback.

DOI: 10.1007/978-3-031-98287-3_29

View paper

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[43] **LiDAR Pedestrian Detection and Trajectory Tracking Based on Morphological Extended-Jump-Distance Clustering Segmentation**

Maybe related

Abstract: This paper proposes a novel method of morphological extended-jump-distance clustering segmentation to improve the steps of noise filtering and clustering segmentation for LiDAR pedestrian detection and trajectory tracking, and applies the novel method to the implementation of the intelligent patrolling security robot. After 2D LiDAR point cloud is input, at the step of noise filtering, this paper adopts morphological opening operator to filter out the noise of 2D LiDAR point cloud. Then, at the step of clustering segmentation, this paper proposes extended-jump-distance clustering segmentation to effectively eliminate redundant cluster and optimize clustering segmentation of 2D LiDAR point cloud for elaborate feature extraction of all human legs. Next, at the step of machine learning and pedestrian detection, this paper adopts leg-feature-based machine learning classifier for pedestrian detection. Finally, at the step of trajectory tracking, this paper switches 3 well-known trajectory tracking methods depending upon various environmental conditions to record the pedestrian trajectory. Experimental results show, under public datasets of Freiburg city center and Freiburg main station, LiDAR pedestrian detection and trajectory tracking based on proposed morphological extended-jump-distance clustering segmentation has better accuracy and

immediateness than those based on conventional geometric distance clustering segmentation and conventional geometric agglomerative clustering segmentation.

DOI: 10.1007/978-981-96-6291-3_15

View paper

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[44] **Transforming Lives: AIoT-Driven Deep Learning for Real-Time Speech Assistance for the Ophthalmologically Impaired**

Maybe related

Abstract: The paper presents the design and development of a smart glass system equipped with AI-based object detection and voice assistance, aimed at aiding visually impaired individuals in navigating their environment independently. Smart glasses use the most advanced computer vision system to detect and identify objects in real time and provide users with audio feedback about the surrounding environment. The system uses pre-trained convolutional neural network (CNN) models to process live video feedback from cameras mounted on the glasses, ensuring accurate and fast information is provided. Smart glasses combined with voice assistants can read text aloud, provide step-by-step instructions, and warn users about potential problems, improving their travel and experience. These new assistive devices are designed to improve the quality of life of the visually impaired by providing reliable and convenient tools for independent navigation and daily activities. This article describes the hardware and software of smart glasses, the implementation process, and performance evaluation.

DOI: 10.1007/978-3-031-98360-3_24

View paper

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DOI: 10.1007/978-3-031-98360-3_24

View paper

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[46] **Acoustic Leak Signal Recognition Based on Convolutional Neural Network Model**

Maybe related

Abstract: With the continuous expansion and extension of pipeline networks, leakage incidents in pipeline systems have become increasingly frequent, severely impacting the surrounding

environment and residents. Consequently, the safety monitoring of pipeline systems has become particularly important. Acoustic leak signal recognition technology plays a pivotal role in detecting and locating pipeline leaks. This technology is gradually transitioning from traditional methods to deep learning approaches, which has introduced new opportunities and challenges to the field. However, the accuracy and generalization capability of acoustic leak signal recognition still require further enhancement. After pre-processing, the acoustic signals are converted into Mel-Frequency Cepstral Coefficients (MFCC) feature maps as inputs, transforming the acoustic signal recognition problem into an image recognition problem. The CNN is then employed for learning and classification to identify the presence of leaks. The dataset includes acoustic signals collected under various environmental conditions. Experimental results indicate that the proposed improved CNN model performs exceptionally well in leak detection tasks, achieving a high accuracy rate. Compared to sound signal recognition methods based on Support Vector Machine (SVM) and Alex Net, the proposed method demonstrates a significant advantage. The CNN-based acoustic leak signal recognition method proposed in this paper not only improves the accuracy of leak detection n but also provides an effective technical means for the safety monitoring of pipeline systems. Future work will focus on further optimizing the model and validating its application in actual industrial environments.

DOI: 10.1007/978-981-95-1334-5_13

View paper

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[47] **Lessons Learned from the RAICAM Doctoral Network Research Sprints**

Maybe related

Abstract: Doctoral Networks (DNs) aim to address systemic challenges in doctoral education, such as fostering

interdisciplinarity, enabling international and intersectoral collaboration, enhancing employability, and promoting responsible innovation. While cohort-based training helps mitigate student isolation through workshops and summer schools, traditional DNs often struggle to fully realise their collaborative potential, often relying on predefined supervisor relationships or the initiative of individual researchers. In contrast, Marie Skłodowska-Curie Doctoral Networks (MSCA-DNs) prioritise doctoral candidates (DCs), challenging them to balance independent research with contributions to a shared, mission-driven objective. This study examines how structured training, including digital communities and application-focused research sprints, enhances system integration and collaboration within the Robotics and AI for Critical Asset Monitoring (RAICAM) Doctoral Network. DCs located across seven European countries worked in virtual teams, refining systems through structured workflows, weekly meetings, and shared workspaces before training schools. Through continuous online collaboration and targeted sprints, RAICAM facilitated interdisciplinary integration. Two research sprints, conducted in Italy and France, allowed teams to develop and test solutions for real-world challenges with an impact-driven plan that considers a given problem from and end-to-end perspective that requires and foster interdisciplinary collaboration. The results highlight the effectiveness of structured training in enhancing collaboration and adaptability, while identifying key areas for improvement. This study translates lessons from RAICAM into practical guidelines for future doctoral networks, demonstrating how structured training empowers students to drive interdisciplinary research independently.

DOI: 10.1007/978-3-032-01486-3_40

View paper

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[48] **Towards Safer Roads: Utilizing Synthetic Data and Neural Networks to Classify Safe Distances in Driving Scenarios**

Maybe related

Abstract: This paper introduces an innovative methodology utilizing image analysis with neural networks (NN) to enhance driver awareness and mitigate road safety risks. By employing Scenic and CARLA simulators, we generate diverse synthetic images representing various driving scenarios, ensuring robustness and generalizability. Unlike traditional approaches, our parameter-free NN model autonomously learns to classify safe and unsafe distances from input images without manual calibration. Through deep learning, it discerns patterns effectively, offering real-time alerts for potential hazards. This methodology enables proactive intervention precisely when driver attention is critical, fostering a symbiotic relationship between driver and automation. We present three datasets comprising 12,000 synthetic images each, establishing the first synthetic dataset for distance classification. Experimentation with custom CNN, VGG16, and ResNet-18 demonstrate the efficacy of our approach, with specified distance ranges for safe and unsafe scenes. Our system shows promising results in classifying distances, contributing to improved road safety.

DOI: 10.1007/978-3-031-93691-3_15

View paper

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[49] **Regulation of the Level in a Wastewater Process Pumping Tank**

Maybe related

Abstract: Efficient level regulation in wastewater process tanks is critical for maintaining optimal performance in wastewater treatment systems. Inefficiencies in current sewage networks struggle to accommodate increasing production and population growth, leading to stringent legislative limits on industrial waste discharge. Consequently, many companies aim to recycle and reuse

wastewater within their processes. This study focuses on designing a control system for wastewater tanks that ensures the optimal maintenance of wastewater levels, thus supporting the overall efficiency of treatment processes. The primary objectives are to develop a straightforward control system, simulate the application software, and create a visualization interface for the operator panel of a sewage pumping station. This work emphasizes the importance of a robust regulator to maintain the required tank levels, which is crucial for the smooth operation of the wastewater treatment process.

DOI: 10.1007/978-3-031-94770-4_40

View paper

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[50] **Toward Semantic Scene Understanding: Benchmarking for Mobile Robot Navigation Indoors**

Maybe related

Abstract: Mobile robot navigation is a constantly evolving field that is adopting new paradigms along the way, and recent methods, such as Transformer-based models, have helped facilitate advancements in perception and decision-making tasks in this decade alone. This paper explores modern scene understanding techniques, including Contrastive Language-Image Pretraining (CLIP) and its role in improving semantic scene comprehension for various indoor environments. Existing benchmarking methods for evaluating autonomous mobile robot navigation performance are limited in accommodating the dynamic nature of real-world scenarios. Therefore, a set of metrics is proposed for robust evaluation, highlighting the need for standardized frameworks that meet modern expectations. Furthermore, a multimodal robot navigation model is introduced; it consists of visual and laser data combined with semantic embeddings to augment navigation performance. The proposed model and metrics aim to contribute to

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DOI: 10.1007/978-3-031-93825-2_9

View paper

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DOI: 10.1007/978-3-031-93825-2_9

View paper

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[52] **MARS-SLAM: Marker-Assisted Region Scanning for Simultaneous Localization and Mapping**

Maybe related

Abstract: This paper presents Marker-Assisted Region Scanning for Simultaneous Localization and Mapping (MARS-SLAM), a novel approach to optimizing the Simultaneous Localization and Mapping process in unknown environments. The method was specifically designed to address the challenges of autonomous exploration in extreme conditions, to enable efficient navigation and offer a systematic approach to determine the completion of mapping. The approach uses markers to indicate unexplored regions, ensuring an organized and complete exploration. During the process, the robot places markers in free areas identified by the LiDAR sensor, located at the sensor's range limit, building a list of regions yet to be explored. The mapping is considered complete when the marker list is empty, indicating that no unexplored regions remain. Target marker selection during navigation is based on age and distance. Age refers to the chronological order in which markers are created, while distance refers to the length of the route from the robot to the marker. The method is validated in two virtual environments of varying complexity. Experimental results demonstrate the effectiveness of MARS-SLAM in achieving complete mapping and accurately identifying mapping completion. Compared to alternative navigation methods, including predefined zigzag routes and routes generated by Ant Colony Optimization (ACO) algorithms, MARS-SLAM shows superior performance, particularly in reducing the number of poses required to complete the mapping, achieving a 64.39% reduction in poses compared to ACO and a 71.07% reduction compared to zigzag.

DOI: 10.1007/978-3-031-97596-7_2

View paper

[53] **MetaRAED: Meta Learning Prototype-Based Retrieval Augmented Few-Shot Event Detection**

Maybe related

Abstract: Few-shot event detection intends to identify events of emerging types given merely a few annotated examples for model training. It is quite a challenging task due to insufficient event information and poor generalization owing to limited data. Although promising results have been achieved, previous methods still ignore the semantic relevance between newly emerging event types and old ones. In this work, we propose MetaRAED, a meta learning prototype-based retrieval augmented model for few-shot event detection. Inspired by retrieval augmented generation (RAG) in large language models, we propose to maintain an event knowledge base storing observed events and then retrieve relevant features from it to augment the detection of novel types of events in a discriminative way called retrieval augmented discrimination (RAD). Additionally, we introduce an estimate-then-sample strategy, which models the distributions of events, as well as the model-agnostic meta learning paradigm for training to further strengthen the model generalization. Extensive experiments on a widely-used large few-shot event detection dataset prove the effectiveness and robustness of our proposed model.

DOI: 10.1007/978-981-96-7008-6_22

View paper

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[54] **Track Sential**

Maybe related

Abstract: This proposed system aims to enhance railway safety by implementing two crucial safety features. The first safety feature involves the use of motorized platforms at railway stations that rotate upward when no trains are on the track, allowing passengers

to board and alight safely. When a train approaches, the platform returns to its normal position. The second safety feature is a braking system installed in the train engines, utilizing ultrasonic sensors to detect obstacles on the track and automatically halt the train to avoid collisions. Both features are implemented using an Arduino Uno board, which interfaces with ultrasonic sensors and servo motors for platform rotation and engine braking control.

DOI: 10.1007/978-3-031-94283-9_5

View paper

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DOI: 10.1007/978-3-031-94283-9_5

View paper

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[56] **Path Planning and Navigation Methods for Quadruped Robots in Complex Energy Storage Station Environments: A Perspective**

Maybe related

Abstract: With the increasing scale and complexity of energy storage stations, traditional manual inspection methods can no longer meet safety and maintenance requirements. Quadruped robots, with their excellent all-terrain adaptability, have become an ideal choice for intelligent inspection of energy storage stations. This paper reviews path planning and navigation technologies for quadruped robots in complex energy storage station environments, including LiDAR SLAM, multi-sensor fusion localization, motion planning, and obstacle avoidance methods, and discusses the possibility of multi-robot collaborative operation to provide references for energy storage station intelligent inspection system design. By analyzing mainstream LiDAR odometry techniques, we propose optimization directions for quadruped robot navigation systems in complex energy storage station environments, aiming to solve the positioning problems of traditional methods in feature-scarce environments and improve inspection efficiency and accuracy.

DOI: 10.1007/978-981-95-1334-5_36

View paper

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[57] **A Low-Cost Vision-Based Framework for Autonomous Driving Using YOLO, MiDaS, and Stereo Vision**

Weak/No relation

Abstract: To revolutionize agriculture and warehouse based autonomous driving, this vision-based system offers a low-cost, adaptable, and scalable solution by leveraging advanced computer vision and robotics techniques. The updated project emphasizes precise object detection using YOLO and a combination of YOLO with MiDaS for depth-aware identification. For row crops, OpenCV based color segmentation is utilized to highlight crop regions, with the largest blob in the perspective identified to determine

prominent rows. Stereo vision plays a crucial role in camera calibration, depth map generation, and accurate human detection with distance estimation. This integrated approach addresses the limitations of traditional LiDAR sensors, which are often hindered by high costs and poor performance in dusty or dense vegetation conditions. By combining real-time environmental modeling with adaptive navigation, the system enhances operational efficiency and effectiveness in complex agricultural scenarios, positioning itself as a reliable tool for modern farming practices.

DOI: 10.1007/978-3-031-98360-3_4

View paper

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[58] **FFYOLO: A Lightweight Small Target Detection Algorithm for UAVs**

Weak/No relation

Abstract: Although existing object detection models have achieved remarkable results in processing speed and accuracy, their performance often deteriorates when dealing with small targets. To address this issue, we propose Feature Fusion YOLO (FFYOLO) based on YOLOv8n. Specifically, we utilize a lightweight CNN based Cross-scale Feature Fusion module (CCFM) to integrate features of different scales. Simultaneously, an adaptive spatial feature fusion (ASFF) method is introduced to effectively filter out conflicting information and enhance scale invariance. Finally, an additional detection head is added to further improve the detection capability for small targets. Experiments conducted on the VisDrone-DET2019 dataset demonstrate that FFYOLO achieves an mAP@0.5 of 40.2%, representing an 8% increase compared to the baseline YOLOv8n model.

DOI: 10.1007/978-981-95-1233-1_51

View paper

[59] **Object Detection Through Finger Count Using Deep Learning Techniques for HRI**

Weak/No relation

Abstract: The Human-Robot Interaction (HRI) system to help disabled and elderly community and improve their standard of living is still offers considerable potential for further exploration. This research work focuses on the automatic detection of objects through the automatic recognition of human finger count. The two Deep Learning (DL) techniques, MediaPipe and You Only Look Once (YOLO) v8 are employed for human finger count recognition and object detection, respectively. The study involves a mapping of finger count and corresponding object classes. A new dataset is created from scratch, encompassing four distinct object classes. Utilizing the Intel RealSense depth camera, the system provides position and depth information of the detected objects based on specific finger count. Simulation and experimental results indicate that the proposed approach outperforms recent related studies, demonstrating significant efficacy in developing an advanced HRI system.

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View paper

[60] **YOLOv9++: An Improved YOLOv9 Detector for Plant Biometrics Using Pseudo-labels**

Weak/No relation

Abstract: Agriculture remains crucial to many economies worldwide, yet plant diseases threaten its productivity and sustainability. Early detection and timely treatment are essential for

mitigating their impact. Traditional detection methods are labor-intensive and costly, necessitating real-time solutions. Deep learning holds promise, but existing approaches struggle with simultaneous localization and classification. To address this, we propose YOLOv9++, an enhanced variant of YOLOv9 integrated with Convolutional Block Attention Module (CBAM). Our model significantly improves accuracy and efficiency in plant leaf disease detection. We introduce a large-scale leaf disease detection dataset called PlantVillage-LD2 inspired by the PlantVillage dataset. YOLOv9++ achieves competitive performance, surpassing the baseline YOLOv9, achieving a mAP:50 of 93.7% on the PlantVillage detection dataset. Moreover, on the PlantDoc dataset, YOLOv9++ achieves an mAP:50 of 61.7%, surpassing other detection algorithms. Our findings highlight the practicality of YOLOv9++ for real-time plant disease detection, fostering sustainable agricultural practices globally.

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View paper

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[61] **Prototype Design and Implementation of an IoT Based Intelligent Dustbin for Smart City**

Weak/No relation

Abstract: In today's evolving urban landscape, garbage management has emerged as a critical challenge for environmental sustainability and public health. Traditional waste collection involves manual inspection, where individuals check for waste accumulation, which is time-consuming and complex. To address this problem and assist waste management staff by saving time and reducing unnecessary trips, an intelligent dustbin prototype is proposed. This system allows workers to focus their efforts only when necessary, improving efficiency in waste collection. The intelligent dustbin prototype uses Internet of Things (IoT) components including NodeMCU ESP8266 microcontroller, HC-SR04

ultrasonic sensor, and Neo 6M GPS module to monitor garbage levels, track dustbin locations, and notify authorities if the garbage exceeds a threshold. The prototype is integrated with two in-built mobile applications: the Blynk App for real-time garbage level monitoring and the Telegram App, where a bot sends alerts and dustbin locations to waste management staff. This aids efficient waste management and improves collection and resource distribution.

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View paper

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[62] **Analysis of Stabilization Control in a Hexapod Robot: An Approach Utilizing MPU6050 and Kalman Filtering**

Weak/No relation

Abstract: This paper presents a stabilization control system for the Freenove Big Hexapod robot, aimed at enhancing locomotion on uneven terrains. The system integrates an MPU6050 sensor for motion tracking, a Kalman filter to reduce sensor noise, and a PD controller to compensate for roll and pitch deviations. Designed for real-time operation, the system dynamically adjusts the robot's posture to maintain stability during movement. Experimental validation was conducted on a custom-built inclined platform simulating various terrain conditions, demonstrating the system's ability to reduce instability and maintain balance under moderate inclinations. While effective within specific limits, the results highlight areas for future improvement, including adaptive control techniques for handling steeper and more variable terrains. The proposed approach underscores the potential of stability-focused control systems in advancing robotic locomotion in complex environments.

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View paper

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[63] **Outside and Inside the Surface. A Statue of Apollo from Villa Corsini in Castello (Florence)**

Weak/No relation

Abstract: This paper focuses on a marble statue representing the god Apollo as an archer, from the collections of the National Archaeological Museum of Florence (MAF), now exhibited at Villa Corsini in Castello (Florence). The larger-than-life-size statue has been considered a Roman pastiche: a head derived from a 4th century BCE (Before Common Era) prototype was joined to a body inspired by models from the beginning of the 5th century BCE. In this perspective, it would be important to define whether this pastiche is a Roman or a Modern work. Having no information about the provenance of this unique sculpture, this research sheds new light on its biography through the investigation of its materiality. Specifically, 3D Ultrasonic Tomography is employed to examine marble characteristics. The obtained velocity model shows interesting results, highlighting areas of obvious integrations and possible metal pins, to join parts of the statue. The analysis of these results leads to the idea that the statue was probably reassembled in modern times, in a way that is not entirely consistent with its original appearance.

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View paper

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[64] **Securing Systems from Aerial Threats: Cybersecurity in the Drone Era**

Weak/No relation

Abstract: This research addresses the critical need for robust cybersecurity frameworks for drone operations as they begin to be essential components of sensitive applications including surveillance, logistics, and crisis response. The study proposes a multi layered defense framework motivated by the vulnerabilities drones introduce to cyber threats such as GPS spoofing, Denial of Service (DoS) attacks, and unauthorized access. This framework was developed using MATLAB Simulink and it integrates many subsystems such as Drone Dynamics and Control, Communication Processing, GPS Spoofing Detection, Anomaly Detection, Threat Response, and Data Logging. The individual subsystems are responsible for focusing on the different aspects of the drone security domain, offering real time threat detection, operational logging and response. The framework was evaluated through simulated attack scenarios, it successfully detected and mitigated various cyber threats with high anomaly detection accuracy and no false positive. When threats were identified, emergency protocols such as Hover, Return Home, and Land modes served to protect the drone. A modular structure would enable subsystems to operate independently, while still contributing towards an integrated, resilient defense. This work showcases that a layer defense approach can provide amplified drone security with an adaptable and functional response to threat mitigation in both military and civilian drone implementations. Efficiencies in processing will be optimized and coverage to more threats will be increased in future improvements to increase drone resilience.

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View paper

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[65] **GRASP-SLAM: Gmapping-Augmented DRL for Active SLAM Using Policy Gradient**

Weak/No relation

Abstract: Traditional Simultaneous Localization and Mapping (SLAM) passively receives sensor information for mapping and positioning, while active SLAM systems allow robots to acquire environmental information actively. The combination of deep reinforcement learning (DRL) and SLAM allows the robot to directly select actions based on its surrounding environment and reward information, becoming a truly autonomous agent. However, most active SLAM algorithms now use the discrete strategy of DRL, and the robot can only act according to the preset speed and angle. Otherwise, the robot can only use the continuous strategy to explore fewer parts. GRASP-SLAM, an active SLAM framework implemented by building a DRL continuous policy framework that conforms to active SLAM principles. We designed relevant data formats based on the Twin Delayed Deep Deterministic policy gradient (TD3) algorithm to enable the robot to independently select actions and termination times. Reward functions based on robot motion and map exploration rate are also designed to allow the robot to reduce collisions and draw a more accurate map. In a complex environment completely different from the training environment, GRASP-SLAM can still achieve a higher degree of map completion in a shorter time than other methods and can be exploited in a loop closure to reduce its uncertainty.

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View paper

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[66] **Induced Antifragility**

Weak/No relation

Abstract: This chapter is dedicated to induced antifragility. Here, we discuss the benefits of input distribution irregularities based on emergent system dynamics in a feedback loop with a controller that drives the system towards a prescribed dynamics. We consider methods for detecting, analyzing, modelling, and controlling road traffic, robotics, and industrial control systems' antifragility.

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View paper

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[67] **Optical Lens Attack on Deep Learning Based Monocular Depth Estimation**

Weak/No relation

Abstract: Monocular Depth Estimation (MDE) plays a crucial role in vision-based Autonomous Driving (AD) systems. It utilizes a single-camera image to determine the depth of objects, facilitating driving decisions such as braking a few meters in front of a detected obstacle or changing lanes to avoid collision. In this paper, we investigate the security risks associated with monocular vision-based depth estimation algorithms utilized by AD systems. By exploiting the vulnerabilities of MDE and the principles of optical lenses, we introduce $LensAttack$ LensAttack , a physical attack that involves strategically placing optical lenses on the camera of an autonomous vehicle to manipulate the perceived object depths. $LensAttack$ LensAttack encompasses two attack formats: concave lens attack and convex lens attack, each utilizing different optical lenses to induce false depth perception. We begin by constructing a mathematical model of our attack, incorporating various attack parameters. Subsequently, we simulate the attack and evaluate its real-world performance in driving scenarios to demonstrate its effect on state-of-the-art MDE models. The results highlight the significant impact of $LensAttack$ LensAttack on the accuracy of depth estimation in AD systems.

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View paper

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[68] **Pbstam: A Proactive Borewell Safety Using Teachable Arduino Model**

Weak/No relation

Abstract: India is a developing country where people depend on natural resources like water, air, land, and others. People extract these natural resources by digging borewells. It is observed that many of the borewells are left uncovered due to various reasons. These uncovered bore wells are the main reasons for the death of children and animals, who accidentally fall into it. According to the Indian census, falling inside the borewells has increased abundantly over the past decade. Many researchers tried to solve this problem using IoT devices which is a time-consuming process and provides only post-rescue solutions. This model strongly believes “Prevention is better than cure”. So, it integrates teachable ML with IoT devices to prevent objects from falling into the borewell. Integrating ML with IoT will automate the process of bore well and save many lives. The main advantage of using Teachable ML is it has a lot of images related to humans, birds, and animals which helps us to prevent training the model from scratch. In this model, if it recognizes an animal or a human being then it automatically closes the door. The model automatically recognizes the darkness of the environment and closes the door throughout the night. All the existing systems provide solutions with IoT devices, but they need human intervention which is automated in this model. The model also provides security by authenticating the system with automatic recognition of the corresponding higher officials. Even after providing prevention measures by chance, if any object falls into the borewell, the corresponding authority will receive an alert notification and a quick rescue team will reach the borewell location.

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View paper

[69] **FSR in Wireless Sensor Networks and UAVs: Enhancing Routing Efficiency**

Weak/No relation

Abstract: Routing protocols play a critical role in Mobile Ad-Hoc Networks (MANETs) by establishing efficient routes between source and destination nodes, ensuring timely data dissemination and transfer. These protocols adaptively map recipient addresses to current network locations through a Locator Service, utilizing single-hop transmission services for reliable end-to-end delivery. Key characteristics include minimal control overhead, loop prevention, topology management, scalability, and support for security and Quality of Service parameters. Fisheye State Routing (FSR), widely adopted in Wireless Sensor Networks (WSNs) and Unmanned Aerial Vehicles (UAVs), optimizes data delivery in various environments. The integration of FSR with mobile robots improves navigation and communication in dynamic environments, enhancing collaboration and task coordination in disaster response and industrial automation. FSR's efficient management of update messages, employing the fisheye technique to adjust coverage levels based on network size, mitigates bandwidth impact while maintaining routing accuracy. This study investigates FSR's advantages, emphasizing simplicity, resilience to host mobility, and efficient route updates. Performance metrics including packet delivery rate, network control overhead, throughput, and end-to-end delay are evaluated in grid environments. FSR demonstrates robust performance under various Quality of Service constraints, validating its effectiveness through NS2 simulations with high packet delivery rates and optimized throughput management.

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View paper

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[70] **PMC Peripheral Interfacing**

Weak/No relation

Abstract: After reading this chapter, the reader should be able.

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View paper

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[71] **Frequency Map Enhancement Revisited and Extended for Biohybrid Robotics**

Weak/No relation

Abstract: Frequency Map Enhancement with its ability to forecast periodic dynamics is a crucial step forward in robotic autonomy. We propose an extension that allows the modelling of phenomena that can be quantified by rational numbers, thus broadening its usability and applicability. We are evaluating its functionality in a simulation using data from the extensive robotic field experiment currently underway as part of the RoboRoyale project, which aims to help slow the global pollination crisis by supporting the most important pollinators - honeybees. The project performs vast amounts of robotic experiments around honeybee colony with thousands of bees interacting in a densely populated and ever-changing system, individual bees performing distinct tasks simultaneously. A honey bee colony is a challenging environment for autonomous robotics and spatio-temporal modelling. It opens questions on spatio-temporal modelling that were in the pure robotic experiments hidden or quietly bypassed.

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View paper

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[72] **Collision Detection and Avoidance Among SWARM Robots Using Convolutional Neural Networks (CNNs) in a Harsh Environment**

Weak/No relation

Abstract: The use of autonomous robots is rapidly increasing in industries, requiring advanced navigation strategies to ensure safe operations. SWARM robotics, inspired by natural swarm intelligence, faces critical challenges in collision detection and avoidance. Traditional rule-based methods often struggle in dynamic environments, whereas neural network-based approaches provide adaptive solutions. This paper presents a CNN-based collision detection and avoidance system utilizing LiDAR data for SWARM multi-robot systems. The proposed model was trained and tested using simulated data in the Gazebo and ROS 2 environments. A comprehensive description of the data set, a detailed model architecture, training parameters, and evaluation metrics are provided in this paper. The results show a precision of 85.65% in collision detection, with the precision, recall, and F1-score reported to better understand the performance. In addition, we compare our approach with baseline rule-based methods to highlight improvements.

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View paper

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[73] **Collision Detection and Avoidance Among SWARM Robots Using Convolutional Neural Networks (CNNs) in a Harsh Environment**

Weak/No relation

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intelligence, faces critical challenges in collision detection and avoidance. Traditional rule-based methods often struggle in dynamic environments, whereas neural network-based approaches provide adaptive solutions. This paper presents a CNN-based collision detection and avoidance system utilizing LiDAR data for SWARM multi-robot systems. The proposed model was trained and tested using simulated data in the Gazebo and ROS 2 environments. A comprehensive description of the data set, a detailed model architecture, training parameters, and evaluation metrics are provided in this paper. The results show a precision of 85.65% in collision detection, with the precision, recall, and F1-score reported to better understand the performance. In addition, we compare our approach with baseline rule-based methods to highlight improvements.

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View paper

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[74] **The HAVOC Model for Attacking VCDs**

Weak/No relation

Abstract: In this chapter, we first look at the fundamentals of attacks in the cyberspace by introducing common attack models used to formalise cyberattacks. After that, we tailor techniques we learned to the environment of voice-controllable devices, and we build the HAVOC Kill Chain, which describes the typical attack structure against the voice channel of a VCD. After that, we introduce the HAVOC Threat Model, with which we formalise the adversary’s capabilities and knowledge in a typical attack against the voice channel. Together, these two form the HAVOC (Hostile Activities on the VOice Channel) Model, that can be used to describe preconditions and unfolding of any attack against the voice channel.

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View paper

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[75] **Hierarchical Coverage Path Planning for a Multi-modal Robot Exploring Disconnected Regions**

Weak/No relation

Abstract: We present a near-optimal Coverage Path Planning (CPP) approach for multi-modal robots in complex environments with multiple arbitrarily shaped disconnected regions. The problem arises in ground coverage missions conducted in unstructured terrains, such as planetary exploration or search and rescue missions, where safe regions are disconnected by areas of high slope that a robot with a single locomotion modality cannot traverse. A multi-modal robot can switch between different locomotion modalities (e.g. driving and flying) to safely navigate these challenging environments while ensuring complete coverage. The proposed method identifies both traversable and non-traversable areas based on Digital Elevation Model (DEM) meshes. The problem is then formulated as a hierarchical Traveling Salesman Problem (TSP) and solved using Mixed-Integer Linear Programming (MILP). The proposed approach is evaluated on 500 randomly generated maps and four real-world simulation scenarios constructed from Martian terrain DEM data.

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View paper
