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EDITORIAL

Introduction to the focused section on novel sensing and multi-sensor fusion in robotics

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Intelligent robotic systems call for novel sensors and sensing technologies with the abilities to better interpret surroundings/environment, measure system parameters and monitor system status. Emerging applications, such as human–machine interface, mobile robots, and intelligent manufacturing etc., are developing along with rapid advances of communication, computer, control and AI technologies now widely available at low cost. Nowadays, stringent requirements and new expectations for highly cost-effective and reliable sensing systems are more and more challenging, including intelligentization, multi-purpose, multi-dimensional perception, modularization, high fault-tolerance, biocompatibility in addition to high accuracy and bandwidth.

With the emerging applications to robotics, this focused section competitively selects 11 research papers dedicating to report the latest advances and trends in sensing system design, modeling, and implementation, including novel sensing methods for robotic applications, intelligent sensing and machine perception for robotic systems, multi-sensor and multi-modal data fusion, human–machine interface for robotic systems, distributed sensing and networking, model-based and data-driven sensing system design. Although there are numerous new sensors, novel sensing methods and applications nowadays, the reported sensing methods cover typical approaches from optimization based, learning based to neural network based ones, and the sensing systems that integrate common visual, laser point cloud sensors, to distributed sensing network, which can move forward new and emerging technologies in intelligent robotics and applications.

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1 Novel sensing methods for robotic applications

Acting like the human brain, novel sensing methods are the center of the sensing system, which are capable of efficiently and accurately extracting desired information to interpret the surroundings for the robots using the measurements of commonly seen and low-cost sensors. Recently, the emerging developments of AI technologies and high-speed microcontrollers facilitate novel sensing methods applied in robotics.

The paper entitled "*Bayesian cue integration of structure from motion and CNN-based monocular depth estimation for autonomous robot navigation*" develops a framework for integrating structure from motion information into a dense monocular depth model trained on a standard dataset to enable robot navigation in an unstructured, hitherto unfamiliar environment. The paper entitled "*An edge implementation of a traffic sign detection system for advanced driver assistance systems*" proposes a lightweight squeezeNet model, which can fit into the memory of edge devices, such as the FPGA. The integration of the YOLO framework with the squeezeNet model achieves high-performance in terms of speed and accuracy for traffic sign detection.

2 Intelligent sensing and machine perception for robotic systems

Perception is a key function for robots to perceive, comprehend, and reason about the surroundings. It provides crucial information to guide robots to navigate through real-world environments and fulfill the operational goals.

The paper entitled "*LEDet: Localization Estimation Detector with Data Augmentation for Ship Detection Based on Unmanned Surface Vehicle*" proposes a one-stage localization estimation detector with ship-customized data augmentation. Specifically, LEDet integrates the localization quality estimation into the classification branch as a soft label localization score and further applied ship-customized data augmentation named "cutting-transform-paste" to create diverse ship datasets without manual annotation. The paper entitled "Car detection and damage segmentation in the real scene using a deep learning approach" presents a deep learning-based outer car surface damage detection, which can significantly reduce the cost of insurance claim assessments. Two convolutional neural network pipelines are developed, and state-of-the-art performance is achieved.

3 Multi-sensor and multi-modal data fusion

Advances in multi-sensor and sensor fusion technology have made localization possible without external navigation systems. Recently, various high-performance sensors such as cameras, magnetic sensors, IMU, LIDAR, etc. are utilized to identify the current location. Localization techniques along with deep learning and data fusion are extensively applied in numerous applications including wireless networks, robotics, and industrial automation.

The review paper "*AUV localisation: a review of passive and active techniques*" surveys two main techniques for localization in a harsh environment without an external navigation aid such as underwater. One is passive to provide the best estimation of the position based on the past and current information from sensors. The other is active to additionally produce guidance output minimizing the uncertainty of estimated position. The paper entitled "*Rbot: development of a robot-driven radio base station maintenance system*" presents to develop a remote teleoperation and autonomous operation system of a robotic arm with 5G network. The robot with two cameras demonstrates the practical task of cable switching through a first-person view. The localization technique of the robotic arm is applied to calibrate camera information in augmented reality.

4 Human–machine interface for robotic systems

Human–machine collaboration has become widespread, from semi-autonomous driving to manufacturing to assisted living. Effective human–machine interface is crucial for safe, efficient, and reliable execution of human–machine collaboration. Such interface needs to have the ability train robots to perform complex human-like tasks.

The paper entitled "*Development of Improved Coyote Optimization with Deep Neural Network for Intelligent Skill Knowledge Transfer for Human to Robot Interaction*" presents an approach for skill transfer between human and a robot through a novel Transfer Expert Reinforcement Learning (TERL) approach. This paper proses an improved Coyote optimization algorithm for fine tuning the skill transfer learning. Further, it demonstrates the use of deep neural networks to control robotic movements. The proposed approach is demonstrated by making use of the Robotics simulation in MATLAB.

5 Distributed sensing and networking

With the development of sensing and networking technologies, distributed sensor networks are replacing centralized sensing and control systems. Distributed sensor networks consist of a number of small, intelligent sensor nodes working together and can offer robustness by decentralization. In a structured distributed sensor network, all or some of the sensor nodes are deployed in a pre-planned manner, which results to lower network maintenance and management cost.

The paper entitled "*Taylor CMVO: Taylor Competitive Multi-Verse Optimizer for intrusion detection and cellular automata-based secure routing in WSN*" combines the competitive multi-verse optimizer (CMVO) and Taylor series to develop a Taylor CMVO-based Deep Q network model for effective anomalous behavior detection in wireless sensor network. The developed intrusion detection approach is demonstrated with high accuracy, sensitivity, and specificity. The paper entitled "*Optimal feature selection with CNN-feature learning for DDoS attack detection using meta-heuristic-based LSTM*" presents a Distributed Denial of Service (DDoS) detection model by integrating the CNN and optimized LSTM. DDoS first selects optimal features by Closest Position-based Grey Wolf Optimization to minimize the correlation among the features. Then CNN is adopted for feature learning process and optimized LSTM is used in the detection phase to maximize the detection accuracy by optimizing the hidden neurons of LSTM.

6 Model-based and data-driven sensing system design

Recent years have seen explosive growth in the internet of things (IoT) technology. This results in billions and billions of devices, from numerous household equipment to personal belongings to military and national security equipment, with internet connectivity. Such connectivity offers boundless opportunities for sensing. This new paradigm also exposes the lack of established mathematical models for optimal sensor design. Fortunately, the emergence of cloud computing offers a way to utilize data driven approaches to glean information from IoT devices in the absence of well-established theoretical models. Another feature of sensing technologies in the IoT environment is that they need to be well equipped to detect and prevent cyber-attacks.

The paper entitles "*IoT authentication model with optimized deep Q network for attack detection and mitigation*" offers approaches for detecting and mitigating attacks in the IoT environment. This approach is demonstrated using widely recognized BoT-IoT opensource datasets that emulate typical attacks in IoT environments. In the paper "*Henry MaxNet: tversky index based feature selection and competitive swarm henry gas solubility optimization integrated Deep Maxout network for intrusion detection in IoT*" offers an intrusion detection approach based on competitive swarm Henry Optimization. This paper also highlights the notion of security as a service in IoT environments.

7 Summary and acknowledgement

The 11 papers contained in this focused section were carefully chosen from 39 received submissions, which disseminates the most recent advances in the field of novel sensing and multi-sensor fusion in robotics, with extended applications in autonomous vehicles, human–machine interface and the internet of things (IoT) environments. Novel sensing and multi-sensor fusion cover very broad areas from new sensor design, intelligent algorithms to networked systems. Thus, many topics and excellent works have not been covered in this focused section, and we would like to see more interdisciplinary researches on fundamental sciences, emerging technologies and applications in the future.

Finally, we would like to acknowledge the great efforts and contributions by the authors and anonymous reviewers towards this focused section. We would also like to extend our sincere gratitude to the editor-in-chief and outstanding journal staff at IJIRA that made this focused section possible.

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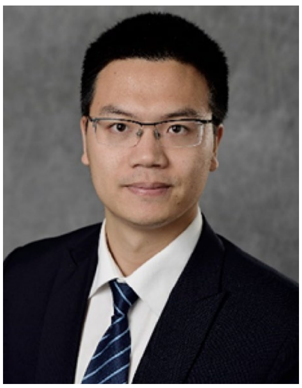

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