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Message from the Editor-in-Chief

As the world of science becomes ever more specialized, researchers may lose themselves in the deep forest of the ever increasing number of subfields being created. This open access journal *Applied Sciences* has been started to link these subfields, so researchers can cut through the forest and see the surrounding, or quite distant fields and subfields to help develop his/her own research even further with the aid of this multi-dimensional network.

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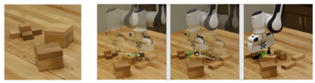
Section Robotics and Automation

Featured Papers

DOI:10.3390/app12020937

Smart Industrial Robot Control Trends, Challenges and Opportunities within Manufacturing

Authors: Janis Arents and Modris Greitans

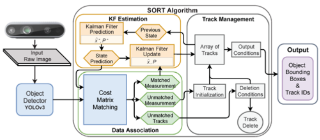


Abstract: Industrial robots and associated control methods are continuously developing. With the recent progress in the field of artificial intelligence, new perspectives in industrial robot control strategies have emerged, and prospects towards cognitive robots have arisen. AI-based robotic systems are strongly becoming one of the main areas of focus, as flexibility and deep understanding of complex manufacturing processes are becoming the key advantage to raise competitiveness. This review first expresses the significance of smart industrial robot control in manufacturing towards future factories by listing the needs, requirements and introducing the envisioned concept of smart industrial robots. Secondly, the current trends that are based on different learning strategies and methods are explored. Current computer-vision, deep reinforcement learning and imitation learning based robot control approaches and possible applications in manufacturing are investigated. Gaps, challenges, limitations and open issues are identified along the way.

DOI:10.3390/app12031319

Sort and Deep-SORT Based Multi-Object Tracking for Mobile Robotics: Evaluation with New Data Association Metrics

Authors: Ricardo Pereira, Guilherme Carvalho, Luís Garrote and Urbano J. Nunes

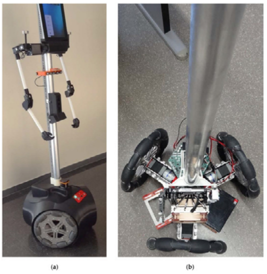


Abstract: Multi-Object Tracking (MOT) techniques have been under continuous research and increasingly applied in a diverse range of tasks. One area in particular concerns its application in navigation tasks of assistive mobile robots, with the aim to increase the mobility and autonomy of people suffering from mobility decay, or severe motor impairments, due to muscular, neurological, or osteoarticular decay. Therefore, in this work, having in view navigation tasks for assistive mobile robots, an evaluation study of two MOTs by detection algorithms, SORT and Deep-SORT, is presented. To improve the data association of both methods, which are solved as a linear assignment problem with a generated cost matrix, a set of new object tracking data association cost matrices based on intersection over union, Euclidean distances, and bounding box metrics is proposed. For the evaluation of the MOT by detection in a real-time pipeline, the YOLOv3 is used to detect and classify the objects available on images. In addition, to perform the proposed evaluation aiming at assistive platforms, the ISR Tracking dataset, which represents the object conditions under which real robotic platforms may navigate, is presented. Experimental evaluations were also carried out on the MOT17 dataset. Promising results were achieved by the proposed object tracking data association cost matrices, showing an improvement in the majority of the MOT evaluation metrics compared to the default data association cost matrix. In addition, promising frame rate values were attained by the pipeline composed of the detector and the tracking module.

DOI:10.3390/app12052606

Systematic Odometry Error Evaluation and Correction in a Human-Sized Three-Wheeled Omnidirectional Mobile Robot Using Flower-Shaped Calibration Trajectories

Authors: Jordi Palacín, Elena Rubies and Eduard Clotet

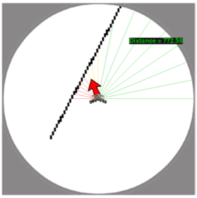


Abstract: Odometry is a simple and practical method that provides a periodic real-time estimation of the relative displacement of a mobile robot based on the measurement of the angular rotational speed of its wheels. The main disadvantage of odometry is its unbounded accumulation of errors, a factor that reduces the accuracy of the estimation of the absolute position and orientation of a mobile robot. This paper proposes a general procedure to evaluate and correct the systematic odometry errors of a human-sized three-wheeled omnidirectional mobile robot designed as a versatile personal assistant tool. The correction procedure is based on the definition of 36 individual calibration trajectories which together depict a flower-shaped figure, on the measurement of the odometry and ground truth trajectory of each calibration trajectory, and on the application of several strategies to iteratively adjust the effective value of the kinematic parameters of the mobile robot in order to match the estimated final position from these two trajectories. The results have shown an average improvement of 82.14% in the estimation of the final position and orientation of the mobile robot. Therefore, these results can be used for odometry calibration during the manufacturing of human-sized three-wheeled omnidirectional mobile robots.

DOI:10.3390/app12157796

A Neural Network-Based Navigation Approach for Autonomous Mobile Robot Systems

Authors: Yiyang Chen, Chuanxin Cheng, Yueyuan Zhang, Xinlin Li and Lining Sun



Abstract: A mobile robot is a futuristic technology that is changing the industry of automobiles as well as boosting the operations of on-demand services and applications. The navigation capability of mobile robots is a crucial task and one of the complex processes that guarantees moving from a starting position to a destination. To prevent any potential incidents or accidents, navigation must focus on the obstacle avoidance issue. This paper considers the navigation scenario of a mobile robot with a finite number of motion types without global environmental information. In addition, appropriate human decisions on motion types were collected in situations involving various obstacle features, and the corresponding environmental information was also recorded with the human decisions to establish a database. Further, an algorithm is proposed to train a neural network model via supervising learning using the collected data to replicate the human decision-making process under the same navigation scenario. The performance of the neural network-based decision-making method was cross-validated using both training and testing data to show an accuracy level close to 90%. In addition, the trained neural network model was installed on a virtual mobile robot within a mobile robot navigation simulator to interact with the environment and to make the decisions, and the results showed the effectiveness and efficacy of the proposed algorithm.

DOI:10.3390/app12073364

A Gravity-Compensated Upper-Limb Exoskeleton for Functional Rehabilitation of the Shoulder Complex

Authors: Stefano Buccelli, Federico Tessari, Fausto Fanin, Luca De Guglielmo, Gianluca Capitta, Chiara Piezzo, Agnese Bruschi, Frank Van Son, Silvia Scarpetta, Antonio Succi, Paolo Rossi, Stefano Maludrottu, Giacinto Barresi, Ilaria Creatini, Elisa Taglione, Matteo Laffranchi and Lorenzo De Michieli

Abstract: In the last decade, several exoskeletons for shoulder rehabilitation have been presented in the literature. Most of these devices focus on the shoulder complex and limit the normal mobility of the rest of the body, forcing the patient into a fixed standing or sitting position. Nevertheless, this severely limits the range of activities that can potentially be simulated during the rehabilitation, preventing the execution of occupational therapy which involves the execution of tasks based on activities of daily living (ADLs). These tasks involve different muscular groups and whole-body movements, such as, e.g., picking up objects from the ground. To enable whole-body functional rehabilitation, the challenge is to shift the paradigm of robotic rehabilitation towards machines that can enable wide workspaces and high mobility. In this perspective, here we present Float: an upper-limb exoskeleton designed to promote and accelerate the motor and functional recovery of the shoulder joint complex following post-traumatic or post-surgical injuries. Indeed, Float allows the patient to move freely in a very large workspace. The key component that enables this is a passive polyarticulated arm which supports the total exoskeleton weight and allows the patient to move freely in space, empowering rehabilitation through a deeper interaction with the surrounding environment. A characterization of the reachable workspace of both the exoskeleton and the polyarticulated passive arm is presented. These results support the conclusion that a patient wearing Float can perform a wide variety of ADLs without bearing its weight.

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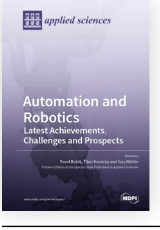

Automation and Robotics: Latest Achievements, Challenges and Prospects

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