Preface

With the growing integration of machine learning techniques into robotics research, there is a need to address this trend in the context of robot intelligence. The multidisciplinary nature of robot intelligence provides a realistic platform for robotics researchers to apply machine learning techniques. One of the principal purposes of this book is to promote idea exchanges and interactions between different communities, which are beneficial and bringing fruitful solutions. Especially when the tasks robots are programmed to achieve become more and more complex, imprecise perception of the environments renders a difficult deliberative control strategy applied for robots for so many years. Understanding the environment where robots operate and then controlling robots gradually rely on machine learning techniques. It is more likely to better off with embedding control problems into the environment perception.

The major challenges for programming autonomous robots stem mainly from firstly the dynamic environment in which it is unable to predict when events will occur and the robots have to perceive their environment repeatedly, secondly uncertain sensory information that is inaccurate, noisy, or faulty, thirdly imperfect actuators that cannot guarantee perfect execution of actions due to mechanical, electrical, and servo problems, and finally limited time that constrains time intervals needed for sensor information processing, actuator control, and goal-oriented planning. As such, the robots cannot rely on their actions to predict motion results. Heavy computation would make the robots move and respond slowly to changes in the environment.

For autonomous mobile robots, early programming approaches followed a sequence: sensing the environment, planning trajectories, and controlling motors to move. With this kind of control strategies, the robot needs to "think" hard, consuming large amounts of time to model the environment and reason about what to do. In addition, modelling and reasoning methods vary with robot tasks and have not reached a widely accepted level of development. Furthermore, this type of control strategies is very fragile, as it can fail to deal with unpredictable events in dynamic environments even if the robot can model and reason precisely. Meanwhile, it is impossible to predict all the potential situations robots may encounter and to specify all the robot behaviors optimally in advance when programming them to achieve complicated tasks in complex environments. Thus, robots have to learn from and adapt to their operating environments.

This volume aims to reflect the latest progresses made on central robotics issues, including robot navigation, human security and surveillance, human-robot interaction, flocking robots, multiple robot cooperation and coordination. The collected chapters not only represent the state-of-the-art research in robot development and investigation, but also demonstrate the application of a wide range of machine learning techniques that vary from artificial neural networks, evolutionary algorithms, fuzzy logic, reinforcement learning, k-means clustering, to multi-agent reinforcing learning. The book can be used as a valuable reference for robotics researchers, engineers, and practitioners for advanced knowledge, and university undergraduates and postgraduates who would like to specialize in robotics research and development.

Thirteen chapters are carefully selected from the extensive body of recent research work, which tackles the challenging issues of robotics development and applications with machine learning techniques. The selection is featured with the breadth of machine learning tools and emphasizes practical robot applications.

Skoglund et al. present a novel approach to robot skill acquisition from human demonstration. Usually the morphology of a robot manipulator is very different from that of the human arm. In this case, a human motion cannot be simply copied. The proposed approach uses a motion planner that operates in an object-related world-frame called hand-state to simplify a skill reconstruction and preserve the essential parts of the skill. In this way, the robot is able to generalize the learned skills to other similar skills without triggering a new learning process.

Palm et al. focus on the robot grasp recognition, which is a major part of the approach for Programming-by-Demonstration. Their work describes three different methods for grasp recognition for a human hand. The finger joint angle trajectories of human grasps are modeled by fuzzy modeling. Three methods for grasp recognition are compared with each other.

Cheng et al. investigate the multiple manipulators which need to achieve the same joint configuration to fulfill certain coordination tasks. Under the multi-agent framework, a robust adaptive control approach is proposed to deal with this consensus problem. Uncertainties and external disturbances in the robot's dynamics are considered, which is more practical in real-world applications. Due to the approximation ability of neural networks, the uncertain dynamics are compensated by the adaptive neural network scheme.

Ji et al. propose an exemplar-based view-invariant human action recognition framework to recognize the human actions from any arbitrary viewpoint image sequence. The proposed framework is evaluated in a public dataset and the results show that it not only reduces computational complexity, but it is also able to accurately recognize human actions using single cameras.

Khoury and Liu introduce the concept of fuzzy Gaussian inference as a novel way to build fuzzy membership functions that map underlying human motions to hidden probability distributions. This method is now combined with a genetic programming fuzzy rule based system in order to classify boxing moves from natural human motion capture data.

Zhou et al. consider the detection of hazards within the ground plane immediately in front of a moving pedestrian. Using epipolar constraints between two views, detected features are matched to compute the camera motion and reconstruct the 3-D geometry. For a less feature based scene a new disparity velocity based obstacle detection scheme is presented.

Tian and Tang explore the feasibility of using monocular vision for robot navigation. The path depth is learned by using the images captured in a single camera. Their work concentrates on finding passable regions from a single still color image and making the robot vision less sensitive to illumination changes.

Liu et al. propose a new model to characterize camera distortion in the process of the camera calibration. This model attempts to blindly characterize the overall camera distortion without taking the specific radial, decentering, or thin prism distortion into account. To estimate the parameters of interest, the well-known Levernburg-Marquardt algorithm is applied. To initialize the Levernburg-Marquardt algorithm, the results from the classical Tsai algorithm are estimated. After both the camera intrinsic and distortion parameters have been estimated, the distorted image points are corrected using again the Levernburg-Marquardt algorithm.

Wang and Gu present an approach to design a flocking algorithm by using fuzzy logic. The design of three basic behaviors in a flocking algorithm is discussed. They are alignment behavior, separation behavior, and cohesion behavior. Navigation control component is used in the design of cohesion behavior. To avoid becoming crowding or collision, an adaptive navigation gain is used. This gain changes with the number of neighbors. The flocking stability is analyzed and stability conditions are acquired from the stability analysis.

Oyekan et al. develop a behavior based control architecture for UAV surveillance mission. This architecture contains two layers: atomic action layer and behavior layer. They have also developed six atomic actions and ten behaviors for these layers. Various techniques have been used in the development, including adaptive PID controller, fuzzy logic controller, SURF algorithm, and Kalman filter.

Guo et al. present a novel anti-disturbance control strategy named hierarchical composite anti-disturbance control for a class of non-linear robotic systems with multiple disturbances. The strategy is established which includes a disturbance observer based controller and an H_∞ controller, stability analysis for two case studies are provided.

Ballantyne et al. present some of the key considerations for human guided navigation in the context of dynamic and complex indoor environments. Solutions and issues related to gesture recognition, multi-cue integration, tracking, target pursuing, scene association and navigation planning are discussed.

Kubota and Nishida discuss the adaptation of perceptual modules of a partner robot based on classification and prediction through actual interactions with a human. They proposed a prediction-based perceptual system consisting of the input layer, clustering layer, prediction layer, and perceptual module selection layer. They apply the proposed method to the actual interaction between a human and a human-like partner robot.

We would like to express our sincere thanks to all the authors who have contributed to the book and support during the book preparation. Without their support,

it is impossible to see the advent of this book. Thanks also go to Natasha Harding from Springer UK who kindly and effectively communicated between the publisher and our editors of this book. We feel especially grateful to our publisher, Springer, who kindly supports the research direction of robot intelligence and the publication of the book. Finally, it would be our pleasure that this book would be valuable, for in-depth understanding of robot intelligence from the advanced knowledge processing point of view, to a wide range of audience from multi-disciplinary research communities and industrial practitioners.

Portsmouth, UK Honghai Liu
Colchester, UK Dongbing Gu
Brighton, UK Robert J. Howlett
Aberystwyth, UK Yonghuai Liu

Springer

http://www.springer.com/978-1-84996-328-2

Robot Intelligence
An Advanced Knowledge Processing Approach
Liu, H.; Gu, D.; Howlett, R.J.; Liu, Y. (Eds.)
2010, XIV, 294 p., Hardcover
ISBN: 978-1-84996-328-2