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Editors

Deep Learning for Unmanned Systems

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Preface

Deep learning (DL) has been applied to a wide range of research areas, such as prediction, classification, image/talk recognition, and vision, and has greatly surpassed conventional methodologies. The main difference between other approaches and in-depth research is the computational simulation of neural network layers by learning and multilevel representation. Therefore, the dynamic nature of large data sets can be easily understood by deep learning. Deep learning models can therefore provide insights into the complex structures of large data sets. Deep learning methods have been shown to outperform previous state-of-the-art techniques in several tasks because of the abundance of complex data from various sources (e.g., visual, audio, medical, social, and sensor).

Objectives of the Book

The main reason of editing this book is the increasing demand for deep learning (DL), unmanned systems (USs), and the exponential growth and evolution of USs in the last couple of years. This book seeks to investigate the latest deep learning applications in theoretical and practical fields of for any unmanned system, robot, drone, underwater, etc. The book discusses different applications of DL in drones and robotics where reinforcement learning methods have excellent potentials for use.

Both novice and expert readers should find this book a useful reference in the field of deep learning and reinforcement learning for unmanned systems.

Organization of the Book

This well-structured book consists of 20 full chapters.

Book Features

- The chapters deal with the recent research problems in the areas of reinforcement learning-based control of UAVs and deep learning for unmanned aerial systems (UASs).

- The chapters present various techniques of deep learning for robotic applications.
- The chapters contain a good literature survey with a long list of references.
- The chapters are well written with a good exposition of the research problem, methodology, block diagrams, and mathematical techniques.
- The chapters are lucidly illustrated with numerical examples and simulations.
- The chapters discuss details of applications and future research areas.

Audience

The book is primarily meant for researchers from academia and industry, who are working on in the research areas such as engineering, control engineering, robotics, mechatronics, biomedical engineering, mechanical engineering, and computer science. The book can also be used at the graduate or advanced undergraduate level and many others.

Acknowledgements

As the editors, we hope that the chapters in this well-structured book will stimulate further research in reinforcement learning-based control and deep learning for UAS and utilize them in real-world applications.

We hope sincerely that this book, covering so many different topics, will be very useful for all readers.

We would like to thank all the reviewers for their diligence in reviewing the chapters.

Special thanks go to Springer, especially the book editorial team.

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Contents

Bioinspired Robotic Arm Planning by *τ-Jerk* Theory and Recurrent Multilayered ANN

I. Carvajal, E. A. Martínez-García, R. Torres-Córdoba, and V. M. Carrillo-Saucedo

Abstract This work presents a planning model control for a 6-axis robot manipulator simulation assembling task. This work's purpose is to plan trajectories for locking cable harnesses in palettes using nylon ties. This work is motivated by two biologically inspired approaches. The general τ-$\mathcal{J}erk$ theory for trajectory tracking and a recurrent bi-layer Hopfield artificial neural networks (HANN) for visual feedback of multiple palette's elements. Equidistant Cartesian points describing free-collision paths between the robot and target positions are generated. Nonlinear regression-based 3th grade polynomials are obtained by multidimensional least squares as assembling trajectories. The Cartesian paths between robot and target position are chosen based on optimization with derivatives, where the path's height is a criteria to minimize a route. This work validated the proposed method through computer simulations, which showed feasibility and effectiveness for assembling tasks.

Keywords Robotic-arm · Robot-assembling · Model-based-control · Tau-theory · Artificial-vision · Hopfield-neurons · Multi-layer-ANN

1 Introduction

Today's manufacturing systems and organizations strongly depends on the need to use numerous aritificial intelligence techniques and computer science tools in order to fulfill their production goals [1]. The work presented in this chapter was motivated by the need to provide an engineering solution at the level of computer simulation for common automatic problems in the assembly industry [2]. Automatic industrial assembly deploys robotic arms for assembling self-locking nylon ties in palettes of cable harnesses. The two main problems are stated. First, redundancy by deploying

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