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Tree Climbing Robot

Design, Kinematics and Motion Planning

Springer

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To our families

Foreword

Robotics is undergoing a major transformation in scope and dimension. From a largely dominant industrial focus, robotics is rapidly expanding into human environments and vigorously engaged in its new challenges. Interacting with, assisting, serving, and exploring with humans, the emerging robots will increasingly touch people and their lives.

Beyond its impact on physical robots, the body of knowledge robotics has produced is revealing a much wider range of applications reaching across diverse research areas and scientific disciplines, such as: biomechanics, haptics, neurosciences, virtual simulation, animation, surgery, and sensor networks among others. In return, the challenges of the new emerging areas are proving an abundant source of stimulation and insights for the field of robotics. It is indeed at the intersection of disciplines that the most striking advances happen.

The *Springer Tracts in Advanced Robotics (STAR)* is devoted to bringing to the research community the latest advances in the robotics field on the basis of their significance and quality. Through a wide and timely dissemination of critical research developments in robotics, our objective with this series is to promote more exchanges and collaborations among the researchers in the community and contribute to further advancements in this rapidly growing field.

The monograph by Tin Lun Lam and Yangsheng Xu is based on the first author's doctoral thesis under the supervision of his co-author. Tree-climbing robots have been receiving an increasing interest in the research community in view of the number of challenges posed to the design by the application scenario. Several approaches in autonomous tree-climbing, including the sensing methodology, cognition of the environment, path planning and motion planning are proposed in the text. Further, a novel biologically inspired prototype is presented and its enhanced performance over the state of the art in the field is demonstrated in a number of experiments for both known and unknown environments.

The first contribution to the series on climbing robots, this volume constitutes a fine addition to STAR!

Naples, Italy
December 2011

Bruno Siciliano
STAR Editor

Preface

Climbing robot is a challenging research topic that has gained much attention from researchers. Most of the climbing robots reported in the literature are designed to work on manmade structures, such as vertical walls, glass windows or structural frames. There are seldom robots designed for climbing natural structures such as trees. Trees and manmade structures are very different in nature. For example, tree surfaces are seldom flat and smooth, and some trees have soft bark that peels off easily. It brings different aspects of technical challenges to the robot design. In the state-of-the-art tree-climbing robots, the workspaces are restricted on tree trunks only. They cannot act like arboreal animals such as squirrels to reach any position on irregularly shaped trees with branches. As branches and curvature are presented in many kinds of trees, the application of these robots is strongly restricted. It is clearly that the tree-climbing technology in robotics still has big room for improvement.

Through billions of years of evolution, many types of arboreal animals have evolved and developed diverse methods to deal with these challenges. The rigorous competition of natural selection process confirms the effectiveness and efficiency of the present solutions in nature. It is believed that the solution in nature can inspire an idea to solve the captioned technical challenges in certain level.

In this book, a comprehensive study and analysis of both natural and artificial tree-climbing methods is presented. It provides a valuable reference for robot designers to select appropriate climbing methods in designing tree-climbing robots for specific purposes. Based on the study, a novel bio-inspired tree-climbing robot with several breakthrough performances has been developed and presents in this book. It is capable of performing various actions that is impossible in the state-of-the-art tree-climbing robots, such as moving between trunk and branches. This book also proposes several approaches in autonomous tree-climbing, including the sensing methodology, cognition of the environment, path planning and motion planning on both known and unknown environment.

This book originates from the PhD thesis of the first author at the Chinese University of Hong Kong, supervised by the second author. In this book, you can find a collection of the cutting edge technologies in the field of tree-climbing robot and the ways that animals climb. You can also find the development and application

of a novel type of climbing mechanism. Although the novel mechanism is applied for tree climbing in this book, it has high potential to apply on others fields due to its distinguish characteristics. In addition, the work also illustrates a successful example of biomimetics as several important aspects in the work such as maneuver mechanism and the method of environment cognition in autonomous control.

This book is appropriate for postgraduate students, research scientists and engineers with interests in climbing robots and biologically inspired robots. In particular, the book will be a valuable reference for those interested in the topics of mechanical design, implementation, and autonomous control for tree-climbing robots.

The Chinese University of Hong Kong *Tin Lun Lam*
November 2011 *Yangsheng Xu*

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