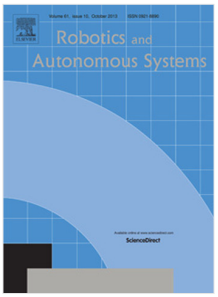
Accepted Manuscript



Representation of truss-style structures for autonomous climbing of biped pole-climbing robots

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PII: S0921-8890(17)30309-3
DOI: https://doi.org/10.1016/j.robot.2018.01.002
Reference: ROBOT 2971

To appear in: *Robotics and Autonomous Systems*

Received date : 11 May 2017
Revised date : 24 November 2017
Accepted date : 2 January 2018

Please cite this article as: W. Chen, S. Gu, L. Zhu, H. Zhang, H. Zhu, Y. Guan, Representation of truss-style structures for autonomous climbing of biped pole-climbing robots, *Robotics and Autonomous Systems* (2018), https://doi.org/10.1016/j.robot.2018.01.002

Representation of Truss-style Structures for Autonomous Climbing of Biped Pole-climbing Robots*

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***Abstract*— For autonomous pole-climbing robots, mapping and recognition of truss-style structures is a challenging task. To build an autonomous climbing system, a truss modeling and recognition system is proposed and applied to autonomous climbing. The system consists of three parts: environment modeling, segmentation by a proposed algorithm called Pouring Algorithm, as well as Truss Parametric Expression Algorithm (TPEA). The experiments show that our study is able to model the truss and extract the parametric expression with a 7.11mm absolute error of the pole radius and a 9.38% relative error of the pole length. In addition, an autonomous climbing experiment based on our system with a climbing robot is illustrated, verifying the ability of our work to meet the requirement of autonomous climbing.**

Keywords: Autonomous Climbing Robot, Parametric Expression, Truss-style Structure

I. Introduction

Climbing robots are an increasingly dominant class of robots to carry out high-rise tasks on large buildings or structures instead of human beings. A number of climbing robots have been developed all around the world. A tree-climbing robot called WOODY was made by Waseda University [1]. Inspired by human climbing using timber jacks, a pruning robot was built [2]. Climbing parallel robots (CPRs) based on Stewart-Goughs platform for climbing along tubular or metallic structures were developed in [3]. Without extra special devices, the aforementioned robots cannot trans between trunks and branches. Taking a different approach, Carnegie-Melon University and other organizations jointly undertook the project RiSE (Robots in Scansorial Environments)[4][5].

For an autonomous climbing robot system, modeling and expressing an unknown truss in a form that is convenient for autonomous climbing path planning [6] is a key problem. As a kind of CAD (Computer-Aided Design) representation, parametric expression of the environment is known to provide a memory efficient expression [7], it is also an ideal alternative for path planning [8][9]. For a long time, path planning assumes a known environment, especially a CAD representation of the environment. Even though there have been some path planning works [10] [11] based on the point-clouds expression, but they are always more complicated. Also, when it comes to environment modeling, most mapping systems [12][13] generate a pointcloud model or costmap model that is discrete and mathematically meaningless, and is not memory-efficient.

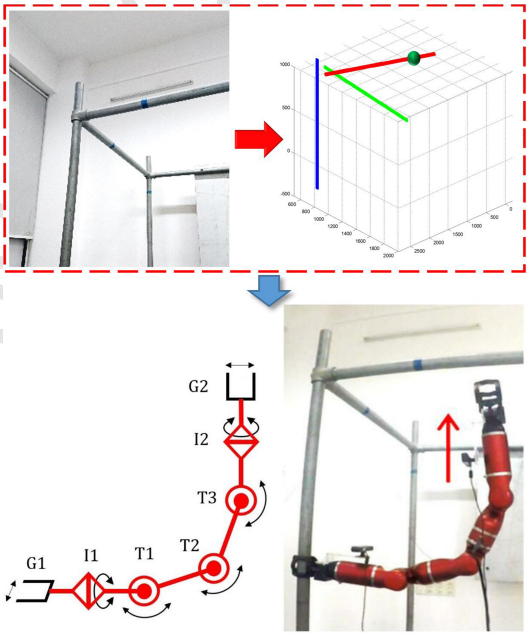

Fig. 1: An truss-style structure is shown in the top-left figure, which the robot observes and models. The parametric expression of the truss is generated by our system, as shown in the top-right figure, and it is applied to autonomous climbing. The climbing robot we study is shown in the down figure. The concentration of this paper is boxed in red.

Exactly, CAD model recognition is a problem in SLAM (Simultaneous localization and mapping), which has been studied to some extent [14]. Also, there has been some related works of extracting parametric expression from the pointclouds data [15] as well as pointclouds segmentation

* The work in this paper is supported by the NSFC-Guangdong Joint Fund (Grant No. U1401240), the State International Science and Technology Cooperation Special Items (Grant No. 201DFA11700), the Natural Science Foundation of Guangdong Province (Grant No. 2015A030308011), the National Natural Science Foundation of China (Grant No. 51605096, 61673125), the Frontier and Key Technology Innovation Special Funds of Guangdong Province (Grant No. 2014B090919002, 2015B010917003, 2017B050506008), and the Program of Foshan Innovation Team of Science and Technology (Grant No. 2015IT100072).