JOURNAL OF AEROSPACE COMPUTING, INFORMATION, AND COMMUNICATION
Vol. 4, December 2007

Real-time Obstacles Avoidance for Vehicles in the Urban Grand Challenge

Jian Yang* , Zhihua Qu† and Jing Wang‡
Electrical and Computer Engineering Department, University of Central Florida, Orlando, FL 32816

Kevin L. Conrad§
Lockheed Martin Missile and Fire Control, Dallas, TX 75265-0003

and
Richard A. Hull¶
SAIC, 14E. Washington Street, Suite 401 Orlando, Florida 32801-2320

DOI: 10.2514/1.32761

In this paper, the real-time trajectory planning problem is considered for vehicles in the urban grand challenge. Typically, reference paths generated by a high level path planner are not feasible for vehicles and need improvement. In addition, moving obstacles in the environment are generally not known apriori, which also requires the paths to be able to be replanned in real-time. The proposed method presents three novel features to satisfy those requirements. First, all the paths satisfying boundary conditions and the vehicle's kinematic constraints are parameterized in terms of polynomials of sufficient order. Then, a collision-free criterion is developed for avoiding "hard" and "soft" obstacles detected. In the third step, a L_2-norm performance index is introduced to find the best path among the class of collision-free paths. The performance index is chosen such that a path analogous to the shortest path can be analytically solved. The proposed method provides a systematic and analytical solution to find the feasible path while addressing obstacle avoidance and guaranteeing performance. Simulation results illustrate the proposed algorithm.

Nomenclature

(x, y)	Cartesian coordinates of the guidepoint
$[a_0\ a_1\ \cdots\ a_p]$	Coefficients of the pth polynomial
$\boldsymbol{q}$	Configuration space variables

Received 12 June 2007; revision received 21 October 2007; accepted for publication 22 October 2007.

*Ph.D student. *Corresponding author.* School of Electrical Engineering and Computer Science, University of Central Florida, Orlando, FL 32816, USA. Phone: (407) 882-2209. Email:fish2bear@hotmail.com.

†Professor, School of Electrical Engineering and Computer Science, University of Central Florida, Orlando, FL 32816, USA. Phone: (407) 823-5796. Email: qu@mail.ucf.edu.

‡Postdoctoral Researcher, School of Electrical Engineering and Computer Science, University of Central Florida, FL 32816. Email: jwang@pegasus.cc.ucf.edu.

§Lockheed Martin Missile and Fire Control, Dallas, TX 75265-0003. Phone: (972) 603-2681. Email: kevin.l.conrad@lmco.com.

¶Principal Engineer. SAIC, 14E. Washington Street, Suite 401, Orlando, Florida 32801-2320. Phone: (407) 835-4027. Email: hullra@bellsouth.net.