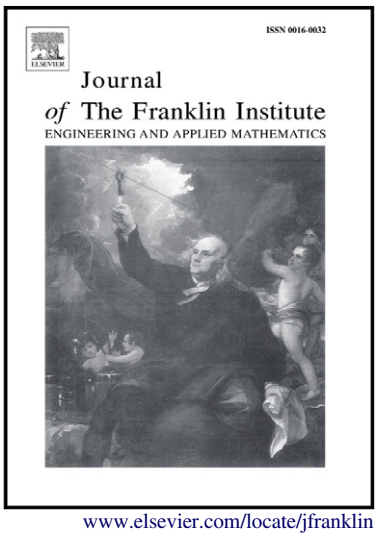

www.elsevier.com/locate/jfranklin

An Integrated Active Nonlinear Controller for Wheeled Vehicles

C. Acosta Lúa, B. Castillo Toledo, R. Cespi, S. Di Gennaro

PII: S0016-0032(15)00311-7
DOI: http://dx.doi.org/10.1016/j.jfranklin.2015.07.018
Reference: FI2408

To appear in: *Journal of the Franklin Institute*

Received date: 7 October 2014
Revised date: 10 June 2015
Accepted date: 29 July 2015

Cite this article as: C. Acosta Lúa, B. Castillo Toledo, R. Cespi, S. Di Gennaro, An Integrated Active Nonlinear Controller for Wheeled Vehicles, *Journal of the Franklin Institute,* http://dx.doi.org/10.1016/j.jfranklin.2015.07.018

Journal of the Franklin Institute

Journal of the Franklin Institute 00 (2015) 1–20

An Integrated Active Nonlinear Controller for Wheeled Vehicles

C. Acosta Lúa[a,*], B. Castillo Toledo[b], R. Cespi[b], and S. Di Gennaro[c,d]

[a]Centro Universitario de la Ciénega – UdG, Av. Universidad Numero 1115, Col. Lindavista, Ocotlán, Jalisco. E.mail: cuauhtemoc.acosta@cuci.udg.mx

[b]Centro de Investigación y de Estudios Avanzados CINVESTAV del I.P.N., Unidad Guadalajara Av. Científica, Col. El Bajío, Zapopan, 45010, Jalisco, México. E. mail: toledo@gdl.cinvestav.mx, riccardocespi@yahoo.it

[c]Department of Information Engineering, Computer Science and Mathematics, University of L'Aquila Via Vetoio, Loc. Coppito, 67100 – L'Aquila, Italy. E-mail: stefano.digennaro@univaq.it

[d]Center of Excellence DEWS, University of L'Aquila Via G. Gronchi 18, 67100 – L'Aquila, Italy

Abstract

In this paper a dynamic nonlinear controller for lateral and yaw velocities is presented, for vehicles in which the roll dynamics can not be neglected. The controller dynamics estimate the lateral velocity, the roll position and the roll velocity. This technique is based on measurements of the longitudinal and lateral accelerations, longitudinal velocity, yaw rate and steer angle, usually available in modern vehicles. The nonlinear controller ensures exponential convergence of the estimations. Test maneuvers, obtained with the full–vehicle CarSim model under different road adhesion conditions, have been used to check the controller performance, as well as its robustness with respect to parameter variations and measurement noise.

Keywords: Dynamic nonlinear controller, Active vehicle control, AFS, RTV.

1. Introduction

In automotive the elimination of the mechanical links allows greater flexibility in the control of various subsystems. Examples of subsystems controlled "by–wire" are the steer–by–wire, brake–by–wire, *et cetera*. More in general this technology, *mutando mutandis*, can be applied to vehicle chassis active control systems, developed to enhance vehicle stability and handling performance in critical situations, simplifying at the same time the design of active controllers [1]. Examples include yaw stability control systems [2], roll stability control systems [3], and integrated vehicle dynamic control systems [4]. These active devices modify the vehicle dynamics imposing forces or moments to the vehicle, see e.g. [5]. In the next future, the active systems will possibly use more sensors than those actually available onboard, allowing precise and distributed measurements from the environment, especially of the tire–road friction [6]. All these new sensors will increase the performance of the control action, the vehicle stability, and the safety and comfort of the driver.

This paper deals with the design of an integrated active controller, with Active Front Steering (AFS) and Rear Torque Vectoring (RTV) as controls. Three aspects are here taken into account: the integrated design of an AFS/RTV control, the vehicle roll dynamics control, and the reconstruction of unmeasured variables. Works on these aspects can be found in literature, as discussed hereinafter, but to the best of the authors' knowledge no work is available dealing these three issues *simultaneously*. This represents the main contribution of this paper. The interest in these three