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DYNAMIC MODELLING AND MANEUVERING CONTROL OF A FRONT-WHEEL-DRIVE AUTONOMOUS VEHICLE

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Abstract. This work proposes the problem of dynamic modelling and maneuvering control of a front-wheel-drive car-like vehicle. The vehicle is controlled by a torque steering the front wheels and by a second torque driving the front wheels via a differential gear-box and side-shafts. Methods from Lagrangian mechanics are applied to derive the mathematical model of the vehicle subject to nonholonomic constraints. A design methodology is presented for computing nonlinear feedback control strategies for the driving and steering torques such that a point on the vehicle asymptotically tracks smooth reference paths in the plane.

Keywords. Front-wheel-drive vehicle, Differential gear-box, Lagrangian mechanics, Instantaneous center of rotation, Nonholonomic constraints, Path tracking control.

1 Introduction

In past years, research in autonomous vehicles has included the investigation of path planning problems for car-like vehicles, [2], multiwheel vehicles, [11], and mobile robots, [6]. Previous works have dealt with the modelling and control of various types of basic autonomous vehicles, for example, a unicycle, [4], [3], and a bicycle, [13]. In the present work, the dynamic modelling and maneuvering control of a more complicated car-like vehicle is considered.

The vehicle consists of a planar body and four wheels (see Figure 1). It is assumed that the vehicle is controlled by a torque steering the front wheels and by a second torque driving the front wheels via a differential gear-box and side-shafts. The motion of the vehicle is subject to nonholonomic constraints ([8], [5]) due to the assumption that all four wheels roll without slipping.