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Optimal Control of a Formula One Car on a Three-Dimensional Track—Part 1: Track Modeling and Identification

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The identification of three-dimensional (3D) race track models from noisy measured GPS data is treated as a problem in the differential geometry of curves and surfaces. Curvilinear coordinates are adopted to facilitate the use of the track model in the solution of vehicular optimal control problems. Our proposal is to model race tracks using a generalized Frenet-Serret apparatus, so that the track is specified in terms of three displacement-dependent curvatures and two edge variables. The optimal smoothing of the curvature and edge variables is achieved using numerical optimal control techniques. Track closure is enforced through the boundary conditions associated with the optimal control problem. The Barcelona formula one track is used as an illustrative example.

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