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Smooth path planning based on PH splines with tension

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The determination of a collision free path between start and goal positions through a set of obstacles is of fundamental importance for several applications, e.g. robotics, game design, automatic surgery and computer numerical control. We present an integrated smooth path planner strategy that properly combines graph search algorithms and obstacle avoidance techniques with spline interpolation schemes. By focusing on planar scenarios, if only an image of the scenario is available, a proper representation of the environment can be obtained with image segmentation methods. By exploiting established graph search algorithms, we show that spline interpolation algorithms with tension parameters may subsequently provide an effective solution for the design of collision free curvature continuous paths. To define an obstacle avoiding curvilinear smooth path, we rely on a spline extension of polynomial Pythagorean Hodograph curves, whose first derivative components satisfy the Pythagorean condition in the real polynomial ring. Thanks to this intrinsic feature, PH curves and their spline extensions offer several advantages with respect to the standard representations adopted for computer aided design, such as polynomial arc-length functions, rational offset curves and real-time highly accurate and efficient CNC interpolators. Our path planner strategy is composed by two stages. In the first stage, an admissible piecewise linear path joining the start and goal positions is obtained by relying on obstacle avoidance techniques developed for selecting polylines with small angles within a set of collision-free solutions. In the second stage, the final smooth path is obtained by defining a suitable PH quintic spline curve interpolating the vertices of this polyline. Obstacle avoidance is ensured with an automatic choice of the tension parameters available in the scheme. A suitable selection of these shape parameters allows us to tighten the curve as much as necessary to the associated polyline.

Biography

Duccio Mugnaini is a PhD student in Computer Science and Computational Mathematics at Università degli Studi dell'Insubria, Italy. He received his Master's degree in Computer Science at Università degli Studi di Firenze. He has experience in the study and development of algorithms for motion design with focus to algebraic-geometric structure in Computer Aided Geometric Design.

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