Modeling Freeways for Digital High Precision Maps

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Abstract

Modern driver assistance systems increasingly support the driver to drive safer and more efficient. Besides extracting the needed information about the vehicle environment from sensors, it is also possible to use stored static data from a map. This allows a reliable and fast access to the environmental data without the typical problems faced with the recognition by sensors. Nowadays street maps produced for navigation purposes reach a precision of several meters. To support the driver during manoeuvres however a precision one magnitude better is necessary.

The positioning technology has steadily improved over the years, so it is possible today to determine a position with an accuracy of a few millimeters (i.e. using DGPS). With the introduction of EGNOS and Galileo in the near future, the quality and the level of service of future positioning solutions will be further improved. As a result, high-precision street maps will also become more relevant in the future for advanced driver assistance systems.

In the following a method and algorithms are described that are able to largely automated generate such street maps for freeways. The basis for the map generation is measured street data which is collected by the test vehicle ViewCar (Figure 1). This vehicle has a high-precision coupled navigation, which is based upon DGPS, an inertial measurement unit and an odometer. Disturbances, errors and so on are reduced by taking several test sets from the same roadway lane. All measurement data is stored in a spatially enabled database for efficient access.

The focus of this paper is the discussion how to process the gathered and preprocessed data. The generated result is a model, which precisely describes the course of the street. Freeways are designed using clothoid models (Figure 2). Clothoids are curves, which can have a steadily changing curvature. In more detail they are constructed using attributes which are very important for driving a vehicle on a street. These attributes are the bend and bend changing rate. So they are very well suited for a reengineering of the original freeway characteristics. But because the mathematical handling of clothoids is complex, the approximation of the highway is not trivial.

Figure 1: Test vehicle ViewCar

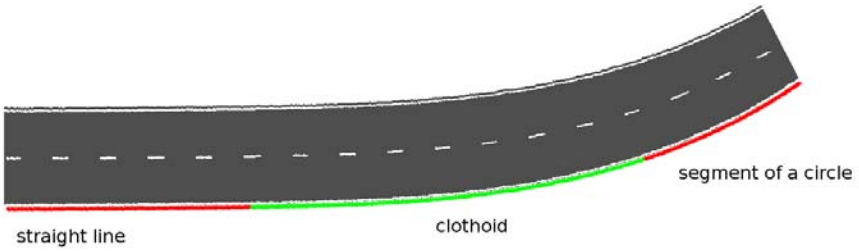

Figure 2: Two street segments with a constant bend connected by a clothoid

Furthermore for the map generation process uniquely identifiable objects along the street are of interest. If such a object is marked in a map and its relative position is later detected, a vehicle can reconstruct its position more precisely. So the vehicle mounted laser scanner is optimized to detect just small objects like road signs and reflection posts for the best possible position detection. When driving fast along the street, this will especially help to locate the vehicles position in street direction.

Several test drives have been performed on the freeways A2 and A39 to get far more than 100 km of data for the development of the method. The steps of the method have been implemented in software and tested on the collected data. The results show the general potential of the method.