Chapter VII
Real-Time Extraction of the Road Geometry

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ABSTRACT

The development of road database requires the management of continuously growing road databases. Mobile mapping systems can acquire this information, while offering an unbeatable productivity with the combination of navigation and videogrammetry tools. However, the complexity of data georeferencing and the fusion of the results with video sequences require numerous hours of repetitive labor. We propose to introduce the concept of "real time" in the field of mobile mapping. The deterministic exploitation of the data captured during a kinematic survey aims at restricting human intervention in the sophisticated georeferencing process, while authorizing the dissemination of this technique outside well-informed communities. What are the tools and algorithms robust enough to ensure the quality control of the georeferencing of the road objects? We intend to provide these concerns a pertinent answer, while demonstrating the validity of the concept via the automatic acquisition and interpretation of the road geometry.

CHALLENGES OF MOBILE MAPPING

The transport-telematics market witnesses considerable expansion, as can be seen from the popularization of vehicle-navigation systems. This success now causes the development of road-oriented cartographic databases that are inspired by the FGDC or GDF standards. Only a close-range view allows road managers to assess the quality of their network, so that traditional methods for updating road databases often prove insufficient. Satellite-based remote sensing and aerial photogrammetry indeed offers reasonable

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costs (Mather, 1999). Unfortunately, the first technique is linked to inadequate accuracy for numerous applications, whereas the second only provides partial information due to its nadiral viewpoint. The early 1990s experienced substantial progress in GPS/INS coupling, followed by the market launch of affordable digital cameras with sufficient quality. This has enabled the acquisition of a significant part of the road data by vehicles equipped with navigation and videogrammetry tools (Ellum et al., 2002). Land-based mobile-mapping systems were conceptualized. However, such a technically-advanced method goes together with high investments in staff and hardware.

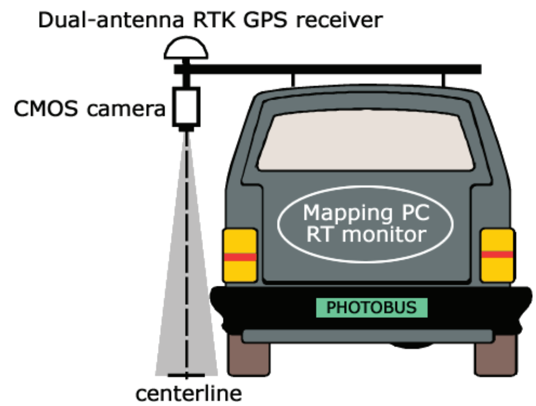
Ideally, the information captured by a mobile-mapping system should be processed by real-time algorithmics. This may reduce the need for human intervention to driving the data-collecting platform while ensuring immediate quality control. The Geodetic Engineering Laboratory in Lausanne has been investigating this topic where precise time registration, georeferencing, and instantaneous feature extraction are crucial challenges (Gontran et al., 2004).

INCURSION INTO REAL-TIME MAPPING

The author's vision of real-time mapping systems encompasses a mobile acquisition platform dedicated for a well-defined task. To sustain the high optimization requirements of such a data-critical application, the use of custom-made software based on open source libraries is a privileged approach of implementation. Road-geometry extraction from painted marks is an appropriate subject for a proof-of-concept demonstration. In this context, the Geodetic Engineering Laboratory investigates the suitability of using a vertical camera to automatically extract the road geometry (Figure 1).

To georeference road data with the shortest delay, a real-time OS powers the computer hosting the mapping software (Abbott, 2003). Despite this precaution, an inter-thread latency exceeding 5 ms may arise, which proves that the host computer should be relieved from non-time-critical tasks. We chose the methodology of distributed computing to deal with the navigation- and image-preprocessing steps for georeferencing.

Figure 1. Our concept of real-time mapping



DISTRIBUTED COMPUTING SERVING REAL-TIME MAPPING

A first subsystem applies the concept of the moving base station to determine the position and heading of the video unit (Cannon et al., 2003). The proposed implementation relies on a dual-antenna RTK GPS receiver outputting navigation data to the host computer. The primary chip of this receiver permanently broadcasts 5 Hz corrections to the secondary one. Degree-level accuracy for the heading is thus obtained. A custom Internet-based regional DGPS server contributes to the 5 Hz centimeter-level position of the primary GPS receiver antenna via a GPRS connection. This server behaves as a transparent relay that forwards RTK corrections from a cellular-enabled GPS reference to any authenticated rover in the close vicinity. This approach offers:

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