A cityGML EXTENSION FOR TRAFFIC-SIGN OBJECTS THAT GUIDES THE AUTOMATIC PROCESSING OF DATA COLLECTED USING MOBILE MAPPING TECHNOLOGY

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ABSTRACT:

During the last years, the development of Geographic Information Systems in 3D (3DGIS) has provided the 2D or 2.5D geographic representations of a spatial perspective. For most of current mapping applications not only geometry is relevant but also topologic and semantic information is required to have models supplied with attributes.
The rapid evolution of integral schemes, accounting for geometric and semantic data, has been importantly motivated by the advances in the last decade in mobile laser scanning technology; automation in data processing has also recently influenced the expansion of the new model concepts.
The stunning growth of mobile mapping technology has demonstrated that this is probably the most powerful solution for the improvement in the maintenance of large terrestrial infrastructures. Its principal application nowadays probably relates to geometric inventory and routine inspection of road infrastructure, not only due to its significance for the optimization of life cycle of the infrastructures but also due to the importance of road mapping in road safety.
Despite of the quality, in terms of geometric accuracy as well as detailed data, of the product derived from a mobile mapping survey, the technology reduces its potential due to the difficulties associated to the handling large and dense point clouds. In order to ease the implementation of the technology in the tasks mentioned above, automate data processing reveals essential. It is remarkable the important number of publications in the last years related to automatic road elements detection and characterization (Serna & Marcotegui. 2014; González-Jorge et al, 2012). In road elements such as traffic signs semantic information is essential, thus Pu et al. (2011) show preliminary findings for the detection and classification of off-ground traffic signs, González-Jorge et al. (2012) develop a procedure to automatically perform routine inspection of vertical signs. The improvements in the automation of data processing and the structuring of results following schemes that allow the interchange and interoperability will definitely contribute to the modelling of the emerging smart cities; this is one of the current challenges for geotechnologies.
As stated above, classical GIS is turning into 3DGIS which is being implemented in several well know commercial suites. However, reaching these layers of information in the 3D space is not a trivial task, and specific processing of geometric data is required. It is important here to cite the roll of those schemes internationally recognized as Standards for land modelling (eg cityGML scheme).
CityGML has the core objective of establishing a common definition for basic entities, attributes and relationship of the 3D city model. This pretends to be completed not only representing geometry, topology and appearance of the city objects in a coherent and homogeneous manner, but also its semantical aspects (its structures, taxonomies and aggregations (Groger & Plümer, 2012). Even the scheme in deeply developed in some of its modules and properties (eg building model), elements related to traffic signs (poles and road marks) does not have sufficient representation in the schema yet. Currently, these city elements are represented as City Furniture objects without a deep characterization (they are only coded by their function (CityFurnitureFunctionType).
In order to improve the management of road infrastructures and road safety based on the potential of the cityGML scheme, it is essential to extend its modelling structure to include all the properties related to this management aim. Thus, this will mark the route to be followed during the development of 3D automatic reconstruction of road environments. Consequently, this must be taken into account when developing the automatic procedures for mobile mapping data processing.
Through this article a proposal of extension of cityGML is presented by using an Application Domain Extension (ADE). Thus, traffic signs are supplied with specific feature types, attributes, and relations into the Transportation module because this module contain the road networks modelling, in which traffic signs play a key role.
In parallel to the extension of the scheme, several strategies towards automatic detection and characterization of traffic sign objects from mobile LiDAR data were developed. Different attributes such as shape (related to sign function), segmentation of signs hung in a common pole, position, orientation, etc., were automatically extracted using the algorithms proposed in this article. The approach presented here takes into account geometric and radiometric inputs, however several important limitations in state-of-the-art sensors are still pendent; principally, sensors do not provide enough spatial resolution yet to identify characters on traffic signs, so achieving further signs classification still require of complementary imagery data.
This paper confirms the utility of mobile mapping technology for an optimised and productive application. This challenge started with the development of a mobile mapping unit for road inspection (Martínez et al., 2013); then, automatic data processing is tackled in order to deliver those attributes for modelling in accordance with the new standards of 3D city modelling. Several case studies are presented to show the performance and accuracy of the proposed method.

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