Collaborative 3D Modeling: Conceptual and Technical Issues

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ABSTRACT

The need of 3D city models increases day by day. However, 3D modeling still faces some impediments to be generalized. Therefore, new solutions such as collaboration should be investigated. The paper presents a new vision of collaboration applied on 3D modeling through the definition of the concept of a 3D collaborative model. The paper highlights basic questions to be considered for the definition and the development of that model then argues the importance of reuse of 2D data as a promising solution to reconstruct 3D data and to upgrade to integrated 3D solutions in the future. This idea is supported by a case study, to demonstrate how 2D/2.5D data collected from different providers in Walloon region in Belgium can be integrated and reengineered to match the specifications of a 3D building model compatible with the CityGML standard.

KEYWORDS

3D Collaborative Model, CityGML, Collaboration, Data Integration

INTRODUCTION

Geographic Information Systems (GIS) have been designed in accordance with the way people have conceptualized space (Freundschuh & Egenhofer, 1997). While the reality is tridimensional in nature, paradoxically, its representation has been for long decades dominated by the metaphor of the paper map. This has resulted to two separate models: 2D GIS models and Digital Terrain Models (DTM). “The third topographic dimension is often handled, but only by imposing the assumption that elevation is a function of location, a solution often termed “2.5D” (Goodchild, 2010). Nevertheless, 2.5D representations cannot efficiently deal with representing multi-level structures which might be of interest in some applications requiring higher-dimensional models. Vertical cadaster is one of the appealing examples of applications where a veritable 3D representation is needed. Likewise, consideration of indoor and outdoor objects in 3D models is relevant for several applications such as the evacuation of buildings through the short path in case of extraordinary circumstances (disastrous accidents, terrorist attacks, etc.) (Atila et al., 2013).

Currently, there is an increasing need for representing and analyzing the third dimension of urban space. Nowadays, technologies make it easier to produce and access to 3D information. Free web-mapping services and virtual globes provide users with a large amount of 3D data but it cannot be easily extracted in many cases. Moreover, new forms of 3D data crowdsourcing are emerging at a rapid race, such as OpenStreetMap-3D platform. Anyone with internet access and mobiles devices (Smartphones, GPS, cameras, etc.) has the ability to produce data voluntarily and make it available to a large community of users. However, data produced by this way is certainly optimized for exploration and visualization purposes, but cannot deal with a large spectrum of applications requiring geometric

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Spatial information is recognized as an essential resource that requires better collaboration for an efficient management of spatial problems. Developing emergency plans and procedures based on geospatial maps is one of the appealing situations where collaboration is crucial (Schafer et al., 2007). In recent years, partnerships have emerged as a useful mechanism for establishing a framework and environment conducive to data sharing. The motivations are generally related to sharing cost or improvements in data quality (Nedović-Budić et al., 2004). Generally, motivations for collaboration will vary with each organization and each type of collaboration. Dedekorkut (2004) identifies “the pursuit of common goals, environmental uncertainty, mutual interdependence and resource scarcity” as some principal reasons for collaboration.

Although 3D information is well established in many government agencies and private organizations that make significant 3D development, agencies with smaller budgets, especially in local government, are generally the least able to undertake significant investments on 3D data production. Their eventual 3D achievements remain mediocre. These organizations are challenged by adopting a collaborative approach in 3D modeling and design by sharing cost and experiences in order to make 3D available, structured and formalized enough to be shared in a consistent way.

This paper addresses the issue about 3D collaborative modeling. Two contributions are presented in this regard. The first one is a conceptual framing of a 3D collaborative model, a concept which will be presented and analyzed according to the conceptual and the technical level and the second contribution addresses a technical challenge about 3D collaborative modeling: how to capitalize and reuse existing 2D/2.5D data in order to produce a 3D collaborative model? This issue is addressed through a case study in Belgium, which can be easily transferable to other contexts. Our objective is not to present a new method of 3D data reconstruction but to demonstrate how to reuse existing data as a building block for the 3D model. In particular, we will focus on buildings as basic objects of 3D city modeling.

**COLLABORATION AS A FUTURE SOLUTION FOR 3D MODELING**

According to the state of the art, collaboration is generally involved in the decision process to resolve spatial problems. There is a lack of collaborative forms on spatial modeling and design, resulting in duplicated management of spatial information and systems.

In this section, we present an overview about collaborative forms on spatial data. Then, our vision of collaboration applied to 3D modeling is proposed. A concept of a 3D collaborative model will be discussed to deal with challenges about 3D modeling of reference data in the urban space.

**Current Collaborative Forms in Spatial Data**

Spatial data is at the center of several economic, social and environmental problems. It must be, at any time, identified, located and integrated with other information for decision making. In most situations, data may be at the crossroads of several disciplines involving several players. The objectives should not be limited to only technical framework for data exchange, but some spatial problems require inter organizational formalized relationships to undertake common actions (Hajji, 2013).

In Geographic Information Science (GIScience), we can distinguish four participatory and hierarchical levels of partnerships: communication, cooperation, coordination, and collaboration. Communication is limited to exchanging ideas in social interactions while cooperation aims to develop an overall agreement, despite individuals may not interact with each other (Balram & Dragicevic, 2006). Coordination, seen as more formal as cooperation (McDougall et al., 2005), occurs when there is a planned implementation of cooperative activity to reinforce collective group gains. As a mature form of partnerships, collaboration deals with a shared sense of meaning and achievement in the group process (Balram & Dragicevic, 2006). In this sense, collaboration may be considered as
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