Geospatial Ontology to support the Documentation of Minor Historical Centres

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Abstract

The research presented in this work encompasses two main research fields: geomatics, focusing on geographical information (GI) and Artificial Intelligence (AI), studying and applying ontologies.

The core of this research methodology focuses on the study and the design of ontologies for spatial data: ***geospatial ontologies.*** Ontologies can be considered as conceptual structures able to formalise the explicit knowledge of a domain. They are of particular usefulness to create a unique and standard thesaurus and to ensure semantic interoperability. In the ontology engineering process, classes are semantically expressed and connected by relations. In geographic sciences, this formalisation of concepts allows digital information control between different operating systems by communicating with geographic tools. This thesis is targeted to fill various gaps in the current scenario of GI.

The main research topic of this thesis focuses on the possibility to standardise spatial information in the domain of ***minor historical centres (MHC)*** and the related *architectural, built and landscape heritage.* Nevertheless, the notions of the urban centre, historical city, and ancient urban area are not consolidated overall, took different meanings, and evolved over the centuries. Historical centres (HC) are intended as a historical part of cities, villages and hamlets (urban, rural, minor or abandoned) with cultural, social and economic values. They need to be preserved, documented and safeguarded due to their intrinsic values, connected with their functions and evolution. The documentation is a fundamental tool for increasing the resilience of CH. Therefore, the study, the communication and the protection of this heritage are supported by many processes and require specific data to be collected, stored, and post-processed. In addition, these activities involve many disciplines, actors, and stakeholders, leading to sharing common knowledge and using a unique language. For this purpose, the use of ontology is of relevant interest and usability.

There is no defined ontology containing helpful information to manage, share and collect data on historical and minor rural centres. Moreover, an interoperable structure is lacking to semantic formalises cultural built, urban, architectural heritage. The research developed a spatial ontology

integrating existing knowledge (ontologies, vocabularies and standards) representing geographical objects of built and territorial heritage.

The domain of this study is identified in historical centres, and the ontology scope is their ***spatial and temporal documentation***. The design of this ontological structure can help various actors involved in the decision-making process of small urban and rural areas in different scenarios (such as rural villages, alpine hamlets, historical city centres needing restoration actions, urban planning or rehinabitation activities). For this purpose, the methodology is validated, enriching and populating (adding classes and instances) the ontology with structured and unstructured data of real data case studies (a Dutch fortified village and an Italian alpine hamlet). Concepts from existing urban regulation plans, historical documents, regional landscape plans, data models, datasets and data from 3D integrated metric surveys have been collected, harmonised and inserted into the ontology.

Finally, this thesis wants to produce an accurate representation of reality through a ***multi-scale approach considering different levels of detail***. This final aim regards the publication of the GIS (Geographic Information System/Science) projects of the case studies. For each use case, a geodatabase was published in a ***WebGIS*** application in which it is possible to query geometries and directly open the related semantic classes of the ontology.