Extracting Meta-Information From 3-Dimensional Shapes With Protege

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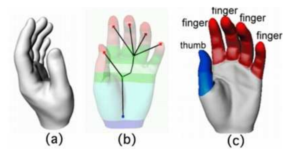

Figure 1: Image Courtesy of the AIM@SHAPE project.

Abstract

Connection between material objects and human perceptions conveys a varied amount of information by means not only of pure registrable data but also concepts with a formalizable objective meaning. Thanks to the advancing of current technology acquisition and registration of such data is become a daily routine. An incredible amount of tool exists as support to the visualization of phenomena in terms of their appearance and attributes, not an equally wide range of tool is available to interact with the semantic information conveyed by such phenomena. To address this issue we developed a tool called TriMeshInfo that aims at supporting the process of switching between the three basic levels of shape-knowledge representation: *geometric, structural and semantic*.

1 Introduction

An infinite variety of shapes falls daily under our human experience. Connection between material objects and human perceptions conveys an equally varied amount of information by means not only of pure registrable data but also concepts with a formalizable objective meaning. Thank to the advancing of current technology acquisition and registration of such data is become a daily routine. An incredible amount of tool exists as support to the visualization of phenomena in terms of their appearance and attributes, not an equally wide range of tool is available to interact with the semantic information conveyed by such phenomena. Within the AIM@SHAPE project [1] efforts have been put together at developing a framework capable of following the treatment of data from their digital acquisition and visualization to the processing of their inherently conveyed knowledge. Following their formalism we define as Shape any *"individual object having a visual appearance which exists in some (two-, three- or higher- dimensional) space (e.g., pictures, sketches, images, 3D objects, videos, 4D animations, etc.)"*. A digital shape corresponds then to the synthetic image produced by the digitalization of a shape. Beneath the perceptive aspect of a shape, i.e. purely geometry-based representation as in Fig. 1a, the contextualization of the shape itself, i.e. pure structural view to encode how components are linked together Fig. 1b or pure semantic view to propose an interpretation or meaning Fig. 1c, contributes to a much richer reading of the shape itself. Tools to support semantic organization of knowledge exists but few has been accomplished in bridging the gap between geometry-aware tools and semantic-aware tools for organizing the multi-featured knowledge inferable from the inspection of a shapes. To address this issue we developed a tool called TriMeshInfo (Fig. 2) that aims at supporting the process of switching between the aforementioned three basic levels of shape-knowledge representation: *geometric, structural and semantic*.

2 Extracting Meta-Data: TriMeshInfo

Digital shapes are employed in different kind of fields from entertainment to visualization scientific oriented; what is common to all shapes is that a set of invariant properties can be always defined (i.e. geometry, qualifying attributes, meaning etc.), tough task is the definition of which "properties" can be qualified as universally common to all shapes. Within the aim@shape project effort have been focused at developing a repository [2] populated with digital shapes in which for each inserted shapes a set of features is extracted and used as "advanced key" to search the repository itself. Extracted features correspond to metadata specified by shape ontologies developed by the aim@shape consortium, through metadata ontology-driven searching can be performed on the repository. The metadata currently detected by the consortium mostly describe the variety of information carried out by a shape in terms of:

- *Geometrical/Topological Information*: number of vertices, number of edges, number of faces, connected components, number of holes, number of isolated vertices, number of duplicated vertices, self-intersections, genus, color, manifold, regularity, orientability, scale, format;
- *Abstract Knowledge*: origin, author, purpose, way of creation, copyright.

The process of shape digitalization mainly covers the organization of geometrical and topological information, by making explicit the association between parts or components of shape models or shape data, while all the considerable amount of knowledge available about the shape is neither captured nor coded. The development of the TriMeshInfo application started at this level as a tool to support insertion of shapes into the repository able to take into consideration also the semantic aspect of the information conveyed by each inserted shape.

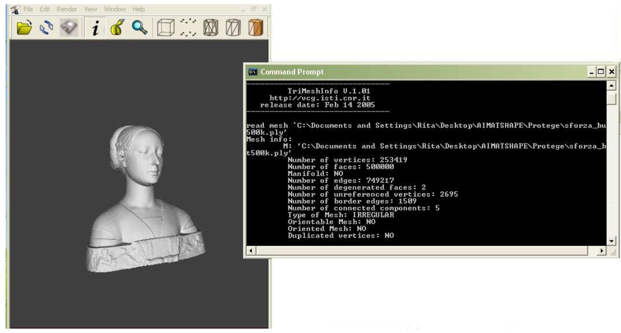

Figure 2: TriMeshInfo Interface. Information collected for the Ippolita Sforza Bust 500K triangular faces.

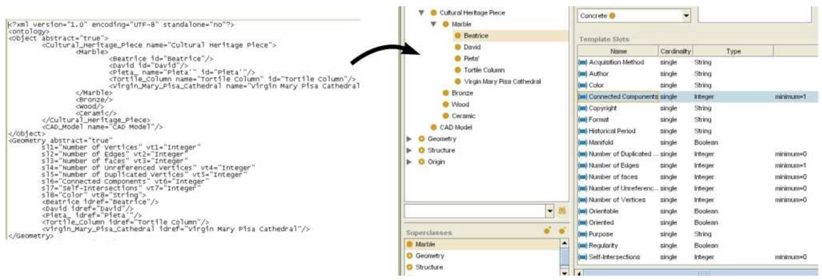

Figure 3: (a)TriMeshInfo XML File (b)Loaded in Protege.

2.1 TriMeshInfo: Detailed Overview

In our application we have started with the analysis of 2D and 3D shapes composed of triangular patches. For each analyzed dataset the aforementioned information are extracted. Topological and geometrical metadata are automatically generated through an inspection of the dataset topology. The Semantic information are instead provided as a separate .txt file associated to the model and compiled by the creator of the model itself. To formalize the extracted information in terms of metadata, which describe shape models and shape processing tools, and ontologies, which provide the rules for linking semantics to shape or shape parts, we decided to exploit the protege knowledge formalization mechanisms. We save all extracted data in a .xml file and import it into the protege environment. The syntax follows the format provided in the xml schema specification (.xsd file) provided by the xml backend plugin. At this stage of the project TriMeshInfo creates through the xml backend a taxonomy for each shape and a class for each level of knowledge while each attribute becomes a slot for the class it belongs to (Fig. 3). We have decide to make such a characterization for experimental purposes while the final Ontology is still under development. With this process we avoid the manual data entry in Protege and once the .xml file has been automatically produced by TriMeshInfo, it can be easily loaded into Protege as a xml backend project. Once loaded we can start to populate our database of shape instances and develop queries and graph-chart overworking all the possibilities provided by the Protege platform. The TriMehsInfo Interface is console based and easy to use, works on command line and is platform independent. The tool appear with a main window where the shape geometry is visualized and a console where all the extracted metadata are listed. While the data inspection proceeds the metadata are stored in the .xml file. TriMeshInfo is written in C++ and makes use of the VCL library. The tool supports several image file formats like ply, stl and off. The ideal target would be to be able to make TriMeshInfo a plug-in of Protege. Current information systems may handle the geometric representation of digital shapes, but not their semantics (meaning or functionality) in a given context. Through a common formalization framework, it would be possible to build a shared conceptualization of a multi-layered architecture for shape models, where the simple geometry is organized in different levels of increasing abstraction (geometric, structural and semantic layers). Technological innovation would be high in terms of tools for the automated semantic annotation of digital shapes, as well as tools for accounting for the semantics while digitizing, modelling, and sharing shape data.

3 Acknowledgments

The ontology formalization is still under development, we still have to finalize which keys will become respectively Entities, Attributes or Relation within the final Ontology. TriMeshInfo has been developed as part of the tool repository of the AIM@SHAPE EU Project [3]. We thank Dott. Bianca Falcidieno and the IMATI Group of the National Research Council in Genova for both technical and financial support.

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