ONTO-MAMA

An Unified Ontology and 3D Graphic Model of the Female Breast Anatomy

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Abstract: The science of ontology has been widely used in knowledge management, either to define and organize concepts for the purpose of future preservation or to provide more efficient information processing by our computers. From this, the use of ontology in medical field has become increasingly consolidated, either to simply describe the correct meaning of technical terms or to completely depict the anatomical structure of the human body or medical procedures. In addition, the use of ontology has been associated to artificial intelligence and virtual reality in order to provide simulation of medical environments with the aim of better understand the complexities of the human anatomy and the medical procedures. Accordingly, this article presents the elaboration of an ontology and a 3D graphic model of the female breast anatomy to be used in a virtual reality environment containing an intelligent tutor system which will eventually be able to assist learners in the practice of the core needle biopsy. This article reports our experience so as to share information about the process used, the artifacts generated and the systematic involved in the structuring of such unified model.

1 INTRODUCTION

Information Technology (IT) has played an important role in the process of improving medical education by intensively using resources from virtual reality, computer graphics, intelligent tutoring systems and knowledge management techniques and tools. The combination of conceptual models which express the meaning of things and graphical models which fulfill the need of a visual representation for the objects being learning makes it possible to completely replace the deteriorating human anatomical parts from medical labs. Moreover, models that were built by applying the aforementioned computational techniques are easier and cheaper to maintain. Such models, besides being extremely reusable, are also likely to undergo changes, or even a complete overhaul, if need be.

With regard to knowledge management, one of the most relevant and complex goals of the area is the appropriate transformation of implicit knowledge into explicit, which implies ensuring that knowledge about a specific subject must be correctly identified and disseminated in order to preserve it. Knowledge management is not different when applied to the medical field. Expressing a concept or idea accepted by different experts in a single way is not a trivial matter, even when those concepts have an extensive bibliography and dictionaries to address issues of specific interest, as in the case of medical terms. Another aspect that contributes to the difficulty of expressing a concept of the real world through written language involves the way one concept relates to others. A concept is often not simply defined by a word or word etymology. For a better understanding of its meaning, it is necessary to identify associations with other similar, complementary or antagonistic idea, outright concepts or even complete learning objects (videos, images, sound, texts, animations, etc). The science of Ontology acts in this context, and it has been used as an alternative to define, organize and share knowledge in a standardized way so that is susceptible to be processed easily by a computer. As a result, a more automatic process for extracting or derivate meaningful information is created. Nevertheless, the main issue of building ontology models lies in the definition of the concepts under a

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coherent, complete and utterly understandable fashion. After all, this is what will guarantee the usability of the model and its connection to other complementary resources such as a graphical model or learning objects used for tutoring.

Hence, this article presents the elaboration of an ontology model in conjunction with a 3D graphical model for the anatomy of the female breast. Such models are intended to be used in a virtual reality environment having an intelligent tutor system which aims at assisting the future doctor in the practice of core needle biopsy. We aim to describe how the two worlds (conceptual and visual) can be constructed together in order to fulfill the requirements of a virtual reality environment idealized for tutoring purpose. The article is structured as follows: section 2 presents a brief review of the concepts associated to the science of ontology, section 3 presents the work developed, with emphasis on the construction process, the artifacts generated and the internal structure of the model. The article ends in Section 4, where we state our conclusions and share our experiences and difficulties in the carrying out of the task.

2 ONTOLOGY OVERVIEW

Ontologies define terms or concepts, the relationships among them, the rules for the most complex definitions and some extensions accepted for purpose of vocabulary completeness and understandability (Neches et al., 1999).

It refers to an abstract model of some phenomenon or something that can be identified in the real world. It is a formal technique, an explicit specification of concepts that is intended to be shared. It is formal because it is expressed in a language which allows for easier processing through a machine or computer. It has the characteristic to be explicit, since the type of concepts expressed and the rules and restrictions imposed must be categorically defined. Finally, it is supposed to be shared because it aims to capture and disseminate knowledge to everybody, i.e. it should not be restricted to a few individuals, but accepted and used by a group or community (Studer et al., 1998). Ontology can be manifested in several ways, but must necessarily include a vocabulary of terms and specifications detailing its meaning, which includes definitions of rules and records of how concepts are interrelated (Uschold and Jasper, 1999).

By providing a systematic framework to record information, an ontology model creates enormous possibilities for associations among concepts, which broaden understanding on specific areas of expertise. Consequently, new information can be extracted from the model so that the initially imagined horizon of knowledge is extended. For this reason, the science of ontology highlights two types of models: the conceptual model and the inference model. The conceptual model is the one originally envisioned by the creators of ontology. The inference model, on the other hand, is that one which is generated by an intelligent agent, i.e. a piece of software that captures and extracts information not easily identified during the idealization of the conceptual model.

In the health field, ontologies have been developed to translate texts related to medical oncology (ONCOTERM), connect biomedical vocabulary from various sources (UMLS - The Unified Medical Language System) and to equalize medical terms used in studies of anatomy, physiology and pathology. Regarding to our project, the creation of an ontology model was needed because the existing ones couldn't fulfill the requirements of our project. The next sections will present the process and methodology used to build the ontology model (conceptual and inference models) and the 3D model (visual model) in a unified manner.

3 ONTO-MAMA PROJECT

3.1 Contextualization

The Onto-MAMA is part of a wider scientific project called "3D Anatomical Atlas Applied to the Breast". Such project is an initiative of the National Laboratory of Scientific Computing of Brazil (LNCC) and with the participation of the University of Brasilia (UnB), the current co-executor of the work. The project has the scientific and financial support of the National Council for Scientific and Technological Development (CNPq), an agency that is connected to the Brazilian Ministry of Science and Technology and has as its goal to promote scientific and technological research and to create human resources for research in Brazil.

The building project of a 3D Anatomical Atlas Applied to the Breast began in July 2009, and its goal is the search for new proposals for training students in areas related to the anatomy of the human breast, in opposition to the teaching of classical anatomy using the dissection of cadavers.

As a practical and more comprehensive result of the project, it is expected that a web-based educational environment can be established, allowing for the practical-morphological learning of the internal and external structures of the female breast. By using artificial intelligence and virtual reality techniques, we aim to seek new approaches to the teaching of students of Health Sciences and Human Biology, as well as to benefit teachers and health professionals interested in receiving continued education in teaching the anatomy of the human breast. Another goal is to provide guided surgical training to students and health professionals interested in mastering the core needle biopsy procedure.

Figure 1 illustrates the major components of the project and identifies the key role played by the ontology model for anatomy of the female breast, which is the main subject in this paper.

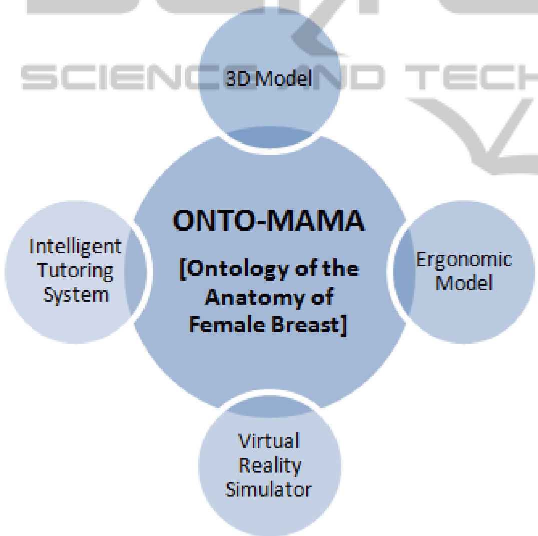

Figure 1: 3D Anatomical Atlas Applied to the Breast.

3.2 Methodology

The construction of an ontological model comprises the following steps: (a) the adoption of a working methodology, (b) the study of the field of action, (c) the formal representation of knowledge and (d) the distribution of the model for validation and use.

The elaboration of the ONTO-MAMA model started in 2009 with a systematic study of existing methodologies for the building of ontologies. The project team defined five criteria for selecting a methodology which could best adapt to the characteristics of the project (Table 1). Additionally, studies of the following existing and widely used methodologies were conducted: CYC, USCHOLD and KING, KACTUS, SENSUS, GRÜNINGER and FOX, METHONTOLOGY and ON-TO-KNOWLEDGE.

Table 1: Criteria for adoption of a working methodology.

Criteria	Description
Scope of work	The methodology must describe the complete creation cycle of an ontological model (planning, creation and maintenance)
Prototyping	The methodology must provide the capacity to create intermediate models throughout the development cycle
Adaptability	The methodology must be easily adaptable by the team so as to incorporate peculiarities inherent to the project.
Documentation	The methodology must provide sufficient documentation for its understanding.
Reputation	The methodology must be well renowned and highly reputed among scientists.

The methodology which best suited the requirements of the project was METHONTOLOGY, since not only does it meet the established criteria relatively well, but it also had the advantage of having a cycle of evolutionary development, based entirely on prototyping. Prototyping was a requirement of great importance in the context of our work, because we planned for other sub-projects to use the models generated since the beginning, either with the aim of experimenting ideas and concepts, or as a simple mechanism of immediate feedback to the ontology team.

Therefore, the ontology team started using METHONTOLOGY as the working methodology, as well as the tool called Protégé (version 4.1) for the purpose of prototyping the model throughout its whole development cycle. In addition, intermediate artifacts were produced to facilitate communication among members of the team and the medical experts. These artifacts will be presented in the subsequent sections.

Once the methodology was defined, the team's next step was to decide whether the work would be undertaken from an existing ontology (ontology merge approach) or whether a new model should be created specifically for the project (ontology creation approach). On one hand, the creation of a new ontology implied extra research efforts and intense dedication by the breast anatomy experts. On the other hand, the use of existing ontologies required well-planned strategies for merge non-existent concepts with the existent ones, not to mention the need of specific arrangements for future evolution of the model. Thus, the project team initially opted for conducting an investigation of the pre-selected ontologies in order to identify whether some of them could actually be reused or not. The evaluated ontologies were, therefore, classified according to six categories shown in Table 2.

Table 2: Classification used for ontologies assessment.

Criteria	Description
Degree of Detail	It indicates the level of description of the terms contained in the ontology (low, medium and high degree of detail).
Degree of formalism	It describes the degree of formality used by the ontology, which are: formal, semi-formal and informal.
Technique used for modeling	Description of the systematic used to construct the ontological model, e.g. first order logic, logic description or other more specific techniques.
Licensing	It identifies the type of licensing of the ontology.
Type of ontological model	Classification of ontologies according to the criteria defined by Lassila and McGuinness (2001), comprising ontologies in: controlled vocabulary, glossary, thesaurus, formal hierarchy, informal hierarchy, frames, value restriction and logical constraint.

The project team also decided to verify the adherence of the ontologies to the principles of Gruber T. R. (1993a), namely: (a) clarity, (b) coherence, (c) extensibility, (d) consistency in the use of common vocabulary and (e) non-dependence of specific symbologies. Since this assessment is out of the context of this paper, it is sufficient to mention that among the pre-selected ontologies the Foundation Model of Anatomy (FMA) was the one which most closely represented the needs of the project. However, the project team decided to build a new model from scratch while keeping the FMA as a reference ontology which could be integrated to the ONTO-MAMA in future work if the need arises. The main reason for such decision stems from the degree of detail desired and from the need to be in compliance with the principles established by Gruber T. R. (1993a). Even a quite extensive and complete ontology such as FMA did not present, at a high level of detail, the concepts needed to describe the macro and micro structures of the female breast, as required in our project. Besides, the evaluated models provided little or no documentation in order to clarify the concepts and its usage, making it difficult to extend the model.

The METHONTOLOGY will be described in the next section under the point of view of ONTO-MAMA project as well as by considering a unified methodology which promotes the integration of a ontology model and a 3D graphic model.

3.3 A "Unified Ontology Model"

3.3.1 METHONTOLOGY: Building the Ontology Model

METHONTOLOGY is a methodology for building ontologies created by the Universidad Politécnica de Madrid by the Ontological Engineering Group.

Figure 2 illustrates the METHONTOLOGY's phases and stages (or tasks). The most important tasks or stages, located in the development phase, are the followings: (a) Specification, (b) Conceptualization, (c) Formalization, (d) Implementation and (e) Maintenance. Additionally, METHONTOLOGY describes management and support activities, both necessary to complete the cycle of construction, evolution and maintenance of the ontology model.

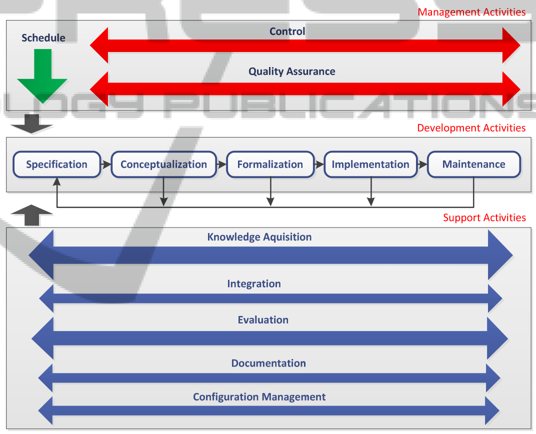

Figure 2: METHONTOLOGY Process.

The first step of METHONTOLGY is the specification. It defines the boundaries of the model and clearly states, to all participants, the objectives that are supposed to be achieved, the desired degrees of formality, the scope of the ontology and the desired degree of granularity.

The next step involves the organization and capture of the knowledge, which is called Conceptualization stage in the METHONTOLOGY process. This step consists on the conversion of tacit knowledge obtained from experts into explicit and semi-formal knowledge. It is an intermediate record of knowledge, a leveling mechanism of concepts among all team members. Gomez-Perez A., Corcho O. and Fernandez-Lopez M. (2004) suggest some intermediate representations, for example, glossaries of terms, tables and data dictionaries to be used at this stage.

The formalization and implementation stages consist of describing the model using a formal language. In the case of this project the language chosen was Web Ontology Language (OWL) generated by Protégé. During the formalization and implementation stages the ontology model can be submitted for validation by experts as well as be used by others sub-projects members in order to provide immediate feedback. The implementation stage may also include the construction of libraries or reusable softwares which aims to use the model so that usability, performance and portability can be measured beforehand.

The METHONTOLOGY development cycle is concluded with the maintenance stage which includes the validation and the delivery of the model for the scientific community. One may understand this phase as a beta test of the ontology model.

3.3.2 METHONTOLOGY: Building the 3D Graphic Model

The first multimedia model incorporated to our unified ontology model was the 3D graphic model. This model was chosen due to the importance of representing the anatomical parts in a more appealing manner, including the possibility of interaction and animation directly performed on the 3D structure (for simulation purpose) and also because the 3D modeling brought to us some challenges to overcome in order to represent the anatomic parts in a more realistic way.

Some of the challenges we had to overcome can be summarized as follows: (a) the lack of a specific 3D modeling methodology, (b) the divergences found among different anatomical atlases used as reference, (c) the difficulty of setting standards for the 3D modeling such as the size of the 3D objects, proportionality of the model compared with a real breast, color and texture issues and grouping and/or linkage of the 3D objects to the ontology model.

The lack of a 3D modeling methodology was solved by adapting the METHONTOLOGY process to the 3D modeling tasks. This way we could provide a better interaction between the ontology team and the 3D modeling team which resulted in a better validation process since the graphical artifacts was frequently used to check the comprehension of a concept described by the ontology model. The divergences among the references were solved by using the opinion of the experts and scientific community whom were in participation of the ontology model construction. Finally, the need of setting standards were addressed in the beginning of the 3D modeling process so that all the people involved already new and understood our goals and limitations for modeling the female breast in a more fidelity and truthiness manner.

In conclusion, we decided to keep and adapt the METHONTOLOGY as the working methodology for the 3D modeling tasks.

From this, the first step of 3D modeling consisted of planning the work. During the planning the following tasks were executed: a) study of the METHONTOLOGY; b) structuring of METHONTOLOGY stages to the 3D modeling needs; c) production of schedule; d) initial preparation of requirements.

Next the planning phase, the stages of METHONTOLOGY were applied directly to the 3D modeling tasks with some adaptations.

In the Specification stage the 3D team worked closely to the ontology team by gathering the requirements of the model from the experts. Consequently, the use of knowledge acquisition (KA) techniques is imperative at this point as defined in Brasil L. M (1994). Some of the KA techniques applied in this project are: a) dynamic reading of documents; b) observations; c) interviews; d) definition of protocols.

In the Conceptualization stage the 3D team provided support to the ontology team by initially prototyping visual presentations of the concepts as well as by validating such concepts with the experts in mastology. It is also part of the work to define the technique to be applied in the final version of the 3D modeling. Regarding to this, the method of polygons has proved effective due to its compatibility with complementary techniques such as edge loops and face projection which improved our results.

The Formalization and Implementation stages of METHONTOLOGY represent the construction of the 3D model for an anatomic structure as well as the connection of such graphical object to the ontology. At this stage, the 3D modeling team may also need to compare graphical models constructed by using different techniques which improves the accuracy of the work.

It is important to point out that due to modeling easiness and the already acquired knowledge of our 3D modeling team we have opted for using Maya Software 2010. Maya has a system of particles and fluids and the facility of texturization, composition, renderization and animation which have proved to be handy in our project. Besides, this software is widely used in the biomedical area and was the object of study in Gu S. (2006) and Sharpe J., Lumsden C. J. and Woolridge N. (2008) whom presented it as an accessible alternative to capture biomedical properties. Maya also allows the 3D modeling by using polygons, NURBS (Non-Uniform Rational B-Spline) and subdivisions which provided us a way of modeling at different levels of complexity. In our project we also opted for applying complementary 3D techniques in order to modify or simply polish the final 3D model (Maraffi C., 2003).

The connection with the ontology model is done by grouping the 3D structures (vertices, edges and faces) according to its semantic meaning. After a long period of research, it was found that there were no visual ontologies for 3D models in the health field. Therefore, this characteristic represents a great contribution of this work. In this regard, Maya proved to be very efficient in storing the simplified version of the identification structure defined primarily in our ontology model with the purpose of tagging each 3D object. As a result, from the generated 3D model, in VRML or OBJ format, we were able to retrieve not only the descriptions of our 3D objects (vertices, edges and faces), but also the metadata for their identification, which further on could be linked to our entire ontology model or be manipulated by the intelligent tutoring system.

The stage of Maintenance is the endpoint and is represented basically by the validation process. At this point, both models (ontology and 3D) and intermediate artifacts go through a systematic verification and validation by experts in the area of radiology and mastology.

3.3.3 The “Unified Model”

Since our goal in the ONTO-MAMA was to construct an ontology model to be used as a reference for learning medical concepts related to the female breast anatomy and to the core needle biopsy, the primary requirement of the project became the representation of the knowledge in several formats or medias, not only in textual mode.

Therefore, our building process as showed before provided the possibility for combination of the ontology model and a 3D model. We have no doubt that such a process can also accommodate others digital models in a more general and unified view. This unified view, then, will be considered the most complete representation of the knowledge because it will contain different points of view and also the possibility of interchangeability among them.

From this idea of building a unified ontology model we defined a more complete structure for identification of the objects in our ontology model by considering different types of media and external resources. This same identification or linkage structure will be used in future versions in order to add references to a diversified set of digital media so that an ontology engine could make the connection among several different types of knowledge representation. Furthermore, the linkage structure in our ontology model serves to determine the details of the relationship among the ontology description and any external media resource.

The next section describes the results obtained so far on each phase of our building process by considering both models: the ontology and the 3D model.

3.4 Results

3.4.1 Stage 1: Specification

The Specification stage of the ONTO-MAMA project, was formalized in a document called "Ontology Requirements Specification" that follows the pattern suggested by Gomez-Perez A., Corcho O. and Fernandez-Lopez M. (2004).

Basically, as the goal of the ontology we’ve defined that the model express the vocabulary of the female breast anatomy for the purpose of performing the core needle biopsy procedure. In the future the description of these medical procedures will be also incorporated to the model.

Regarding to the characteristics of the model, we’ve decided for building a formal ontology described in Resource Description Framework (RDF) or Web Ontology Language (OWL) format and doted of a medium degree of granularity which means to say that we won’t intend to represent and describe the very microscopic structure of the breast anatomy, not relevant to the performance of the medical procedure.

As we can notice the specification phase provided the general guidelines for both ontology and 3D graphic modeling.

3.4.2 Stage 2: Conceptualization

The outcomes generated during the Conceptualization stage are the three types of glossaries of terms, as well as diagrams which define the structure of the model in a high-level view called Model View, and intermediate visions of the model, which were named Meta data view and Implementation view.

Figure 3 illustrates the structure of all artifacts that compose the ONTO-MAMA. The Glossary of Terms and the Model View (Diagrams) can be optionally used to guide the modeling of any type of multimedia representation, for instance the 3D graphic model. The ontology model, on the other hand, is considered a compulsory artifact which serves as the main guidance for the multimedia modeling if we consider the unified ontology model described in previous section.

In fact, it is the ontology model that will determine which objects can be represented by multimedia artifacts and what characteristics and degree of detail (anatomical and visual aspect) it is expected or accepted.

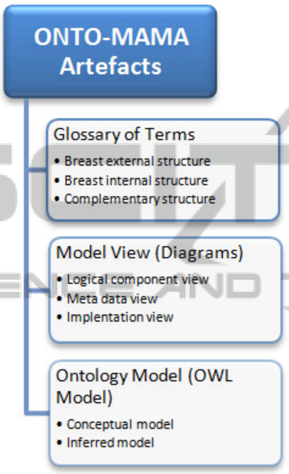

Figure 3: Intermediate Representation in the conceptualization phase.

Table 3, in turn, illustrates the structure of the glossaries of terms created in the project that broadly follows the recommendations of Gomez-Perez A., Corcho O. and Fernandez-Lopez M. (2004). An example of the glossary of terms and the meta data structure for the ontology model created for this project can be found in the appendix section at the end of this paper.

Table 3: Structure of glossaries of term.

Sections of the document	
-	Term or concept name
-	Term or concept description
-	Source of reference for term or concept
-	Copyright statement for using the term/concept description (optional)
-	Examples of multimedia representation (optional)
-	Source of reference for multimedia representation (optional)
-	Copyright statement multimedia usage (optional)

From the point of view of the 3D modeling, the team provided some intermediate 3D objects for conceptualization, understanding and future improvements. Some examples are shown in Figure 4.

Figure 4: a) External view of the breast: triangulated mesh; b) Side view of the Ductal System – Current model mammary glands Part 1; c) Side view of the Ductal System – Current model mammary glands Part 2.

3.4.3 Stage 3 and 4: Formalization and Implementation

As stated earlier, beside the artifacts suggested by the methodology itself, the project team decided for building complementary diagrams which are able to express the building block structures of the unified model in a more understandable way.

This decision took into account the different profiles of people involved in the project, which include professionals with little or no knowledge whatsoever of concepts involving ontology. Thus, these diagrams facilitated communication within the team in order to equalize levels of knowledge among all participants. Furthermore, these artifacts were shown to be quite useful to experts as a source of validation and verification regarding to the evolution of the work over time.

Figure 5 illustrates the so-called Model View diagram that describes the high-level ONTO-MAMA structure.

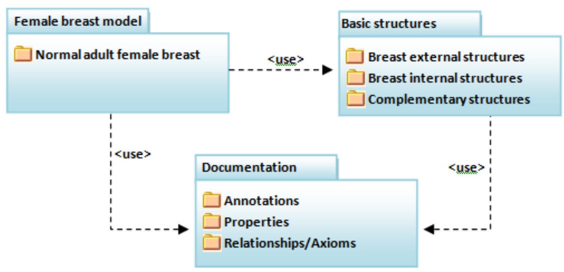

Figure 5: Model view.

From this Model view of ONTO-MAMA, it is possible to verify that the model was constructed from basic structures existing in the female breast.

These structures, in turn, were categorized according to the point of view of an observer that may be external or internal to the breast. The model also proposes to describe some additional anatomical structures which contribute to a better understanding of the female breast, namely: lymphatic, venous and arterial structures. Such structures are classified in the model as complementary structures. The Model View also suggests that any structure in the model make use of a documentation element which is implemented as notes, properties, attributes, relationships, rules and axioms.

As for the annotations and properties / attributes, they are considered elements of metadata in the ONTO-MAMA model because they define the detailing mechanisms of the concepts presented in the model. For these elements, the project team has defined a systematic representation that is shown in Figure 6.

The systematic definition of the metadata from the ontology model primarily defines that it must contain annotations, which we called "Ontology annotations".

The conceptual elements that represent the anatomical parts of the female breast, in turn, receive annotations and also other specific attributes which were defined by medical experts.

Additionally, a special structure based in annotation or notes is also provided to fulfill the need of identifying the multimedia objects in others associated models.

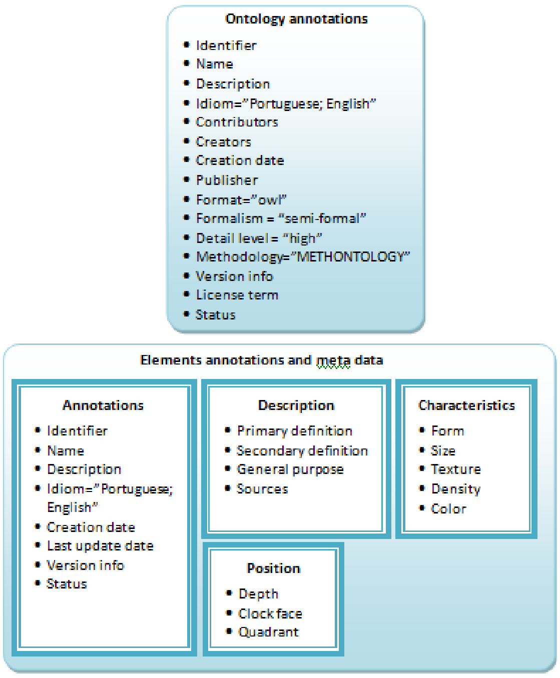

Figure 6: Meta data view.

This identification structure takes into account that a metadata for identifying one object can be expressed basically according the following formats: URI locator, text-based and coded-based which matches a predefined pattern. This way we provide a flexible mechanism for identifying an object of interest in particularly any type of media.

After defining the metadata structure, the project team opted for direct prototyping (implementation) of the models on Protégé and Maya, which brought agility to the construction and review tasks.

For future work we plan the construction of a software library which will facilitate the use of the ONTO-MAMA models by the scientific community.

This library will consist of a set of APIs developed in Java with the ability to interpret and/or reference the model and its constituent parts.

In addition, the library to be built will serve as a basis for the building of a website in which the concepts proposed by the models can be consulted in order to provide a faster and easier access for medical practitioners, students and others interested in the knowledge of breast anatomy and associated medical procedures.

4 CONCLUSIONS

Our experience in the project showed that the success in the creation of an ontology depends on the team's level of commitment, on the level of the experts' knowledge and on the working methods applied.

Furthermore, also deeply connected with the working method is the team's ability to understand the requirements of their project, plan actions, and work on the elaboration of products, which may not have been necessarily explicit in the methodology in use, but that can bring agility and improvement to the communication between those involved.

Regarding to the construction of a unified ontology-multimedia model our project shows up that the teams must be involved since the beginning of the tasks and definition of goals and principals. Also, it proved very handy to use the artifacts produced by the multimedia team as a support for validation and check points with experts. Additionally, it is important to reinforce the need of having efficient and flexible mechanisms for concepts identification so that these can be reused in the identification of the multimedia objects and further yet as a complementary identification of learning objects if we are considering the construction of intelligent tutoring systems.

Currently, the model is defined only in Portuguese (Brazilian), but the translation work into

English has already begun. The ontology model as well as the most important anatomic parts of our 3D model is under validation of experts working in the area of radiology and mastology. We plan to build a complementary ontology as part of the project with the focus on the description of the core needle biopsy procedure. In addition, we also intended to build libraries and supporting tools for others being able to use our models efficiently and easily. Finally, it is also important to mention that the virtual reality environment and the intelligent tutor system are under development in order to validate our models with regard to its usefulness, easiness and importance.

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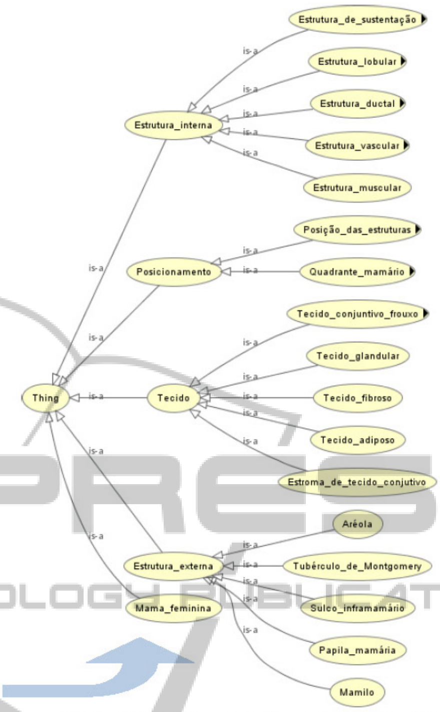
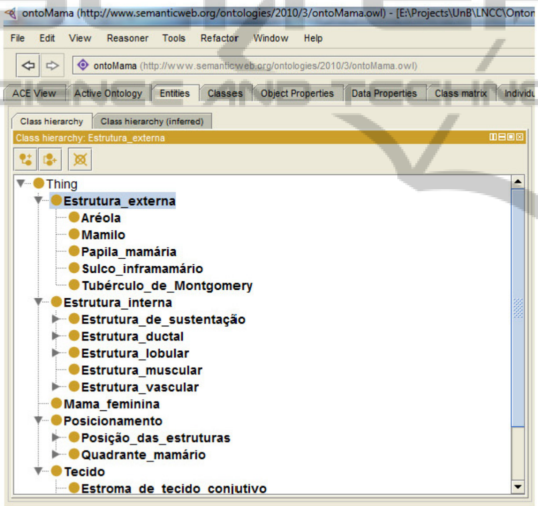
APPENDIX



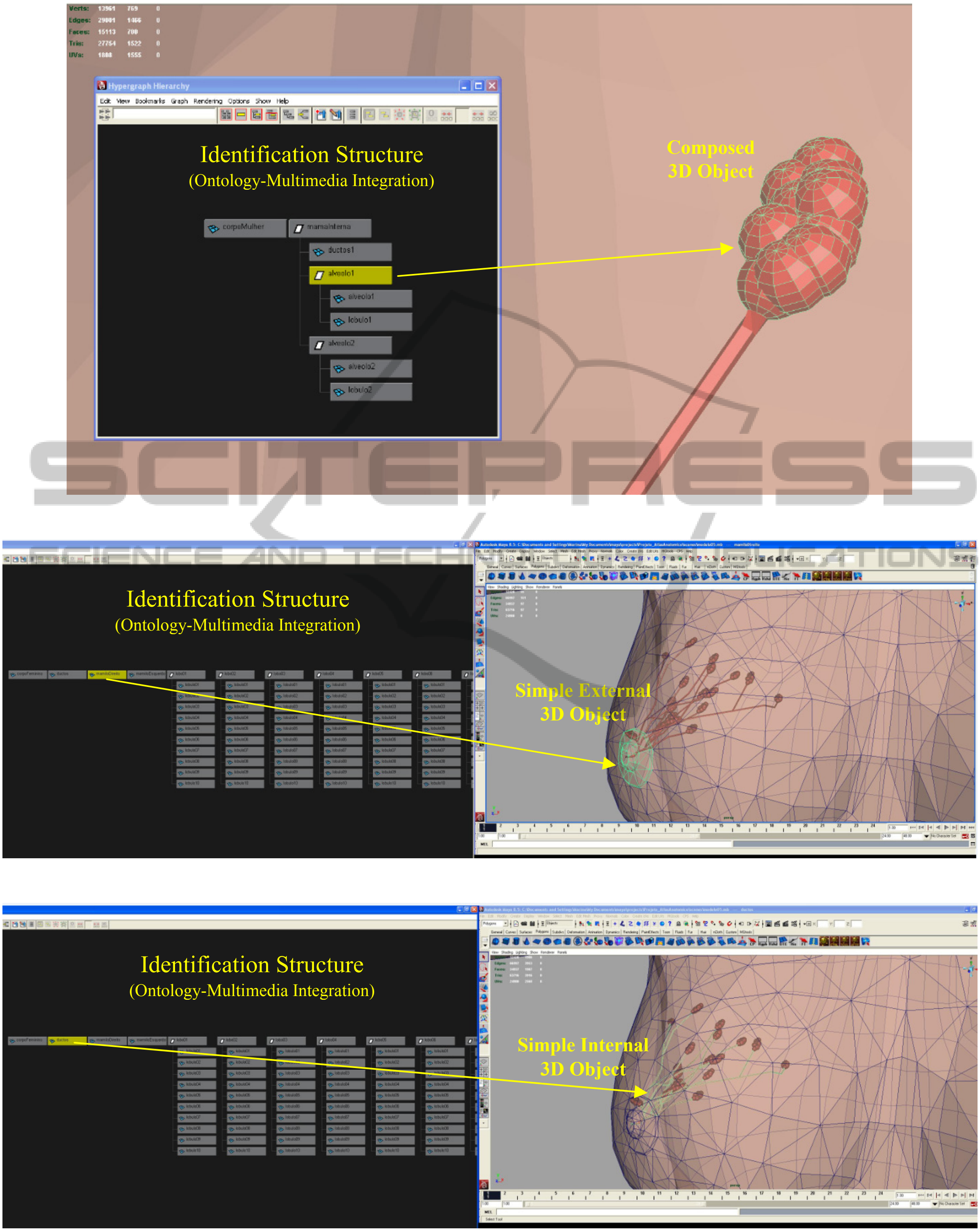
ONTO-MAMA Sample in Protégé (Graphical View)



ONTO-MAMA Sample in Protégé (Breast Internal Structure) – Tree View

ESTRUTURA INTERNA		
Termos	**Definições**	**Ref**
Glândula mamária	É uma glândula alveolar composta, exócrina e apócrina. Existem, em média, 15 glândulas alveolares compostas (lobos da glândula mamária), cada uma formada por lóbulos da glândula mamária. Cada lóbulo possui um ducto lactífero cuja terminação apresenta um seio lactífero, que se abre na papila mamária (mamilo).	1
	É formada por lobos que se dispõem como os raios de uma roda, tendo por centro a papila da mama.	3
	Constitui o tecido secretor da mama.	1
	Situa-se na fáscia superficial. É constituída de 15 a 20 unidades de tecido glandular, cujos lóbulos estão incluídos em um estroma fibroso-areolar, que se irradia do mamilo para o interior da gordura superficial circunjacente.	5
Lobos da glândula mamária	São glândulas alveolares, cada uma formada por lóbulos da glândula mamária. Totalizam em média 15 unidades. O conjunto de lobos mamários formam a glândula mamária.	1
	São alongados (raios da roda) e são percorridos centralmente por um ducto coletor que se denomina ducto lactífero.	3
	São em número de 15 a 20 e são constituídos por lóbulos.	3
Lóbulos da glândula mamária	São estruturas que formam os lobos da glândula mamária.	1
Ductos lactíferos	É um ducto coletor. Canal galactóforo.	1
Canal galactóforo	Ver ducto lactífero.	
Seios lactíferos	Pequena dilatação fusiforme. Ampola galactófora.	3
Ampola galactófora	Ver seio lactífero	
Poros lactíferos	Pequenos orifícios existentes na papila da mama.	3
Ligamentos suspensores da mama	São espessamentos infraclaviculares da fáscia superficial da tela subcutânea ou processos fibrosos periféricos, que se fundem com o estrato superficial da tela.	1
	Anteriormente, a camada superficial da tela subcutânea envia, nas palavras do Sir. Ashley Cooper, "numerosos processos fibrosos, fortes e largos, para a superfície posterior da pele que recobre a mama... é por eles que a mama se encontra suspensa em sua situação."	2
	Une firmemente a glândula mamária à pele, passando pelo estroma entre lóbulos de gordura.	5
	Liga a glândula com firmeza à derme da pele sobrejacente. São particularmente bem desenvolvidos na parte superior da glândula e ajudam a sustentar o tecido glandular.	4
Nervos	Nervos intercostais (2º a 6º), via ramos cutâneos lateral e anterior. Esses nervos, os os vasos intercostais, conduzem fibras simpáticas.	5

Sample of Glossary of Terms (Internal Breast Structure)



ONTO-MAMA Sample of the Unified Ontology-Multimedia Model.
(ontology model associated to the 3D graphic model)