Anatomical knowledge representation: attempting querying integration on VHD via UMLS

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Abstract

The paper presents a novel internet-based application that provides access to anatomy knowledge through symbolic modality expressed by keywords taken from controlled or non-controlled terminology. The system is based on a database where anatomical concepts have been organized into a hierarchical framework. Along with term queries that allow retrieving concepts containing or exactly matching the used keyword, the system provides semantic access to anatomical information. Queries can be setup, which retrieves concepts relying to a particular meaning, and have to share a particular relationship. Moreover the application has the capability to refine the search of the terms by querying the UMLS knowledge server. Anatomical image data have been integrating by using Visible Human Dataset source. A set of these images has been indexed according to our anatomical classification and used inside the application. The system has been all implemented through Java client-server technology and works within standard Internet browsers.

Keywords

Anatomical knowledge representation and visualization, image database, java technology.

Introduction

The Unified Medical Language System (UMLS) and the Visible Human Dataset (VHD) are two remarkable contributions of the National Library of Medicine to the scientific community of Medical Informatics and Telemedicine[1,2]. Independently from the fact that each of them has its own competitors, they are relevant tools for a number of different and complementary applications. Also we generally agree in saying that the implementation of any suitable integration between UMLS and VHD will be such to provide added value to the results obtained by any scientist really involved or in UMLS or in VHD subjects. We did such an attempt of integration.

Integration is something like a magic and always welcome concept. Also it may have a number of specific meanings, unfortunately quite different one from the others, we have to deal with. As far as it concerns integration of UMLS and VHD, some contributions have been already described in the scientific literature. As illustrative examples, we can refer to some experiences developed within major groups. Pommert and Schubert[3,4] designed and implemented an organizational framework for anatomical concepts and produced 3D anatomical models, starting from clinical images, linked to this framework. Equivalently Rosse et al.[5] described new principles for anatomical knowledge representation in the direction of enhancing UMLS and Brinkley et al.[6] focused their scope on the development of an Internet-based application for 3D anatomical visualization based on VHD that integrates at low level image data and such a representation. However none of them has focused on the problem of deeply integrating these two NLM contributions in the sense of making available the access to whole anatomy knowledge (both visually and symbolically) independently of the starting modality.

From what we said we should conclude that an integration between UMLS and VHD, attempting simultaneous visual and symbolic anatomy browsing, stays up to now unattended by the interests of the scientists.

Generally unattended appears the integration allowing one to perform semantic queries on image databases. Multimedia database probably are the area where something has been done. However the need that anatomists have, in willing to do interactive semantic queries on images databases like the VHD and its twenty thousands multi-modal bioimages, is a tremendous task usually not considered by multimedia people. Nevertheless the power of a semantic queries selecting, for instance, the liver contours from all the VHD slices of the man cadaver where part of the liver is present, are highly welcome from medical people. What we did is along such a line.

Methods

Representing anatomy knowledge means to identify a set of categories to cluster real structures (instances) based on properties and mutual relationships they exhibit. Categories and instances are identified by concepts, which are referred by a specific term taken from a controlled vocabulary. Even concept definitions for categories are derived by the morphological, structural, and functional properties recognized into instances. From general categories which represent generic concepts (such as anatomical structure, organ, body space, body structure), more specialized categories, which express specific features, are obtained through *is a kind of* relationships .

An explicit taxonomy of concepts can be carried out in the shape of a hierarchical tree or a semantic network. UMLS provides such a framework in its knowledge source

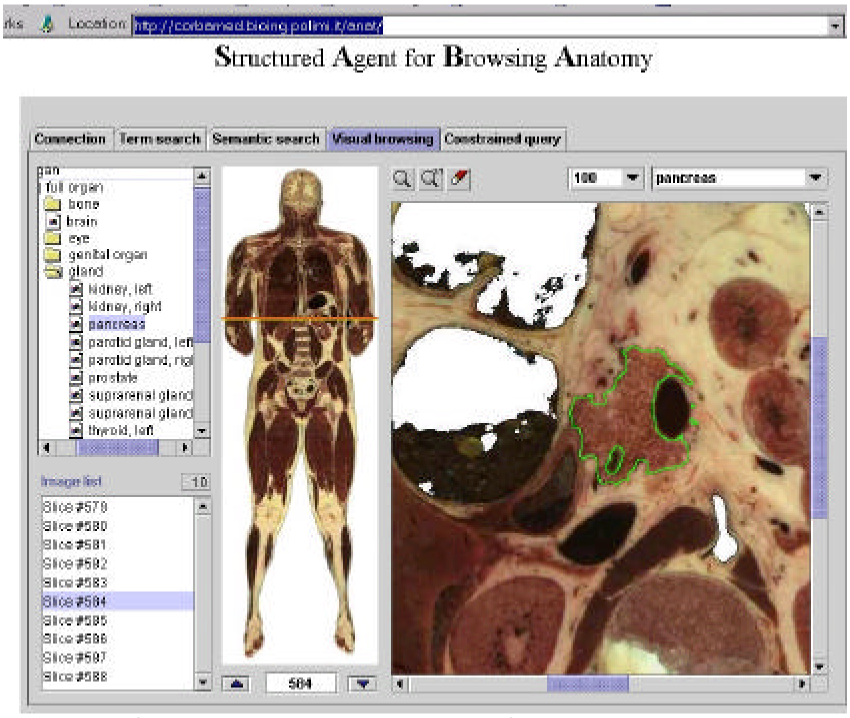

Fig. 1 After semantic hierarchical query (left upper list), the anatomical structure appears as contoured in the slice visualization.

amed Semantic Network. But this does not take into account only for high level categories. Starting from UMLS categories we have developed finer classes for anatomical concepts and linked concepts through hierarchical and non hierarchical relationships. For example "*is part of*" relationship has been adopted to derive a partonomy hierarchical tree. Other relationships as *acts-as*, *has-function-of*, has been used to enhance the representation. A relational database has been used to implement the obtained conceptual organization.

As regards anatomical visualization we utilized VHD images. In particular, we used a set of trial VHD full-color images from Gold Standard Multimedia along with the corresponding segmentation masks-color. The images are derived from the original VHD images through cropping and registration. The masks are single layer maps containing at each pixel location an integer index pointing to a look-up-table (an MS-Excel sheet) where about 1600 anatomical structures were coded and labeled. These codes have been mapped through a devoted database, named Image-Database, into the anatomical knowledge database. From the segmentation masks we obtained the contour of each identified anatomical structure and they have been stored into Image-Database.

Results

A two-layer Java-Based application has been developed to remotely access these two knowledge sources. This application allows the user to retrieve and display as highlighted the contours of the anatomical entities involved in a symbolic query result. Even all the displayed images are active in the sense that user can pick anywhere in the image to retrieve complete information about the anatomical entity containing the picked pixel (see Fig. 1).

Conclusion

The developed system is included into an ongoing project aiming to integrate symbolic and visual knowledge about anatomy domain . Moreover the obtained system is delivered across internet to increase its fruition to a wide range of users. The application is now at an advanced implementation stage, to be followed by a wide set of tests.

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