Database contents, structure, and ontology for WEAR

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Abstract

The World Engineering and Anthropometric Resource (WEAR) project is defining a wide range of data, tools to use and analyze the data, as well as quality and validation methods for using human measurement databases in engineering applications. Examples of the types of data include, individual and aggregate anthropometric data, biomechanical, joint limit and strength data, visual field and fit data. This data comes from a diverse set of sources and the meaningful integration of these sources is a major challenge.

In order to begin the integration process we are developing an ontology, a formal definition of the relationships between the identified data of interest. For example our initial ontology represents anthropometric measures as defined in a preliminary dictionary of anthropometric landmarks. The landmarks are categorized into measures of points, lines, and planes commonly used in a wide range of anthropometric databases.

Many databases already exist and the key purpose of the ontology is to aid in the integration of these databases into a coherent system which can be used to make meaningful queries to solve real-world problems. Web services and database security are also discussed.

Keywords: Anthropometry, Database, Ontology, Data processing, Ergonomics

1. Introduction

WEAR is a collaborative effort to create a world wide resource of anthropometric data for a wide variety of engineering applications. The user of anthropometric data can access the available data through a central portal. This paper describes the database structure for the different databases that can be access through this portal.

2. System requirements

It is foreseen that the databases of WEAR will be used by people from different countries.

So, it is necessary to define the structure of one or a series of databases linked together, with a direct access through the web.

The sub systems are numerous :

- Organized data files of 1-D and 3-D raw data linked with data query tools and statistical modules
- Shape analysis methods
- Biomechanical data files
- Bibliographical data files and synthesis files in ergonomics
- Methods and/or tools for fit tests
- Examples of results for design purposes
- Tools for on-line help and assistance

3. Database structure

The principle of an anthropometric and, more generally, an ergonomic database system is summarized in figure 1. Main files are composed of 1-D and now 3-D anthropometric data.

Database components can be derived as shown on figure 2, with a collection of databases to store and retrieve the different kinds of inputs from surveys.

For raw individual data as well as for aggregate results coming from technical reports and/or articles, the structure adopted to organize the database could be the same. Based on functionalities of Relational DataBase Management Systems (RDBMS), the surveys (individual data) and reports (aggregate data) are described through specific tables linked together and queries can be achieved using SQL (Standard Query Language) (figure 3). Some specific tools are necessary to check the quality of data contained in surveys and the definition of measurements.

In a first step, basic data processing will be searches of surveys or subjects based on selection criteria coming from general information (sex, age, origin,…) and/or ranges of values for measurements (i.e stature> 1750 mm), with calculations of descriptive statistics : mean, standard deviation, correlations, bivariate distributions,...

The next step is to propose methods and tools for fit tests , sizing approaches and shape analysis. An example from Cleopatra, a visual interface developed to navigate and interrogate the CAESAR database, is shown on figure 4.

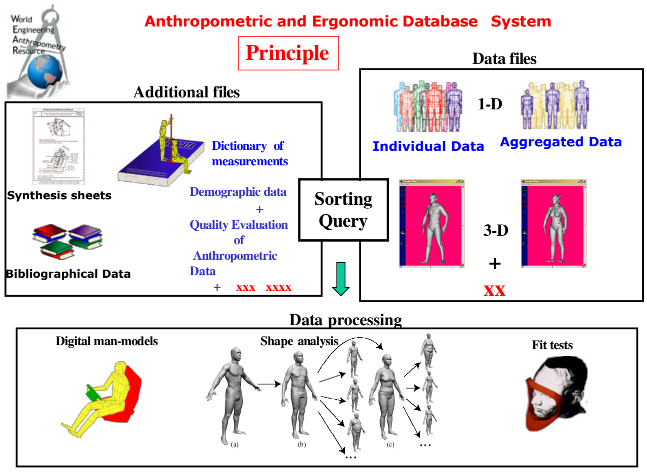


Figure 1

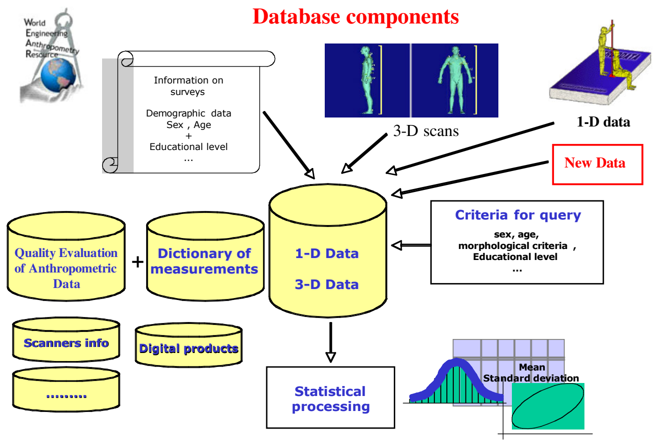


Figure 2

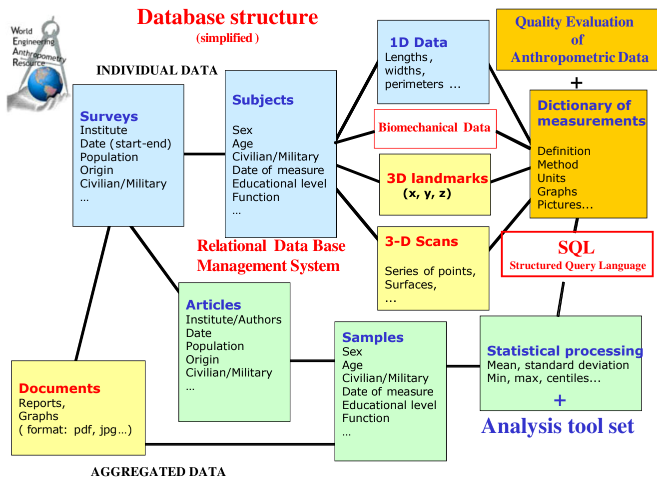


Figure 3

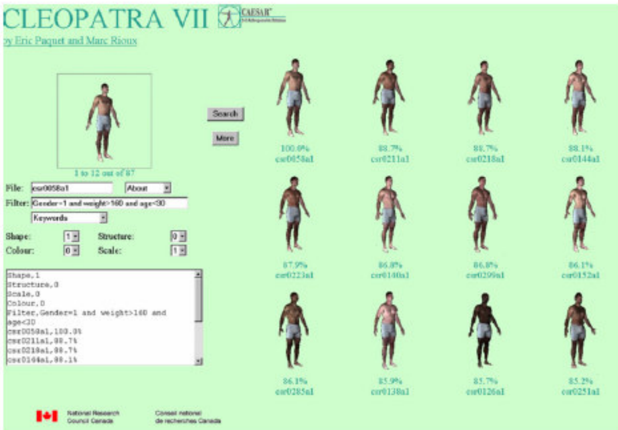


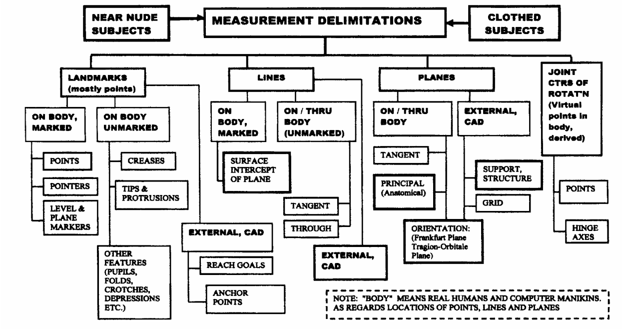
Figure 4

4. Database integration

One of the more challenging aspects to the creation of a large scale multifaceted database is the integration of many different types of database systems, most of which already exist. Our approach is to develop an Ontology to describe the anthropometry domain and use that ontology as guidance in the design of the larger database system.

We have chosen an ontology development tool called "Protégé" developed by Stanford Medical Informatics. The tool itself is freely available, runs on many computing platforms and has a large user community.

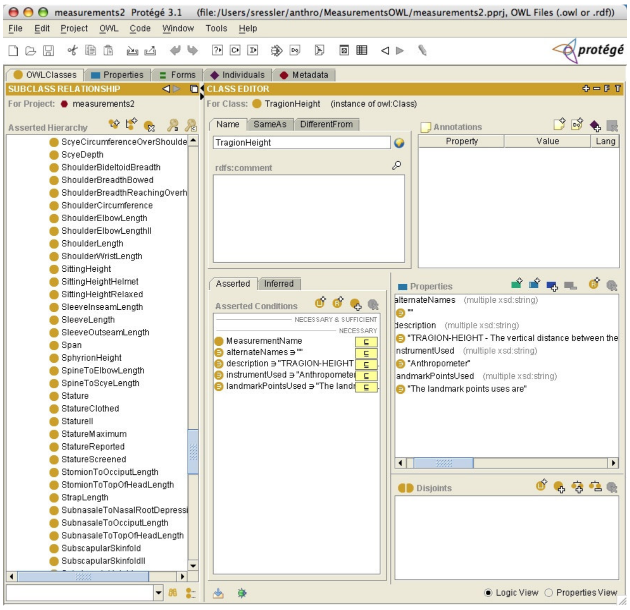
For our initial attempt at the development of an ontology we have begun with documents describing Anthropometric Landmarks produced by John Roebuck. In particular Roebuck has developed a block diagram of measurement delimitations that provide a good organizing structure to body measurements.



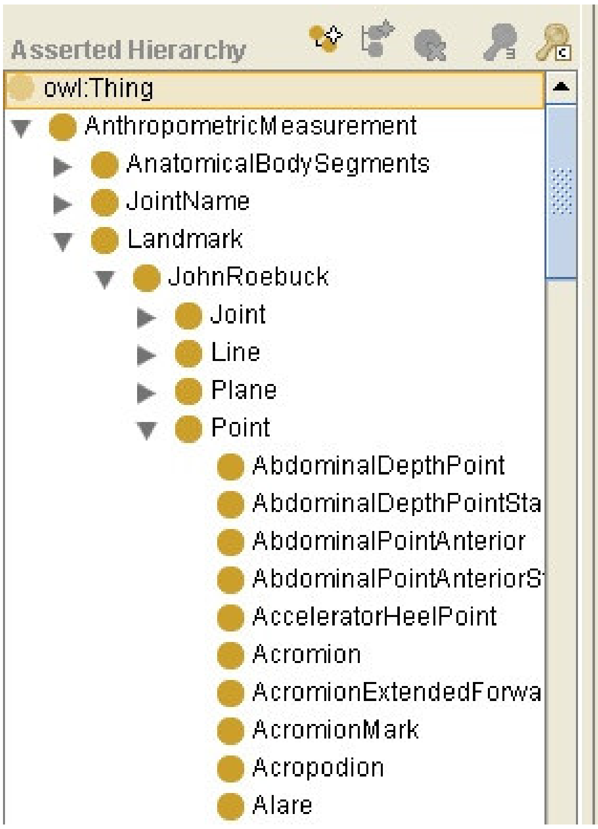
Block Diagram Outline of Relationships Between Different Anthropometric Dimension Delimitations (c) Copyright by J. A. Roebuck (2001) Used by permission.

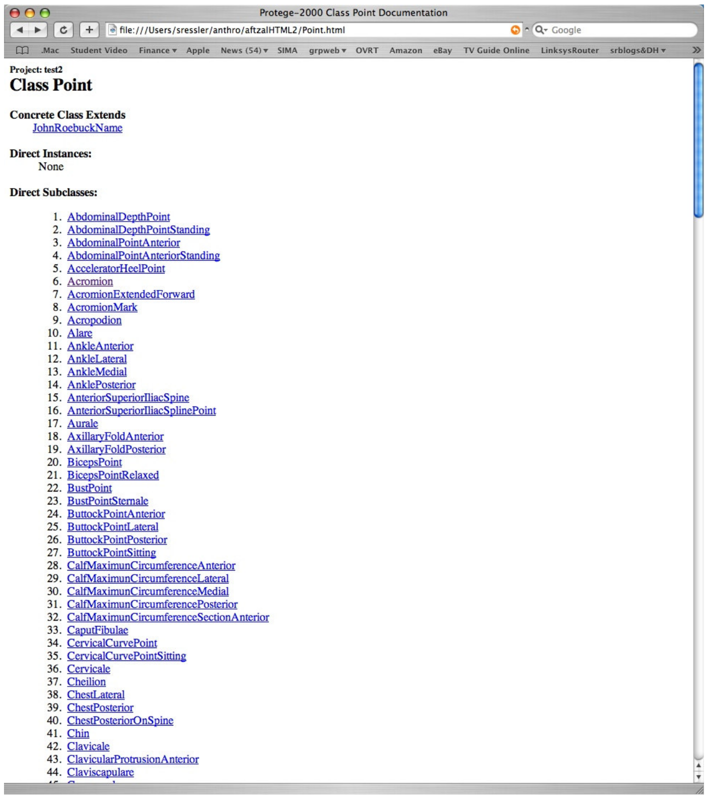
In addition to this organizing structure we are also using the definitions and descriptions of Anthropometric Landmarks in a draft dictionary also being produced by John Roebuck. It was being developed as part of the activities of the SAE's G13 committee and it's draft title is: AIR 5408, DRAFT SAE Aeronautical Information Report; Dictionary of Anthropometric Landmarks and other dimension delimitations for computer Human Model Design Evaluation Verification and Validation. We are indebt to Roebuck for his kind permission to use these documents.

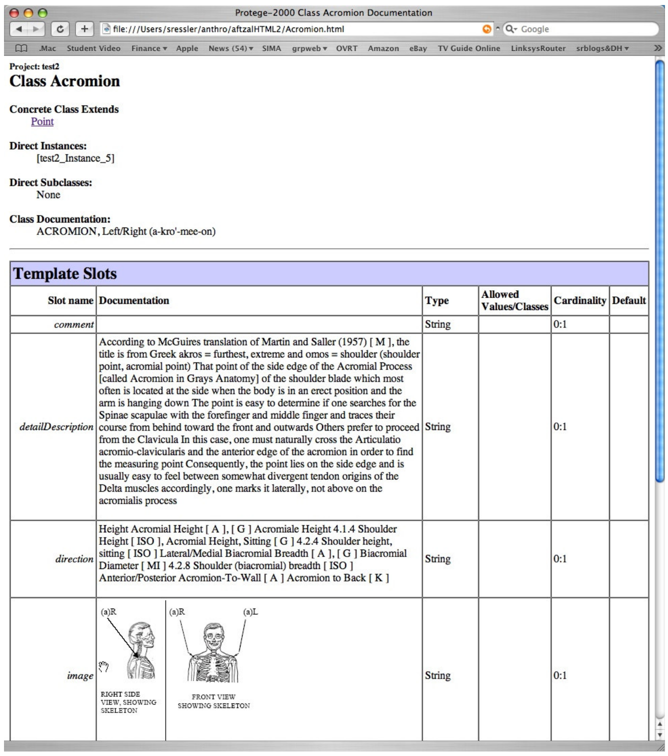
The Protégé screen for a simple ontology for traditional measurements is effectively a flat list of measurements



The Class structure for the Anthropometric Measurement ontology begins to resemble the hierarchy illustrated in the Roebuck block diagram.






Protege-2000 Class Acromion Documentation

file:///Users/sressler/anthro/aftzalHTML2/Acromion.html

Project: test2

Class Acromion

Concrete Class Extends
Point

Direct Instances:
[test2_Instance_5]

Direct Subclasses:
None

Class Documentation:
ACROMION, Left/Right (a-kro'-mee-on)

Template Slots

Slot name	Documentation	Type	Allowed Values/Classes	Cardinality	Default
comment		String		0:1	
detailDescription	According to McGuires translation of Martin and Saller (1957) [M], the title is from Greek akros = furthest, extreme and omos = shoulder (shoulder point, acromial point) That point of the side edge of the Acromial Process [called Acromion in Grays Anatomy] of the shoulder blade which most often is located at the side when the body is in an erect position and the arm is hanging down The point is easy to determine if one searches for the Spinae scapulae with the forefinger and middle finger and traces their course from behind toward the front and outwards Others prefer to proceed from the Clavicula In this case, one must naturally cross the Articulatio acromio-clavicularis and the anterior edge of the acromion in order to find the measuring point Consequently, the point lies on the side edge and is usually easy to feel between somewhat divergent tendon origins of the Delta muscles accordingly, one marks it laterally, not above on the acromialis process	String		0:1	
direction	Height Acromial Height [A], [G] Acromiale Height 4.1.4 Shoulder Height [ISO], Acromial Height, Sitting [G] 4.2.4 Shoulder height, sitting [ISO] Lateral/Medial Biacromial Breadth [A], [G] Biacromial Diameter [MI] 4.2.8 Shoulder (biacromial) breadth [ISO] Anterior/Posterior Acromion-To-Wall [A] Acromion to Back [K]	String		0:1	
image	(a)R RIGHT SIDE VIEW, SHOWING SKELETON (a)R (a)L FRONT VIEW SHOWING SKELETON	String		0:1	

Protégé is a convenient way of organizing the "knowledge" represented in the paper dictionary document. In addition we can automatically produce HTML versions of the ontology making the information easily available over the Web, including the display of images.

The real value of the ontology formalism will occur when we can use a variety of names from different databases and reach a common understanding of what these terms mean. In effect the ontology becomes a giant mapping system to map terms from one database system into another.

5. Web Services and Simple Object Access Protocol (SOAP)

Utilization of web services is the ideal vehicle for exchanging through a distributed on-line database system (figure 5). Using Web services, along with SOAP, will provide the basic, platform-independent messaging framework that is necessary to allow communication of information between all nodes within the proposed WEAR database system.

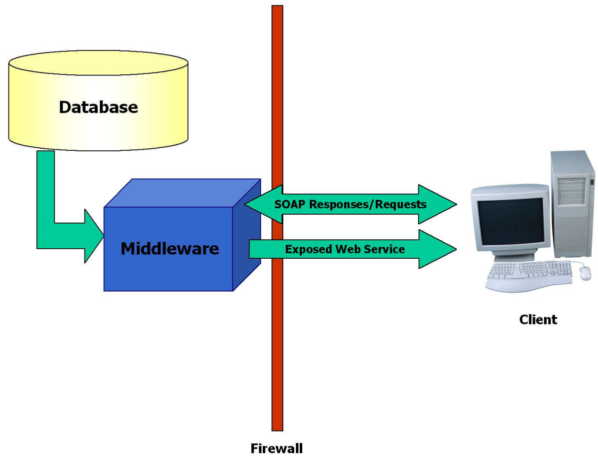


Figure 5: Web Services

A web service is software that allows different programs from different locations to communicate with each other over the Internet. A Web Service Description Language (WSDL) describes the interface of a given web service using common Extensible Markup Language (XML) grammar which includes information on all the publicly available methods, data type information, and address information. Universal Description Discovery and Integration (UDDI) is the standard for discovering web services. UDDI can be considered the yellow pages for all registered web services. Once located with UDDI, a client can then refer to the WSDL to invoke any of the publicly available functions. With WSDL-aware tools, this process can be entirely automated, enabling applications to easily integrate new services with little or no manual code.

Web services are a proven technology and have been successfully implemented in a variety of applications across all industries. One such example is Google's web API, which relies on SOAP and web services to provide other developers with the ability to incorporate Google's web search within their own programs. In the context of anthropometry, a WEAR user could query measurement data from several surveys that are stored at different nodes around the world that have published a WEAR compatible web service. The results from the various nodes could be combined into one composite dataset. In addition to sharing data, a WEAR node will also be able to leverage tools such as 3D shape searching from other nodes. Needless duplication of efforts in data gathering and manipulation can be eliminated.

SOAP is an XML-based protocol used for exchanging information between computers. Because SOAP messages are standard XML documents, they can be transferred over HTTP, which works well with today's most current Internet infrastructures. This is a huge advantage over older technologies such as DCOM or CORBA, which are normally blocked by most corporate firewalls.

Utilizing web services and SOAP allows each node within WEAR to maintain its own database independently while offering the use of data and tools to a wider community. Each node has the flexibility to decide what specific data and tools it would like to make available to WEAR users. WEAR's responsibility will be to provide the user community with the standards and tools to develop compatible web services to "plug" into the WEAR architecture.

6. Web and Database Security

Data within WEAR can be sensitive; therefore it is imperative that the necessary measures are taken to secure all data exchange to ensure information is only viewed by those permitted to see them. Security concerns should be considered in 3 major areas: client/user access, software security, and database security. A written security policy will be defined to clearly state 1) which elements constitute a violation of security and 2) procedures for responding to the violation.