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Medical Image Annotation of Patients Based on SHOE

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Abstract: This study presents the system of annotation of the medical images of the patients which is based on ontologies of the image and of the patient which is a base ontology since the information of this last represent the legends for these images. This system uses for a specification of the ontology and the annotation, the SHOE (Simple HTML Ontology Extensions) language.

Key words: SHOE, ontology, annotation

INTRODUCTION

Let us suppose that in hospital, for the patients who especially ask for a constant follow-up after one or more surgical operations, we create their Web pages.

In each web page, in more of the name and first name of patient, date and place of birth, date of admission in a hospital, we include also the various medical images.

Let us imagine that a doctor seeks for example MRI image of Selka's patient heart taken in 2003?

To answer to such request, instead of having only Web pages written in HTML[1]; which is only a presentation language of pages, we must describe the content[2] of these last and in particular the medical images. Describe the content of medical images of a patient amounts annotating them by adding SHOE (Simple HTML Ontology Extensions) semantic tags (or semantic information) with ontology-based knowledge about image contents of a patient.

The SHOE syntax: SHOE (simple HTML ontology extension) is a Knowledge Representation (KR) language that allows ontologies to be designed and used directly on the World Wide Web. It also allows web pages to be annotated with semantics. SHOE's syntax is a properly-compliant application extension of HTML. For a formal semantic definition of language[3].

SHOE ontologies: In SHOE syntax an ontology appears between the tags <ontology ID=id VERSION=version> and </ontology>. Together id and version make up the unique identifier for a particular ontology. SHOE has flexible facilities for ontologies to be derived from one or more superontologies in a multiple-inheritance scheme.

SHOE defines four basic types: string, number, date and Boolean values.

An ontology can make category definitions (using the tag <DEF-CATEGORY>). Categories may be grouped as subcategories under one or more supercategories.

An ontology can also make relational definitions (using the tag <DEF-RELATION> and </DEF-RELATION>) with n-ary arguments. Lastly an ontology can define inferential declaration (using the tag <DEF-INFERENCE> and </DEF-INFERENCE>).

SHOE instance: In SHOE syntax an instance (Web page or site) appears between the tags <INSTANCE-KEY=key> and </INSTANCE>. Key is the instance's unique identifier. For the web page the URL is a key. Within an instance may be found ground category claims and relations claims made by that instance. A category claim is made within the <CATEGORY> tag. A relational claim is enclosed by the <RELATION NAME= example> and </RELATION> tags.

MEDICAL IMAGES ONTOLOGY

Of what this ontology consists?[4,5]

To create this ontology (Fig. 1), it is necessary to define a taxonomy of categories (concepts of image) that is intended to show IS-A chain, the relationships between one or more arguments, where each argument is a basic type (like STRING, INTEGER…) or category.

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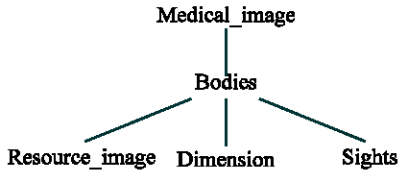

Fig. 1: Draft of medical image ontology

Image, Bodies (as brain, lungs,…), Sights: are categories.
We read: Bodies IS-A Image

Relationships
Name_patient (Patient,.STRING) → name of patient
Date_take_image(Medical_Image,.DATE) → date of image
Image_presents(Medical_Image, Disease, Bodies) → The image presents a myocard infarction of heart
Type_image(Medical_Image, Resource_image)
Resolution_image(Medical_Image, .STRING)

Remarks
STRING, DATE are basic type: Categories, Patient and Disease come from an another ontology which is the base ontology.

ANNOTATION SYSTEM

This system makes it possible to annotate medical images of the patients starting from knowledge available in one or more ontologies (Fig. 2). These ontologies are stored in the server of the hospital to the following address http://www.Name_hospital.org/SHOE/onts/IMG_MEDICAL.SH (SH: extension of SHOE).

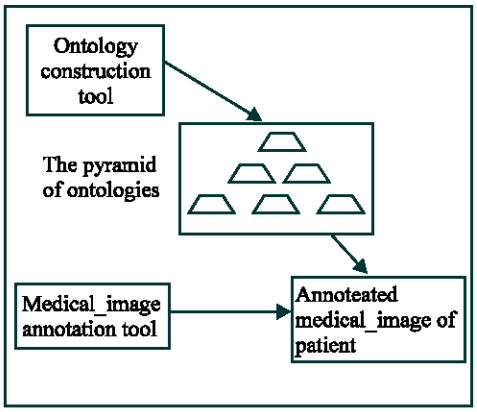

Fig. 2: System architecture

Ontology construction tool: There are many environments[6] for the construction of ontologies among them there is PROTÉGÉ 2000. The disadvantage of this tool is that it doesn't allow the derivation of ontologies of one or more superontologies in a multiple-inheritance scheme. Our tool is a simple Interface(Fig. 3) written in Java.

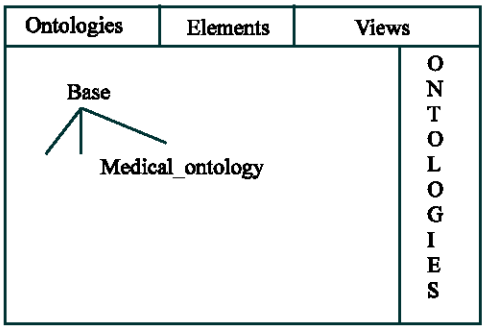

Fig. 3: Ontology editor

Ontologies menu: Allows to build the pyramid of ontologies (sub and superontlogies).

Elements menu: For each ontology, we specify categories, relations and inferences.

View menu: Allows to visualize the SHOE's ontology. This ontology will be as follows:

```
<HTML>
<HEAD>
<TITLE> IMAGE MEDICAL ONTOLOGY </TITLE>
</HEAD>
<BODY>
<META HTTP-EQUIV="SHOE" CONTENT="Version =1.0" >
<!--we indicate that this document is conformant with SHOE 1.0-->

<ONTOLOGY ID = "MEDICAL-ontology" VERSION= "1.0 ">

<!-- We identify the ontology by MEDICAL-ontology and we declare its version 1.0-->

<USE-ONTOLOGY ID= "base-ontology" VERSION="1.0" PREFIX= "base"
URL="http://www.name_hospital.org/SHOE/onts/base.html" >

<!-- use an another ontology named base-ontology whose version is 1.0, the prefix "base" and its URL is "http://www.Name_hospital.org/SHOE/onts/base.html "-->

<DEF-CATEGORY NAME="Image" ISA="base.SHOEENTITY" >
<DEF-CATEGORY NAME="Patient" ISA="base.SHOEENTITY" >
<DEF-CATEGORY NAME="Disease" ISA="base.SHOEENTITY" >
<DEF-CATEGORY NAME="Bodies" ISA="Medical_Image" >
<DEF-CATEGORY NAME="Dimensions" ISA="Bodies" >
<DEF-CATEGORY NAME="Sights" ISA="Bodies" >
<DEF-CATEGORY NAME="Resource_image" ISA="Bodies" >

<!-- We define ontology categories-->

<DEF-RELATION NAME= "Name_Patient" >
<DEF-ARG POS="1" TYPE="Patient " >
<DEF-ARG POS="2" TYPE=".STRING">
</DEF-RELATION>
```

```
<DEF-RELATION NAME= "Date_take_Image">
<DEF-ARG POS="1" TYPE="Patient">
<DEF-ARG POS="2" TYPE=".DATE">
</DEF-RELATION>

<DEF-RELATION NAME="Image_Presents">
<DEF-ARG POS="1" TYPE="Medical_Image" >
<DEF-ARG POS="2" TYPE="Disease">
<DEF-ARG POS="3" TYPE="Bodies">
</DEF-RELATION>

<DEF-RELATION NAME="Type_image">
<DEF-ARG POS="1" TYPE="Medical_Image" >
<DEF-ARG POS="2" TYPE="Resource_image">
</DEF-RELATION>

<!--We define ontology relationships -->
</ONTOLOGY>
</BODY>
</HTML>
```

Medical image annotation tool: This tool adds SHOE Knowledge to medical image of patients by making selection and filling in forms (Fig. 4).

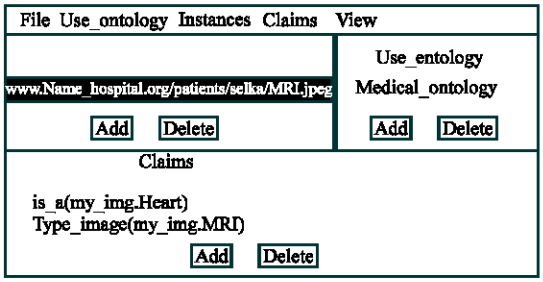

Fig. 4: Annotator tool

File menu: Allows to select the URL of the web page of the patient to start to annotate his medical images.

Example: We go to annotate for example MRI (Magnetic Resonance Image) image of Selka's patient heart which is included in its Web page by using also SHOE and the ontology described previously.
The URL's image is http://www.Name_hospital.org/ patients/Selka/MRI.jpeg. This URL will be added in the window of instances corresponding to these last.

Use_ontology menu: Allows to choose the ontology. Our ontology (MEDICAL_ontology) is prefixed by "MEDICAL" and it is stored in http://www.Name_hospital.org/SHOE/onts/ IMG_MEDIAL.SH

Claims menu: Allows to add the claims by first of all selecting an instance of the window of instances after we select categories and relations.

Example: After having validated the instance http://www.Name_hospital.org/patients/Selka/MRI.jpeg, we select categories and relations of selected ontology.

If we choose the Bodies category, therefore there will be is_a(my_img,Heart).

Remark: Instead of writing all the URL (http://www.Name_hospital.org/patients/Selka/MRI.jpeg), I replace it by "my_img".

Relations: Once that a relation is chosen, URL (instance) is placed automatically in the position of the corresponding argument then we fill the other arguments of the relation which is of type: string, number, date or URL (exemple if we have selected the relation Type_image then Type-image(my_img,MRI)).

At the end the MRI image of Selka's patient heart will be annotated as follows:

```
<HTML>
<HEAD>
<META HTTP-EQUIV ="SHOE" CONTENT="VERSION 1.0">
<TITLE> Patient Selka </TITLE>
</HEAD>
<BODY>
<IMG SRC=Url_Image_MRI.jpeg>

<!-- inclusion of MRI image of Selka's patient heart by using HTML tag -->

<!-- we begin the annotation of image -->

<INSTANCE-KEY= "http://www.Name_hospital.org/
patients/Selka/MRI.jpeg">

<!--to each type of image corresponds a unique key (like for data base the
primary key) -->

<USE-ONTOLOGY ID="MEDICAL-ontology" VERSION="1.0"
PREFIX="MEDICAL"
URL="http://www.Name_hospital.org/SHOE/onts/IMG_MEDICAL.sh">

<!-- we use the ontology defined previously. Let us imagine that ontology
is prefixed by MEDICAL and it is stored at
http://www.Name_hospital.org/SHOE/onts/IMG_MEDICAL.sh-->

<CATEGORY NAME="MEDICAL.Medical_Image" >
<CATEGORY NAME="MEDICAL.Patient" >
<CATEGORY NAME="MEDICAL.Disease" >
<CATEGORY NAME="MEDICAL.Bodies">
<CATEGORY NAME="MEDICAL.Dimensions">
<CATEGORY NAME="MEDICAL.Resource_image">

<RELATION NAME="MEDICAL.Name_Patient" >
<ARG POS=TO VALUE="http://www.name_hospital.org/patients/Selka">
<ARG POS TO VALUE="Selka Sadika" >
</RELATION>
<RELATION NAME="MEDICAL.Date_take_Image" >
<ARG POS=TO VALUE="01/01/2003" >
</RELATION>
<RELATION NAME="MEDICAL.Image_Presents">
<ARG POS=TO VALUE ="Infarction">
<ARG POS=TO VALUE ="heart" >
</RELATION>
<RELATION NAME="MEDICAL.Type_Image">
<ARG POS=TO VALUE ="MRI" >
</RELATION>
</INSTANCE>
```

</BODY>
</HTML>

DISCUSSION

The system must be enriched on the level of the construction ontology tool by checking that SHOE's ontology obtained is correct from point of view of the syntax and semantic. On the level of the annotation tool instead of choosing the categories and the relations, we will use NLP techniques. In more it is necessary to implement the inference engine. Our system answers this type of request "Give the MRI image of Selka's patient heart" or "Give the disease of the selka's patient "

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