

PhotoStuff – An Image Annotation Tool for the Semantic Web

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Abstract

In this paper we present PhotoStuff, an annotation tool for digital images on the Semantic Web. PhotoStuff provides functionality to manually annotate images using Web ontologies, in addition to exploit pre-existing embedded image metadata for automatic annotation. Lastly, PhotoStuff is loosely coupled with a Semantic Web portal which provides image metadata management and interaction functionality.

1 Introduction

Recently, there has been a research focus to develop techniques to annotate the content of images on the Web using Web ontology languages such as RDFS and OWL. Past efforts have largely focused on mapping low-level image features to ontological concepts [Dupplaw 2004] and have involved the development of tools that are closely tied to domain specific ontologies for annotation purposes [Hollink 2003, Schreiber 2001]. Additionally, past approaches have largely left image metadata management and advanced interaction (browsing and search capabilities), which employing Semantic Web technologies enable, unaddressed.

In this work, we present PhotoStuff¹, an image annotation tool that provides domain independent flexibility for both creating (manually and automatically) and publishing annotations (via Web ontologies) of digital images to the Semantic Web. We also provide an overview of a mechanism for managing such annotations through a highly customizable, ontology-backed Semantic Web portal. Through the loose coupling of PhotoStuff with such management components, a seamless environment is provided in which users can annotate, share, and manage their digital images on the Semantic Web.

2 Approach

The overall approach (depicted in Figure 1) adopted by PhotoStuff is primarily composed of two loosely coupled capabilities, namely ontology-based, image annotation

and image metadata management on the Semantic Web. By loose coupling, we refer to allowing ontologies and instance knowledge bases (KBs) to be used in an interactive and ad-hoc manner during image annotation.

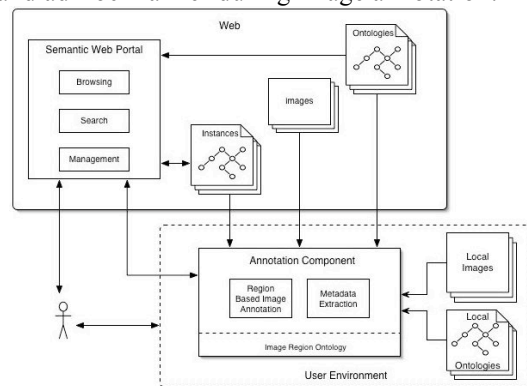


Figure 1. Image Annotation Approach.

2.1 PhotoStuff

PhotoStuff is a platform independent (written in Java), image annotation tool which employs an ontology to provide the expressiveness required to assert the contents of an image, as well information about the image (date created, etc.). In this work, an image-region ontology² [ImageOnt] has been specified using OWL, defining a small set of concepts for images, videos, regions, depictions, etc.

PhotoStuff allows users to annotate regions of an image with respect to concepts in any ontology specified in RDFS or OWL. It provides the functionality to import images (and their embedded metadata), ontologies, instance-bases, perform markup, and export the resulting annotations to disk or a Semantic Web portal. The tool's main interface is depicted below in Figure 2.

PhotoStuff is designed to load multiple ontologies at once, enabling a user to markup images with concepts distributed across any of the loaded ontologies. Using a variety of region drawing tools, users are able to highlight regions around portions of images (from Web

¹ PhotoStuff Page: <http://www.mindswap.org/2004/PhotoStuff>

² Image Region Ontology: available at <http://www.mindswap.org/2005/owl/digital-media>

and/or local disk) loaded in PhotoStuff. Classes from loaded ontologies can be dragged into any region, or into the image itself, creating a new instance of the selected class.

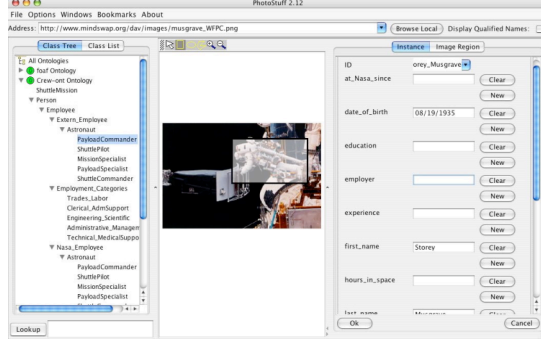


Figure 2. PhotoStuff User Interface.

A form for creating instances is dynamically generated from the properties of the selected class (range restrictions are imposed). Especially valuable, existing instances can be loaded from any URI on the Web. Using these preloaded instances, depictions can reference existing instances, allowing for incremental metadata annotation of images.

PhotoStuff also takes advantage of existing metadata embedded in image files by extracting and encoding such information in RDF/XML. This allows embedded metadata to be directly incorporated into the framework presented here and the Semantic Web in general. To elaborate, if an image contains embedded annotations, they are extracted and converted to two possible schemas, depending on the specific metadata. Currently, embedded metadata it is automatically mapped to the Dublin Core and EXIF schemas (mapping available on PhotoStuff homepage).

PhotoStuff maintains a loose coupling with a Semantic Web portal. In particular, the tool can retrieve all instances that have been submitted to the portal, submit generated RDF image markup, and uploading local images so they can be referenced by a URI (hence referenced in RDF/XML). More specifically, instances can be loaded from preconfigured URIs (referencing RDF/XML documents), allowing users to annotate images against existing instances they, or others, have authored. Second, PhotoStuff can submit the resulting markup to an existing instance base already maintained on the portal, thus making them available on the Semantic Web. Lastly, PhotoStuff provides functionality to upload any local image that the user has annotated.

2.2 Portal-Based Image Management

In order to manage image annotations, our existing work on Semantic Web portals has been used. Details are provided regarding the portal through one of its configurations in the context of a proof-of-concept, SemSpace, developed as an experiment with NASA.

The portal technology is domain independent as it is not limited in the number of ontologies that it can manage. The portal is designed to use information from the

various loaded ontologies to guide the display of and interaction with metadata (e.g., class hierarchy drives the browsing layout).



Figure 3. Image Management via a Semantic Web Portal.

Images (and their co/regions) can be browsed and searched over based on the class types of the instances depicted in them (see Figure 3). Additionally, the portal provides management capabilities including adding/removing submitted RDF/XML documents, merging instances, etc.

3 Conclusion

In this work we have presented a generic, domain independent framework for annotating and managing digital image content using Semantic Web technologies. In the framework, an image annotation tool, PhotoStuff is loosely coupled with a Semantic Web portal that supports browsing, searching and managing digital image annotations. Potential future work includes further automating the annotations process and providing support for annotation of additional digital media types.

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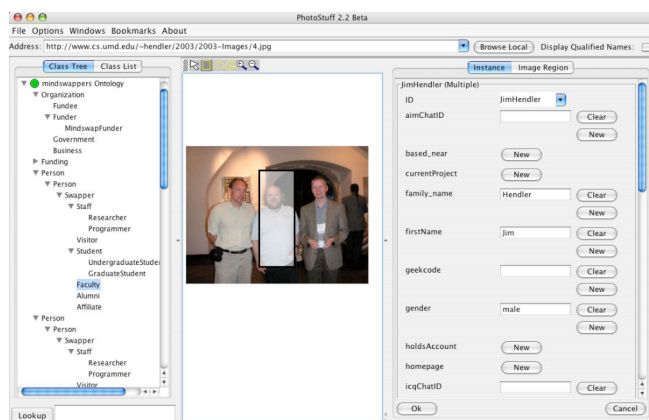
References

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Demonstration Overview

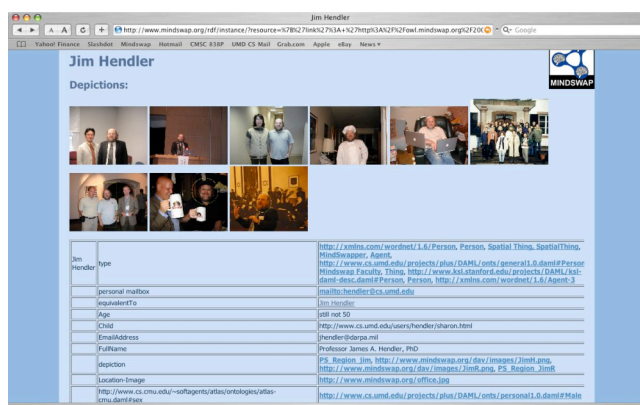
A live software demo will be provided, consisting of interaction with the PhotoStuff tool³, as well as the MINDSWAP portal technology. Individuals will have the option to see either a short or long demo of the features of both technologies.

In the short demonstration, a single image will be annotated using the PhotoStuff tool. The image, as well as the annotation performed will be determined in advance. After the markup is performed, the annotations will be submitted to the SemSpace⁴ website, where the annotations performed will be browsed. The demonstration of the portal will be limited to only browsing submitted annotations of the pre-selected image.



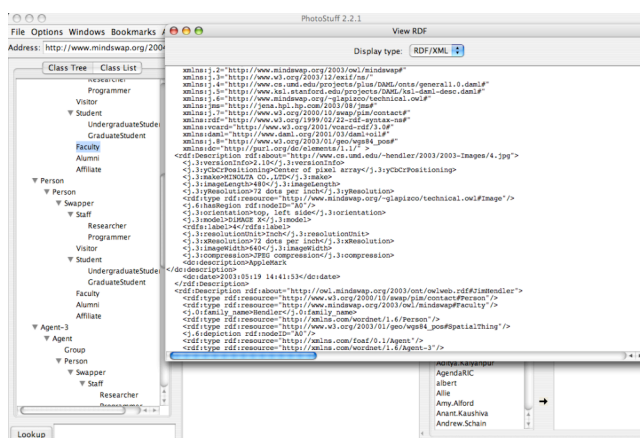
PhotoStuff Annotation Environment

The long demonstration will allow users further interaction with both PhotoStuff and the portal environment. In this case, users will have the opportunity to load images and ontologies of their choice, as well as perform annotations at will. In the full demo, the full capabilities of PhotoStuff will be exhibited, including automatic image metadata extraction, portal configuration (allowing communication of PhotoStuff with the portal), etc. The users will then be allowed to submit their annotations to one of the following portal deployments encompassing a variety of domains, SemSpace⁴, MINDSWAP⁵, and SWINT⁶. Submitted, as well as pre-existing, annotations on the portals will be browsed, determined by the interest of the users. Additionally, the search capabilities of the portal will be shown.



Browsing Resulting Annotations

For individuals interested in the data aspects of PhotoStuff, a separate demo will be provided that will walk the user through the image-region ontology used to represent image annotations. Additionally, the RDF output from the image markup performed will be shown.



RDF Output from PhotoStuff

³ PhotoStuff Download Page:

<http://www.mindswap.org/2003/PhotoStuff/downloads/>

⁴ SemSpace Web Portal: <http://semspace.mindswap.org/>

⁵ MINDSWAP Homepage: <http://www.mindswap.org>

⁶ SWINT Homepage: <http://swint.mindswap.org/>