Semantic Access to Graphical Web Ressources for Blind Users

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Abstract

The overall aim of this work is to grant blind users access to graphically represented information. In order to enable them to also search and retrieve this information an RDF(S) representation is shown which further leads to an application which enables another tininess of the semantic web by extracting explicit semantics of line drawing images.

1 Introduction

Access to textual information in electronic representation for blind users is already facilitated by different technical aids like screen readers with text-to-speech synthesis and/or braille displays[1].

However, a considerable amount of information available today is contained in informational graphics like technical diagrams, which are inherently hard to grasp for people who cannot see them.

Albeit the way blind people build up mental representations of verbally described diagrams is at present hardly understood Wizard of Oz studies conducted within the TeDUB project [Blenkhorn *et al.*, 2003] unveiled a strong tendency towards hierarchical structures having a semantically defined entry point and a recognisable order of items. These findings have been applied to the TeDUB system for the automatic interpretation and presentation of technical diagrams for blind people on which this work is mainly based [Horstmann *et al.*, 2004].

2 Extracting semantics from technical drawings

The basic strategy guiding the interpretation of technical drawings in the TeDUB system is to process components of the diagram by a layered partonomic composition of different abstraction levels. Starting from the lowest level of geometric primitives like lines and curves, a logical inference mechanism is used to stepwise aggregate lower level syntactic constructs to increasingly domain dependent semantic units like "room" in the architectural domain or "pie chart" in a business chart domain. This aggregation process is performed according to a previously defined model for each domain. An example for a simplified partonomic hierarchy from the business chart domain is shown in figure 1.

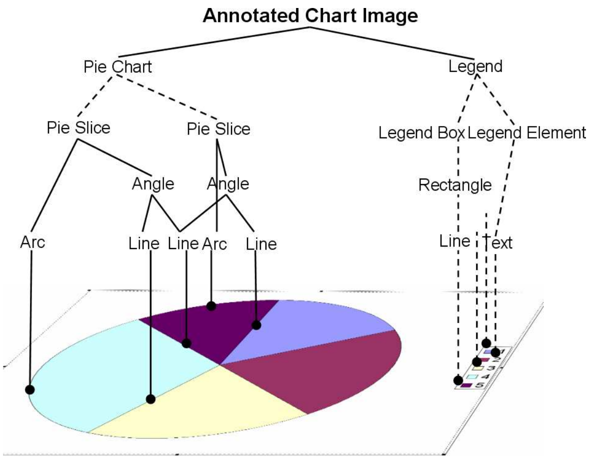

Figure 1: Example of a partonomic hierarchy

The positions of lines in the image are identified using image processing techniques that extract significant line segments first and then determine their thickness, curvature and other properties necessary for the subsequent classification.

In the TeDUB system, technical diagrams are converted into a connected graph of diagram components and presented to blind users through a specialised user interface. The representation allows for two ways of navigation. In the basic partonomic hierarchical representation the user can navigate in a hierarchy of diagram components, which are either atomic components directly extracted from the diagram or compositional components on higher abstraction levels. This approach allows a blind user to get a quick overview of the diagram by introducing predefined semantically relevant starting nodes and also lowers his or her cognitive load by hiding underlying components until needed.

In addition to this partonomic hierarchy a second model for navigating the diagram—orthogonal to this—is built. This is a representation of the diagram as a connected network of nodes, a spatial view. The nodes are consistent across both logical-hierarchical and spatial representations, but in this view the connections between each node in the diagram allow for the navigation in the plane of the origi-

[1] For an overview see http://www.nyise.org/speech/blind.htm

nal print diagram, possibly moving up and down levels in the hierarchy as a consequence. The value of this "view" becomes immediately apparent in the architectural domain when navigating a floor plan.

3 Semantic web enabled access

Results show, that the form of presentation by a partonomic hierarchy and an orthogonally navigable spatial view is of great value for a blind user. Up to now the results described in this paper still require a human recipient to understand and work with the information which was extracted from the respective drawing. No means of automation supported retrieval—taking aside full text search—is so far possible.

To overcome this limitation, methods were investigated which would formalise the annotations generated by the image analysis. The primary aim of this effort is to enable semantic-based retrieval of technical drawings by blind domain experts. As a side effect such semantic retrieval would also be valuable for their sighted colleagues.

For a blind user it is virtually impossible to search for and successfully retrieve graphics in a repository without them being semantically annotated. Furthermore even in restricted domains like architecture or digital circuit design manual annotation is bound to be ambiguous. Therefore we introduced RDF(S) to semantically enrich the automatically extracted information.

The structure, that has already been employed in the previous purely syntactic XML version was translated to a RDFS schema. In the first run the aim was only to explicitly represent the implicitly given semantics of the presentation application for the blind users[2]. The structure defined in the schema is therefore limited to the very needs of the application.

One not so much surprising but usually underestimated outcome of this effort is the insight how much semantics is implicit in an applications data structure which only has to be made explicit in order to gain a great deal of reasoning power within the domain.

Having defined the schema and a means to translate the analysis results to RDF we now have a powerful basis to implement semantic retrieval mechanisms for image data.

4 Related work

We consider this effort widely concordant with the Web Accessibility Program by the W3C (c.f. the recently held Teleconference on Making Visualisations of Complex Information Accessible for People with Disabilities[3] and especially with the note on accessibility features of SVG [McCathieNevile and Koivunen, 2000].)

In a similar context to TeDUB [Baillie *et al.*, 2003] discuss the possibilities of teaching the diagram based UML notation to visually impaired students. They propose an audio/haptic interface quite similar to the one employed in the TeDUB system [Horstmann *et al.*, 2004].

[Weimann and Weber, 2004] show that multi modal media presentation can enhance the accessibility of websites for a range of disabilities like vision impairment, dyslexia and deafness.

[2]A detailed description of this application can be found in [Horstmann *et al.*, 2004]

[3]http://www.w3.org/WAI/RD/2004/06/cfp-viz.html

5 Future directions

To enable higher level reasoning and especially to enhance the retrieval the next step will be to integrate the RDF(S) representation with a higher level ontology. Describing the service provided by this system by means of an ontology can provide a querable semantic web service to the public.

Looking further ahead the active interaction between reasoning on the retrieval side—i.e., making use of a domain ontology—and the image annotation component can enable semantic search in repositories of graphical data especially but not limited to an audience of visually impaired users.

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