

DEMO: Semantic eInk – Pen and Paper-based Interaction with the Semantic Desktop

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Abstract

In this demo we present a system which recognizes and interprets the semantics of handwritten annotations on printed documents. The semantic information is sent to the Semantic Desktop, the personal Semantic Web on the desktop computer, which supports users in their information management. This allows a seamless integration of interactive paper into the individual knowledge work. The current implementation of the proposed system works with OpenOffice documents printed on Anoto paper. The system properties and a use case are described in this paper.

The *paperless office*, i.e., the philosophy of working with minimal paper and converting everything into digital documents, was predicted more than thirty years ago. However, there is still an increasing amount of paper used by humans in their everyday work. Using paper is motivated by several issues. First, the person is not bound to a specific device or to a specific medium. Second, paper is portable, allowing for making notes anytime and anywhere. Furthermore, among other issues, writing on paper is more natural to most persons making the pen their preferred writing instrument for tasks such as brainstorming, collaborative work or reviewing documents [3].

In this demo we present the Semantic eInk system, which automatically processes handwritten annotations on printed documents and interprets the semantic information of these annotations. This information is expressed through formal semantics using the individual's vocabulary, and integrated into the personal knowledge base, the Semantic Desktop. The integration makes this knowledge searchable, reusable, sharable and gives a context for its interpretation. Semantic eInk extends the Semantic Desktop with a new input modality, interactive paper. Thus it supports personal knowledge

work on paper.

The system presented in this demo has been proposed in [1]. While in [1] a description of the research problem and the methodology is given, this paper describes the functionality of the prototype in Section 1 and a use case of the demonstration in Section 2.

1 Functionality

The system presented in this demo allows a seamless integration of interactive paper technology into personal knowledge work. To be more specific, the workflow of printing a document, annotating it while reading, and integrating the new information into the personal knowledge base is supported by an automated interpretation of user annotations. Therefore, the OpenOffice documents are printed onto the Anoto paper and annotations are made with the digital pen. Then, a set of gestures and handwritten text is recognized and finally, the information is sent to the NEPO-MUK system.

It is allowed to use three kinds of annotation (see Fig. 1).

1. The user can make a comment at any place in the document (The topmost handwritten text in Fig. 1). This text is recognized by the handwriting recognition engine and stored as a comment in the knowledge base.
2. The user can mark a text passage with right angle strokes (“[” “[”) and write a comment or a word representing an ontological concept in the knowledge base (“Title” in Fig. 1). For processing the annotation, the handwriting is first recognized. In the case of a comment, the comment and its relation to the marked text is stored in the knowledge base. In the case that the written words represent an ontological concept in

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Semantic Desktop Abstract

In this paper we propose a system which recognizes and interprets the semantics of handwritten annotations on printed documents. The semantic information will be sent to the Semantic Desktop, the personal Semantic Web on the desktop computer which supports users in their information management. This allows a seamless integration of interactive paper into the individual knowledge work. The current implementation of the proposed system works with

made notes and transform them into digital format.

In workflows like reviewing, where the annotations have a meaning for the marked text, the problem of mapping the paper to the digital counterpart arises. A variety of approaches have been investigated to enable this kind of paper-driven digital services. They use cameras, Wacom Graphics Tablets¹, ultrasonic positioning, RFID antennas, bar code readers, or Anoto's Digital Pen and Paper technology². The Anoto technology is particularly interesting because it is based on regular paper and the recording of the

paper-driven
digital services

Figure 1. Annotations on the document which are interpreted by Semantic eInk

the knowledge base, we need to detect the corresponding property, its range of values and the concrete value, e. g., the marked phrase as string or as an instance of the class person. The particular steps of this process are dependent on the kind of recognized ontological concept. The identified property, its value and possibly required instances are stored in the knowledge base. For the latter case, we plan to allow the user to define shortcuts for the most frequent ontological concept that they store (e. g., "T" for "Title")

3. The user can create a side mark and write a comment which will be associated with a specific part of the document. In this case, a new property for the document is inserted in the knowledge base, where the property value is the marked text.

2 Use Case

This section describes a possible scenario in which the Semantic eInk system is used in the personal knowledge work. The annotations made during this scenario are the same as depicted in Fig. 1.

Semantha recently found an interesting article about a topic in her research area. She prints it on Anoto paper and annotates the article using the interactive pen. The annotations are recognized and interpreted automatically and stored as triple entries in her personal Semantic Desktop. To verify that the entries were correctly inserted, Semantha

opens the PIMO-Editor¹. This editor enables Semantha to annotate, classify and relate all resources. In the following, some of the inserted entries are described in detail (see Figs. 2 and 3 for an illustration of the information in the PIMO-Editor) :

- The ontological concepts "Title", "Author" and "Semantic Desktop" were identified and the corresponding properties were detected, i. e., the "Title" was inserted as a string, the "Author" was stored as a new instance of "Person" in the knowledge base, and the "Semantic Desktop" was connected to the corresponding "Topic". Note that the ontological concept "University" would be handled similarly to the concepts "Semantic Desktop" and "Author".
- The comments were stored in the knowledge base together with the corresponding marked text, if available. The comment "paper-driven digital services", for example, was stored as a separate entity together with the marked text (*snippet*) "They use cameras, Wacom Graphics Tablets, ultrasonic positioning, RFID antennas, bar code readers, or Anoto's Digital Pen and Paper technology". Note that the relations to the document are preserved.

Having the new entries stored in the Semantic Desktop facilitates finding information related to the paper, especially the information of special interest for Semantha.

¹ Personal Information Model Editor, see [2]

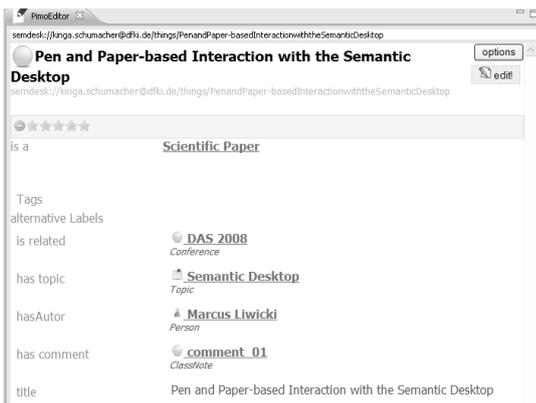


Figure 2. Interpreted information extracted from the annotations

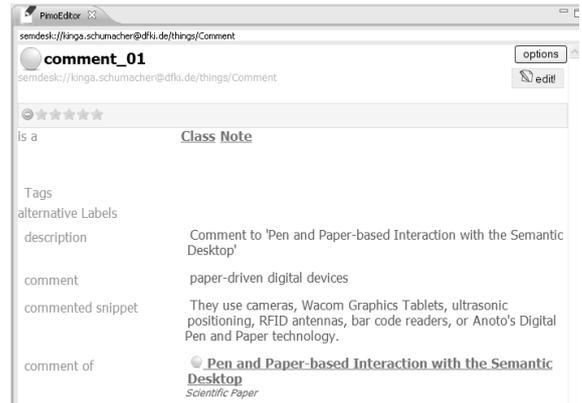


Figure 3. Representation of the comment

When she searches for “paper-driven digital services”, for example, this paper will have a higher ranking, although there seems to be no close relation, e. g., if only the title and the abstract would have been considered for the search.

References

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