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A Framework for the Standardized Description of Handwritten Annotations

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Abstract

In this paper we introduce a novel way for the standardized description of handwritten annotations on an electronic document. This approach allows it on the one hand to describe the annotation itself which means the geometric representation. On the other hand information about the handwritten annotation like author, type, or the text it refers to can also be stored together with the annotation. Furthermore, since our approach is based on Scalable Vector Graphics (SVG) which is based on XML, it nicely ?fits into the structure of a Document Object Model (DOM). This allows it to store the annotation together with the annotated document as well as separate.

Keywords

handwritten Annotations, Metadata, electronic Documents, Scalable Vector Graphics, Dublin Core

1. Introduction

The handwritten annotation of paper documents is a well known reading technique. The usefulness of writing into a book has been shown by di?fferent studies (see [16, 14, 6]). Many scienti?fic papers have been published that deal with the annotation problem (see Section 2. for a brief overview). Consequently, many applications for the annotation of electronic documents, both handwritten and typed, have been developed in the past. The annotation of a text can, for instance, be used for the exchange of information. Imagine a review scenario. Often one author writes the document and one or more reviewers read it and write appropriate hints at the margin. In this case webpages, for instance, are one of the platforms that allow the exchange of annotations. This can be typed annotations or handwritten annotations.

Nearly all applications are focused on the interaction for annotation or the visualization of annotations. The standardized description plays an underestimated role. Nevertheless, the development of applications for the annotation of electronic documents especially in a collaborative environment, can bene?fit from a standardized way of annotation description. This makes it, for instance, much easier to exchange annotations, such as notes, without the annotated document. One can imagine an application for the annotation of webpages. In this case the annotation can not be stored together with the annotated webpage. Standardized annotations would support the extension of document viewers for the visualization of annotations.

For electronic documents di?fferent standards have been developed that support the description of the document content as well as the description of the document itself (metadata). The Extensible Markup Language (XML), for instance, is a common base for the description of di?fferent electronic documents. It is also a starting point for the development of the Document Object Model (DOM) that can be used to access parts of the document.

In contrast to typed annotations, for which di?fferent approaches regarding to a standardized description exists ([13, 12]), handwritten annotation are quite underestimated. In this paper we describe an approach for the description of handwritten annotations based on scalable vector graphics (SVG) and Dublin Core (DC).

The paper is organized as follows. In the next section we give a brief overview about other projects and the literature related to this topic. In Section 3. we introduce the possibilities of describing the geometry of handwritten annotations using SVG and the use of metadata for the description of additional information about the annotation such as author, type, date, etc. In the fourth section we exemplary describe the usage of the previously introduced methods. This is followed by the conclusion and directions for future work.

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2. Related Work

In this section we will discuss the previous work dealing with the annotation of electronic documents as well as the description of annotations and electronic documents.

On the ?field of annotating electronic documents research has been done by many scientists. Schilit, for instance, developed the system XLibris that allows the handwritten annotation of an electronic document [19].One of the goals of this approach was to adopt the pen and paper metaphor for electronic documents. Hence, the system has no restrictions for freehand writing. The reader can write into the electronic document while reading it and so he or she can use the same reading behavior as known from paper documents.

Price, Golovchinsky and Schilit introduced in [18] a method that uses freehand annotations for the creation of links between webpages. The system analyses the marked parts of the text and performs queries for documents based on the marked words. As a result the system presents links to documents for further reading.

Another project, regarding the annotation exchange, was introduced by Baldonado et al [2]. They developed the system Notable that allows it to annotate an electronic document using a handheld device (e. g. , Palm Pilot, Pocket PC). The annotations can later be exchanged between di?fferent users which allows a cooperative work. The authors restrict their system to typed annotations for certain reasons but did not exclude the use of handwritten annotations. The development of the system NotePals by Davis et al. follows the same direction [5]. This system is intended for collaborative note taking, for instance, in a meeting situation. The system also runs on a handheld device were people can write down short notes and synchronize them with other person's notes.

The most in?fluencing work on the description of annotations was the work on "The Use of the Dublin Core in Web Annotation Programs" by D. Grant Campbell [3]. He introduces an approach for the description of typed annotations which is based on the work of Koivunen and Swick [13] which introduces a metadata infrastructure for sharing annotations based on the Annotea project. Campbell describes an enhanced use of the Dublin Core elements for the

(a) underlining (b) margin bars (c) text marker

(d) encircling (e) special signs

(f) frame

Figure 1: Dierent marking types used in electronic documents.

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description of typed annotations, especially in web annotation systems. For the description of handwritten annotation we followed the same approach but propose a slightly di?fferent use of the Dublin Core elements.

Kahan and Koivunen introduce in [12] the system Annotea that is designed for sharing web annotations based on a RDF infrastructure. This approach also allows the description of typed annotations but it is not intended for the use to describe handwritten annotations.

Phelps and Willensky developed the Multivalent Documents Model and the Multivalent Annotations [17].This approach also allows the storage of annotations together with the document content. It is not primary designed to handle handwritten annotations but to combine many di?fferent annotations into one document model. Which was also inspiring for our approach.

The above mentioned projects are just a small overview about this topic. There are much more papers that could be mentioned here

(e. g. [4,15,14,11]).As stated above, the focus of the work on systems and publications for the handwritten annotation is in many cases on the interaction and the visualization of the annotations. The description of such annotations is mostly left out. For this reason we show one possible solution in the next section.

3. Handwritten Annotations and Scalable Vector Graphics

The process of annotating a textual document is an important part of the reading process. This can be observed on paper documents (see Figure 2) and is also a requirement for the acceptance of electronic documents (see O'Hara and Sellen [16]). Annotations in this context means handwritten annotations based on the pen and paper metaphor. By looking at textual documents many di?fferent annotation types, e. g. margin bars, underlinings, surroundings or short notes, can be found.

How somebody annotates the document depends on the reading goal and on the personal likes and dislikes. The interesting aspect is that di?fferent annotation types have di?fferent meanings to the reader. Hence, it is worthwhile to analyze the annotations and to classify annotations based on their types. This allows the typespeci?fic visualization of annotations. Furthermore, it is often necessary to store information about the annotation such as the name of the author and the date of creation. Especially if the chronological order of annotations is important. Both can be achieved using SVG which combines the possibilities of storing annotation data using simple geometric models and the description of the annotation

Figure 2: Annotation of paper documents.

using metadata based on Doublin Core.

Koivunen and Swick propose the use of Dublin Core for the description of the title, creator and date of the annotation (see [13]). Campbell extends this to the elements description, publisher, type, format, identi?fier, language, relation, coverage and rights of the Dublin Core Speci?fication. This allows a comprehensive description of annotations that can be adopted for the use with handwritten annotations. For the storage of the annotation data, especially if it is graphically such as handdrawn notes, this is not feasible.

For this reason we propose the use of SVG to store annotation data and Dublin Core for the metadata as described in the next section.

Scalable Vector Graphics are originally invented for the purpose of describing 2D Graphical Objects. Now it is proposed as the W3C Recommendation, Version 1.1. SVG de?fines many di?fferent geometric objects and attributes from basic objects (e. g. rectangles, circles) to textual elements and animations [8].The use of SVG allows on the one hand the description of the annotation data and on the other hand it supports the use of metadata based on the Resource Description Framework (RDF) to handle information about the annotation.

3.1. Annotation Data

Some annotation types have been exemplary

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mentioned above. In this section the di?fferent annotations will be described in detail together with a possible SVG representation.

Based on the experience with paper documents readers annotate their documents by underlining parts of the document, drawing a surrounding line around parts of the text, writing short notes on the margin, drawing lines on the margin or marking using a textmarker. Additionally, he or she uses PostIt style notes and draws special signs on the margin.

Marking by underlining: This is a annotation technique that is used to mark parts of the text line by line. Readers draw a freehand line under a line of text. See Figure 1(a). In this case, there is no need to store the whole freehand drawing. After a automatic detection of the annotation type only the starting point and endpoint have to be stored. Hence, a possible solution to describe this type of marking in SVG is the use of the line element (see [8], Chapter 9):

```
<line x1 y1 x2 y2 stroke
strokewidth>
```

The stroke and the strokewidth attribute can be used to simulate di?fferent pen types and colors.

Marking using the margin: Readers use this technique to mark more than one line of text (see Figure 1(b)). For this purpose they draw a freehand line beside the text at the margin of the document. From the geometrical point of view, this can also be modeled like an underlining, using a straight line. Hence, the line element can also be used (see [8], Chapter 9):

```
<line x1 y1 x2 y2 stroke
strokewidth>
```

Marking by encircling: Here the reader draws a elliptical shape around the part of the text (see Figure 1(d)). This allows it to mark an arbitrary region of the text, not connected word by word. Because of the elliptical shape of the surrounding, a possible SVG element is naturally the ellipse element (see [8], Chapter 9):

```
<ellipse cx cy rx ry fill stroke
strokewidth>
```

Marking by framing: Drawing a frame around a part of the text is also a technique to mark an arbitrary region of the text. Mostly this is used to mark a whole paragraph. Figure 1(f) shows an example. The SVG element which describes a frame is rect (see [8], Chapter 9):

```
<rect x y width height rx ry fill
stroke strokewidth>
```

Marking using a textmarker: Using a textmarker readers draw a straight line through the words, comparable to the underlining. Figure 1(c) shows an example. The di?fference is that textmarkers draw a wider line that is semitransparent. For the representation of this marking type in SVG either the line element or the rectangle element can be used (see [8], Chapter 9):

```
<line x1 y1 x2 y2 stroke stroke-
width opacity> <rectangle x y width
height fill stroke opacity>
```

For the line element the stroke width can be used to model the line width. In case of using the rectangle element this can be done by changing the height of the rectangle. In both elements the opacity attribute can be used to change the transparency value of the textmarker's line.

Notes: Often readers annotate their documents by writing short notes on the margin or other free space of the document. These notes can not be represented by a straight line. A solution is to use a polyline for this reason the path element can be used (see [8], Chapter 8):

```
<path d cx cy rx ry stroke stroke-
width>
```

The parameter *d* contains the path data.

Images: So far, images and small sketches are treated as notes. Alternatively, the SVGelement image can be used. This allows on the on hand the description of images using the SVG format. On the other hand, raster images can be used as shown by the following example:

```
<image x y width height
xlink:href="myimage.gif">
```

In general, it is possible to describe every above mentioned annotation, known from paper documents, using SVG. The annotationtype can be kept within the metadata. Which will be the focus of the next section.

3.2. The use of Metadata for the Description of Handwritten Annotations

The current SVGSpeci?fication 1.1 proposes the use of metadata based on the Doublin Core 1.1 scheme. This allows the use of all DCelements such as title, creator, subject description, publisher etc. (see [8], Chapter 21 and [7]).

The metadata that describes a handwritten

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annotation is slightly di?fferent from other annotation types like typed annotations. For instance, many types of handwritten annotation such as “advice”, “change”, “comment” or “question” (see [3]) are not interactively de?fined by the author but they are inherent coded by the pen type and the color.

For handwritten annotations we propose to store the following information:

- *The type of the annotation* such as underlining, surrounding, margin bar, notes etc.
- *The pentype* e. g. ball pen, pencil or text marker.
- *The color* of the pen.
- *The author* has to be de?fined because different authors can use the same pen type and color.
- *Date* and *time* because sometimes (for instance in an review scenario) it is necessary to see the chronological order of annotations.
- *The coverage* which contains the scope of the annotation e. g. the part of the text to which this annotation refers
- *The relation* to the annotated document.

Most of the just described parameters elements are prede?fined within the Dublin Core scheme. See [7] for a detailed description. A possible use for handwritten annotations will be described in the following:

Author

The DCelement *author* can be used to store information about the author of the annotation (for instance, given name, surname, etc.)

Date and Time

For the description of annotation time and date the DCelements *date* is de?fined that covers the date as well as the time according on the formats proposed by the W3C Note [20].

Coverage

The scope of the annotation can easily be stored using the DCelement *coverage*. The Dublin Core reference description de?fines the element coverage as follows: “Typically, Coverage will include spatial location (a place name or geographic coordinates), temporal period (a period label, date, or date range) or jurisdiction (such as a named administrative entity).” For the reason of annotation, this can be used to store a range of spatial locations like the beginning and the end or the beginning and the length of a chunk of text to which the annotation refers.

Type

The DCelement *type* can be used to describe the above mentioned types of handwritten annotations. This can also be done automatically by analysis of the hand drawn annotations as shown in [9].

Pentype and color

In contrast to the typed annotations we also have to store the type of the pen and it’s color. For this reason no de?fined DCelement is given. We propose the use of the DCelement *format*. Normally, the format-element describes the mediatype and “...may be used to identify the software, hardware, or other equipment needed to display or operate the resource.” [7]. This element can also be interpreted as the pen type and, hence, determines (the part of) the software that can be used to display this annotation.

Relation

Since the handwritten annotation is not necessarily part of the annotated document, for instance, in web-based annotation systems, such as [10], a reference to the original document has to be stored. This element usually keeps a Uniform Resource Identi?fier (URI) (including the Uniform Resource Locater (URL)), the Digital Object Identi?fier (DOI) and the International Standard Book Number (ISBN).

In general, every SVGelement contains one metadata element because normally every SVG element describes one annotation. It is possible (but depends on the implementation) to combine di?fferent annotations within one SVGelement. This is especially useful if the annotation type is the same, it is drawn by the same author using the same pen type and the color and the time are unimportant.

4. SVG and DOM

Besides the description of the entire annotation the use of SVG also allows the embedding of annotation into a document model such as the DOM. For the sake of simplicity we propose the storage of annotation data into a separate node of the document model. The necessary reference to the annotated chunk of text can be stored in three ways. First, the coverage attribute can be used. Second, the chunk of text can be stored in a separate node that has an identi?fier (ID) that points to the annotation (see Figure 3(a)). Third, the SVG node can be added as a child to the node which contains the chunk of text that has been annotated (see Figure 3(b)). The ?first method is useful for the separation of the document and the annotation. The second and third method is more suitable for the use in a DOM.

5. Conclusion and Future Work

In this paper we presented a novel way of storing handwritten annotations. The goal of this approach

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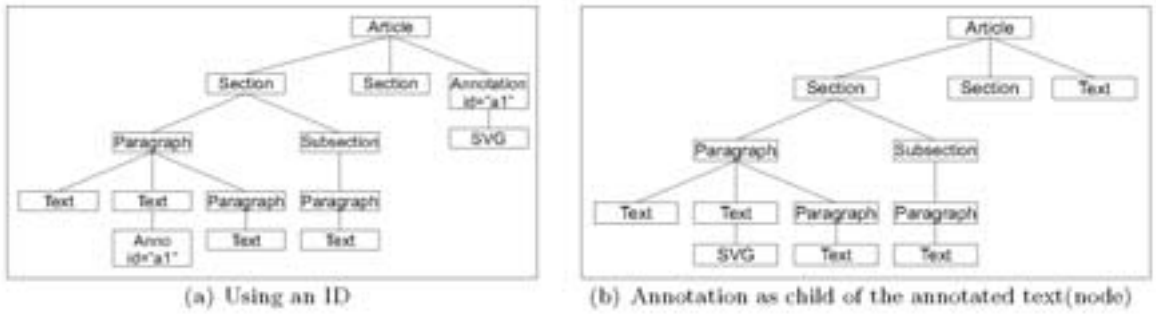

Figure 3: Embedding an SVG-Annotation into a DOM structure.

was ?first to use a standardized method for annotation description. Second, it should be possible to describe the metadata connected with this annotation in a standardized way. Third, the method should ?fit into a document object model. With this respect the use of Scalable Vector Graphics seems to be a possible solution. It allows both the description of the annotation itself and the information about the annotation such as type, author, date, etc.

So far, this framework is in a conceptual state. We have set up a prototypical system for the freehand annotation of webpages [10].This system was originally developed to support the personalization and the active reading of webpages (see [1] for the description of the active reading process). However, due to the readonly nature of webpages, it is designed to store the annotation separately from the annotated document on an annotationserver. This supports the exchange of handwritten annotations between di?fferent users. This system would greatly bene?fit from the concept presented in this paper. The priciples outlined in this paper can be applied, for example, to the annotation framework presented by Kahan et al. in [12].

This is a quite complete solution for the description of handwritten annotations. Nevertheless, there is room for improvements. One direction for future work would be the extension of this approach to typed annotations. One can imagine that a document can contain both types of annotations. Another point for research in the future is the automatic recognition of handwritten notes and it's combination with the handwritten representation. The idea is to store both types together which also allows the processing of these annotations, for instance, to search or to automatically include it into the original document. Another interesting point, not mentioned above, are correction marks. So far we did not introduce a possible solution for the description of these annotations.

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