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ViDio – Virtual Digital Annotations

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Abstract

Today we are far away from a paperless office. Many readers still prefer paper instead of electronic documents and thus they print out their documents for reading. Moreover, solutions for reading, annotating and editing a document away from a desktop computer are still rare to find. A reading processes that requires taking notes or annotating a document is only possible using paper. In this paper we present the prototypical system ViDio that offers the possibility of being mobile while at the same time having the ability to annotate an electronic document. Our approach is based on using mobile handheld computers (personal digital assistants – PDAs) for annotating a document. The user can download the document, read it and take notes wherever she wants. To overcome the main problem of handheld computers – the rather limited screen size – we designed a desktop part of the system that is able to visualize the document together with the annotations. This enables browsing through the document and preserves the context of an annotation. The main contribution of ViDio is the approach to combine a desktop computer to create and edit a document and an additional input device that is small and handy but nevertheless usable for note-taking.

1 Introduction

The popularity of mobile computers, so called handhelds, has raised dramatically in the past few years. They are no longer only a database to store addresses and maintain appointments. They are more and more in use for visualizing, retrieving and consuming electronic documents. This can easily be seen by looking at today's visualization of web-pages (see, for example, (Buyukkokten et al. 2000)) and electronic documents for office use (e. g., DocumentsToGo (Dataviz 2000)). The outstanding advantage of these computers is mobility. The user can transfer the desired document either via a connection to a desktop computer and read the document later (off-line) or she can read the document online via an appropriate Internet connection.

Nevertheless, there are deficiencies concerning the reading process using a handheld computer. The often used, and therefore very common, process of annotating a document is not supported. thus, the process of active reading, where the reader writes little notes and hints or draws small sketches in the margin of the document is impossible. The next two scenarios illustrate the importance of annotating a document.

Imagine a conference attendee listening to and watching a presentation. What she often does is taking handwritten notes about additional information either on a sheet of paper or on a printed version of the conference paper. Another possibility is to use a handheld computer and take notes directly on the screen. This is already supported by freely available and commercial applications. In this case, all the information is kept electronically and in one place. The authors did this already not only during (conference) presentations but also for writing short notes in meeting

situations. The main disadvantage is that notes taken in the just mentioned way or on a blank sheet of paper have no direct relation to the corresponding document. This is especially unpleasant when the note explicitly suggests that a certain part of a document has to be changed as described in the next scenario.

Now, we take a closer look at the process of creating a document, e. g. the already mentioned conference paper. The usual way to a final document is that the author writes a prototypical paper, makes revisions and hands the pages over to one or more "critical" readers. Critical reading in this case means reading and annotating the document to give the author hints to remove mistakes, redesign the paper structure and hence improve the paper's quality.

To get the possibility to read and annotate a document anywhere away from a specific desktop computer, users often print out the electronically existing document. This leads to a paper based intermediate stage and hence to a break in using only on medium (media-break). This media-break should be avoided, for instance, for economical reasons. Paper is a one way medium that means it is thus hard to reuse. Another point is that by keeping the document electronically it can be distributed using a computer (e. g., by email) which is much faster and more efficient. Moreover, annotations on paper have to be post-processed that means they have to be manually typed into the corresponding document.

In the following we present and discuss ViDio, a prototypical, PalmOS based system that is designed to support annotations of electronic documents. This combines the advantages of a mobile computer system with interactive document visualization methods on a desktop computer and hence prevents the before mentioned media-break. After a review of related work we shall describe ViDio and take a closer look at the generation of annotations as well as their visualization on a desktop computer. We illustrate the techniques using a uniform example. The paper concludes with a discussion of the results and ideas for future work.

2 Related Work

Quite a few systems have been developed in the field of annotating documents using desktop computers as well as mobile devices.

As a general basis for our work the research on reading goals summarized by O'Hara (O'Hara 1996) was considered. People interact with documents by reading for instance to learn, write and revise documents and for critical review. The reading process includes different activities, as there are underlining, marking, or annotating. These activities have to be supported in order to support reading also for electronic documents. Marshall therefore summarizes types of annotations for Hypertext documents and formalizes this research by establishing a typology of annotations (Marshall 1998).

Schilit et al. worked on annotating electronic documents using a desktop computer. They developed and introduced the system XLibris (Schilit et al. 1998). The main goal of XLibris is to support active reading. Within this system the placement of annotations is completely up to the user. The whole screen space can be used for writing and drawing. Usually the user (reader) writes in the margin but not necessarily; she can also write overlapping a part of the text. Using XLibris it is only possible to draw handwritten notes what is nice for active reading but makes reuse difficult. The annotation is part of the document and can not manually be made visible or invisible. Another point is that the system can not free any space occupied by the document to make more room for notes. However, this keeps a consistent layout with or without annotations.

Many handheld systems support taking short notes by special applications. In many cases, these programs require to use a specific input alphabet (Graffiti) instead of normal handwriting. Landay, Davis et al. developed NotePals, a system for taking handwritten notes and sharing them within a group (Davis et al. 1999). The system offers the possibility to see another person's notes and hence their experience in a certain context (Landay & Davis 1999), (Davis et al. 1998). However, these notes are not connected to any given document.

Baldonado et al. extend this idea by introducing Notable, a PalmOS based annotation system that builds on the Post-It metaphor (Baldonado et al 1999). Notable connects notes taken on a handheld computer with a document. The handheld simulates the Post-It note. The user reads the document on paper and writes down notes using the Palm Pilot. This also has the consequence that the annotations have to be read independently from the referring document. To perform searches on the annotations it is required that every annotation is based on Graffiti input which means that it is recognizable by the system.

Research on the visualization of electronic documents that include annotations on a desktop computer was performed by Chang et al. They introduced the fluid-document metaphor (Chang et al. 1998) a novel approach dealing with the problem of limited screen space. The techniques they developed allow users to visualize additional information like footnotes, illustrations, or explanatory notes within the text. The system can use available space in the margin to display notes as well as free additional room within the text area. The user can interactively change the level of detail with which additional information is presented. While doing so, the context to the referring document parts is always kept and recognizable.

Previous research has concentrated on keeping all tasks (annotation and visualization) on one computer. In many cases it is is not possible or not wanted so that we decided to break down the system in two parts each of them running on the most appropriate hardware.

3 The System ViDio

The main goal behind the development of our system ViDio is to prevent the media-break between electronic and paper documents while supporting the user's mobility when annotating a document. Thus, the system consists of two parts as can be seen in Figure 1. The document that is available in electronic form is transferred to the handheld computer. The user can now annotate the document independent from a stationary office computer. Afterwards, the annotated document is again sent to a desktop computer and can be processed further. This architecture supports mobile work having restricted layout and visualization possibilities as well as the standards known from office systems.

The system is implemented in Java based on Sun's K Virtual Machine (KVM) for the Palm Pilot part. The benefit is that ViDio runs on every platform that is supported by the KVM. We have tested the system on various handheld computers running a PalmOS. We will first describe the part running on the handheld that is used to generate and enter annotations before we talk about the desktop based part for visualization and layout of the document including annotations.

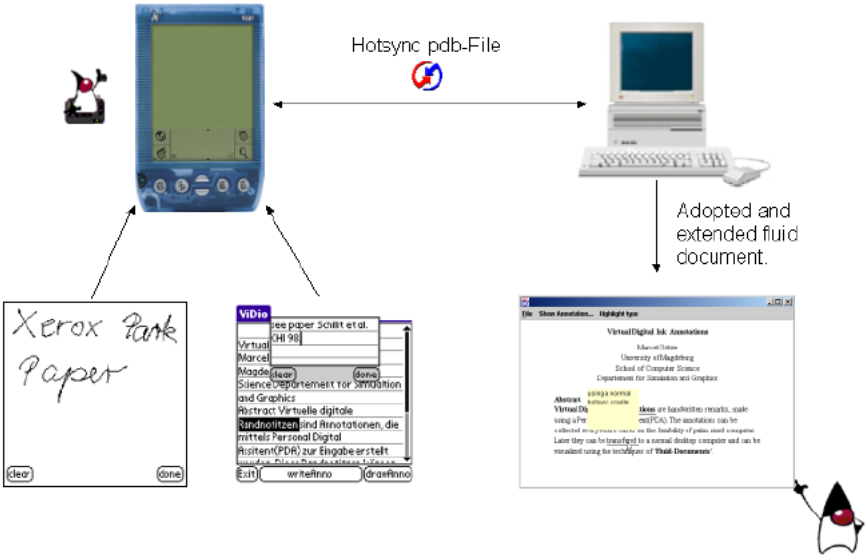

Figure 1: Overview of the system ViDio

3.1 Generating Annotations

Once the document is prepared for the handheld device (basically converting to an appropriate format and transferring it to the mobile device), annotations can be generated. Since there is only limited screen space available – typically 160×160 pixels – the annotations are not permanently shown on screen but are placed on a virtual margin outside the visible area, and are only visible if necessary. The user can select a part of the document's text and generate and assign an annotation. The text being selected is highlighted as shown in Figure 2. Annotations can be generated in two different ways:

1. *Handwritten Annotations*
   Handwritten annotations are based on the ability to write and draw directly on the handheld's screen. It is thus possible to enter handwritten annotations and draw small pictures as shown in Figure 3.
   The advantages of this technique are:
   - *speed*:
     Normal handwriting is faster than using special characters (e. g., Graffiti) since the user is not required to write words character by character in a small dedicated area.
   - *pictures are supported:*
     Pictures can be drawn, for example, small sketches or icons that are sometimes more appropriate than texts.

The disadvantages are:

- *small area:*
  Handhelds have only a limited screen space and resolution. Handwriting takes naturally more space and therefore less information can be stored on a single page.
- *reusability:*
  Handwritten annotations as well as drawn sketches are handled as bitmaps and can thus not be converted to an internal text based representation. This means that also handwriting is not regarded as text.

The authors believe that combining handwriting and drawing pictures plus fast information input overcomes these disadvantages.

2. *Graffiti Annotations*
   Graffiti Annotations use the built-in text recognition methods that are based on special designed stroke characters. In this mode, a little window opens beside the marked text while the selected text is still visible (see Figure 4). The user can now use the handheld's Graffiti pad to write text. The advantages of this technique are:
   - The text is based on ASCII characters and can easily be reused later.
   - The amount of text that can be entered this way does not depend on the screen size as it is the case with handwritten input.

   The drawback of this mode is that Graffiti writing is much slower since the user has to learn this special input technique beforehand.

In general the user can choose between these two modes. The first is fast and supports drawing but is only reusable as bitmap data. For the second mode the user has to be willing to spend a little more time using graffiti but the annotations can be inserted easily into the document's text either manually or automatically. Creating the annotations on a handheld device is now straightforward, however, the visualization of these annotations within the context of the document is rather limited.

Figure 2: Text highlighting on a Palm Pilot

Figure 3: Annotating a document using handwriting

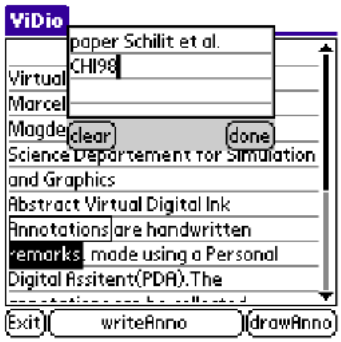

Figure 4: Annotating a document using Graffiti

3.2 Visualizing Annotations on a Desktop Computer

The desktop part of the system ViDio is responsible for two tasks. First, the user can load a document, that is based on HTML and store the text into a Palm Database format (pdb) (Bey &

Dupre 2000). This format is understood by all PalmOS based handheld systems. The file can now be transferred to the handheld via hotsync. Second, the system reads the annotated document and displays the annotations together with the document's text. We shall focus on this part in the following.

The part of the text, an annotation is referring to is highlighted. Different highlighting mechanisms are implemented here that can be chosen by the user. These techniques include underlining the text region or surrounding it with a rectangular or ellipsoidal border.

Since the document is shown using the original layout, strategies have to be developed to include annotations without destroying this layout. To deal with this problem we used and adopted the "fluid-document" method introduced by Chang et al. (Chang et al. 1998). In general, there are four different strategies to place the annotations:

1. *The system keeps track of available space.*
   Annotations are automatically laid out by the system using unused parts of the page. These are usually margins or white spaces on the bottom of the page.
2. *The system makes room for the annotation.*
   The fluid document technique offers various possibilities to make room for additional information. So, for example, the margin can be made wider or lines respectively words can be moved apart. Annotations can then be placed in the space made available this way.
3. *The user places the annotation.*
   It is up to the user to place annotations by dragging them to the desired position.
4. *The blank space is not used.*
   In this case the annotations are placed overlapping the document text. This resembles sticky notes and may hide parts of the original text.

For both types of annotations that are described in Section 3.1 the following layout techniques were implemented:

- Intra-line placement:
  In this case annotation is shown between two lines of text directly above that part of text it refers to. The affected lines are moved apart as can be seen in Figure 5.
- Margin placement:
  Annotations are placed in the margin of the document and scaled to fit the empty space. This technique attempts to visualize annotations like handwritten notes on paper. See Figure 6 for an example.
- Freehand placement:
  To give the user control of the placement of annotations they can be placed anywhere on the document by drag and drop. The system keeps a rubberband connection between the annotation and the part of text it refers to. This technique is oriented on hand drawn annotations that are placed anywhere on the document and connected by a straight line with the corresponding part of the text. See Figure 7 for an example.
- Overlapped placement:
  This technique attempts to emulate the well known little yellow stickers that are placed overlapping the text close to the appropriate part of the text. See Figure 8 for an example.
- Floating placement:
  This method supports browsing through the text. When the user moves the pointer over a highlighted text part the referring annotation will be shown beside the pointer

overlapping the document's text. To overcome the problem of occlusion the annotation is made semitransparent so that the underlying text is still readable as can be seen in Figure 9.

These implemented techniques collectively support many of the previously mentioned goals. The user is able to browse through the annotated document in the original layout, while at the same time getting an overview of the annotations. The annotations are shown temporarily without loosing the reference to the corresponding text. This is especially useful if the document comes back from critical reading and contains a lot of suggestions. So it is left to the user to place the annotations or move them according to her priorities. The system can help with the placement by making room for notes. This also supports the permanent insertion of (handdrawn) pictures into the document.

4 Conclusion

In this paper we have presented the design and implementation of an annotation system for documents that combines the advantage of being mobile with visualization on a desktop computer. This helps to avoid a media-break between electronic and printed documents. The system consists of two parts. The first runs on a PalmOS platform and the second on a normal desktop computer. On the one hand, this supports handwritten annotations because of their flexibility, their fast and natural input and the possibility of drawing little sketches. By using Graffiti based input, on the other hand, the reusability of the annotations is increased since the ASCII text can directly be copied into the document. Even though the handheld can only display either the annotation or the referring text, this seems to be harmless because the user knows the part of the text and can concentrate on writing the annotations.

The second part of the system that runs on a desktop computer is designed to keep the annotation within the referring context. This is important since annotations may stem from a different user and might be unknown. Thus, reading the annotation without having the context might be confusing in the sense of realizing what is the impact on the original text. Therefore, we implemented techniques that are based on experience from annotating on paper and visualization on a computer.

5 Future Work

The design of ViDio offers many possibilities for further improvement. A user study is still pending but based on our observations we can see the following options.

It would be preferable to include a handwriting recognition system as known from the Apple Newton handheld. This would combine the flexibility of handwritten notes with a higher reusability of the annotation text.

So far there are no steps taken towards an integrated visualization of annotations and the document's text on the handheld device. Here, Focus and Context techniques are worth to be investigated. The most crucial aspect here is the extremely limited screen space so that possibly visualizations of a lower quality have to be accepted. The use of Focus and Context techniques may also partially prevent a layout change between the desktop and the handheld.

As for now, data are transferred between desktop and handheld via hotsync. The use of an infrared port may increase the flexibility since wireless connections can now be used. It would also support the exchange of annotations between different users simply by initiating an infrared data transfer between their handhelds.

We are currently working on extending the notion of annotations by including correction marks. They can be regarded as deferred macro executions. Standardized correction marks tell how to change a specified part of a document. If a proof-reader uses them to "annotate" a document, the author can then decide whether or not such a correction should be performed, and the system can change the document based on the recognized correction mark. This can dramatically enhance the effectiveness of the system for reviewing electronic documents.

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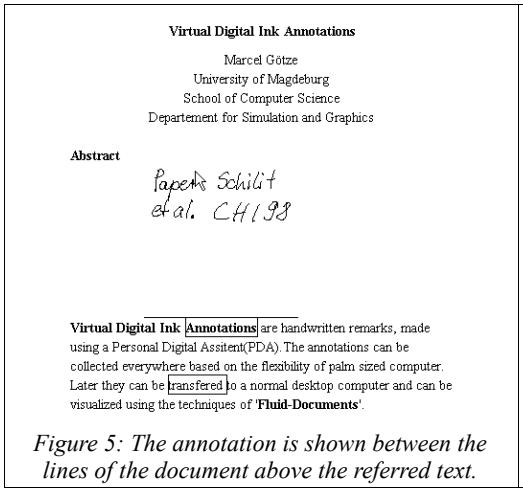

Figure 5: The annotation is shown between the lines of the document above the referred text.

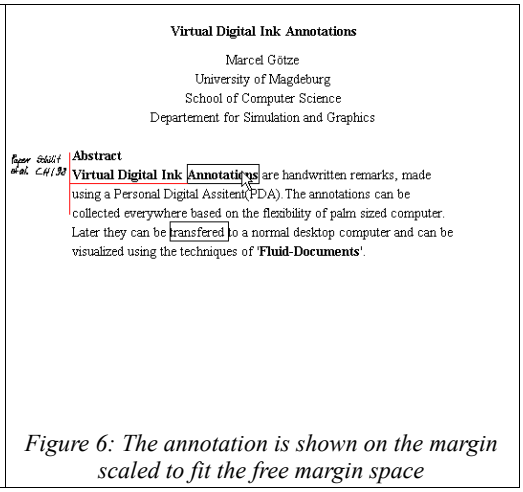

Figure 6: The annotation is shown on the margin scaled to fit the free margin space

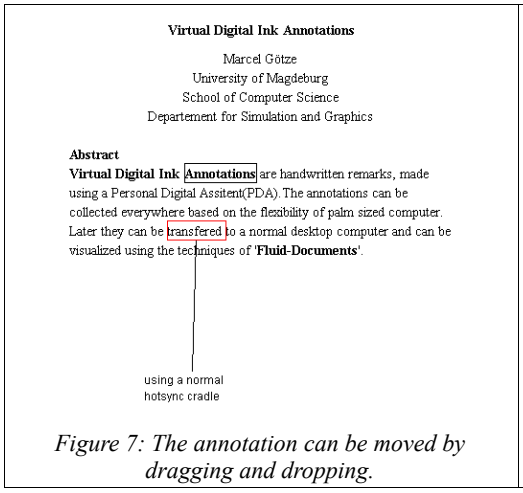

Figure 7: The annotation can be moved by dragging and dropping.

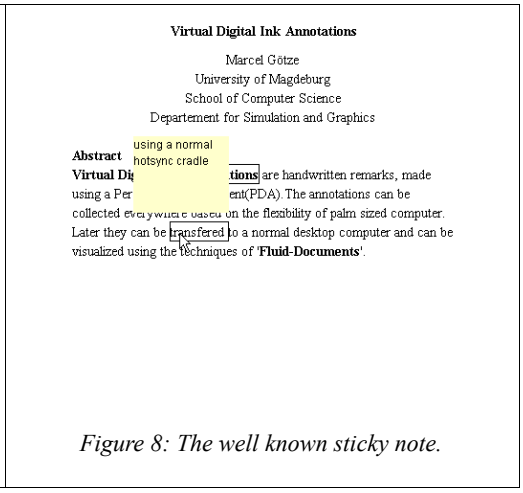

Figure 8: The well known sticky note.

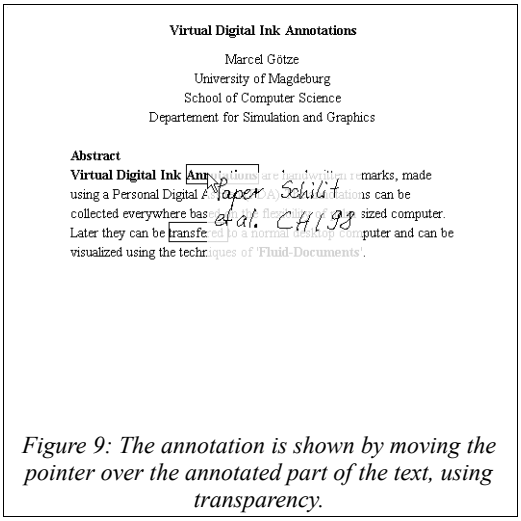

Figure 9: The annotation is shown by moving the pointer over the annotated part of the text, using transparency.