Digital Graffiti: Public Annotation of Multimedia Content

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ABSTRACT

Our physical environment is increasingly filled with multimedia content on situated, community public displays. We are designing methods for people to post and acquire digital information to and from public digital displays, and to modify and annotate previously posted content to create publicly observable threads. We support in-the-moment and on-site "person-to-place-to-people-to-persons" content interaction, annotation, augmentation and publication. We draw design inspiration from field work observations of how people remove, modify and mark up paper postings. We present our initial designs in this arena, and some initial user reactions.

Keywords

Annotation; digital community poster boards; threaded discussion; blogging

ACM Classification Keywords

H5.m. Information interfaces and presentation (*e.g.*, HCI): Miscellaneous.

INTRODUCTION

Content distribution is often one-to-many – with centralized production and distribution to many information consumers. However, people like to augment, comment and annotate content, and pass it around; people are producers and *active* consumers. The Internet has become a key forum for this kind of many-to-many content distribution. Examples include threaded discussions in email and bulletin boards such as Usenet discussions, and collaborative Web-based tools such as Wiki [9].

Multimedia content displayed in public places is becoming more prevalent, but again such content often follows the one-to-many content distribution paradigm. The work we present here follows from the questions: How can we support people in more easily acquiring multimedia content that is published in public spaces, marking it up, and publishing the marked-up content back to public places. What would such public multimedia commenting look like? To explore these questions, we explored the ways in

which people alter physical postings in the world by removing them, tearing them and marking them [1] and reconsidered these actions in the context of online annotation and sharing. Given the rise of personal devices such as cell phones and PDAs that support mobile emailing and texting for on-the-move commenting and blogging of digital content that is designed for online consumption, we are experimenting with a system that allows individuals to attach digital graffiti annotations to publicly posted content.
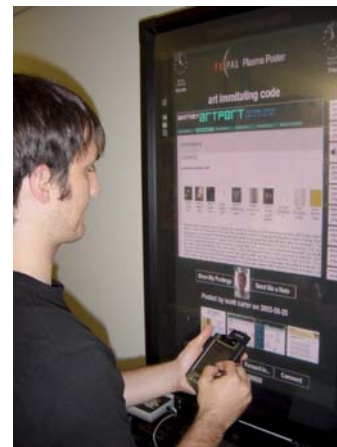

Figure 1: Annotating a public posting using a PDA

The system we describe in this paper allows people to annotate content on Plasma Posters, publicly situated digital community poster boards (Figure 1), using PDAs. This mechanism allows community members to exchange and explore interests and ideas. By publishing such annotations in public places, linked to the content to which they refer, we create a visible "buzz" of "interest clusters."

We first briefly describe the Plasma Posters for context, and present user opinions related to commenting and annotating content published on those boards and related work on online annotation. We then describe our approach to enabling personal and public annotation of digital community content using public and personal devices. We present a scenario, initial reactions to the display from lab and field experiments, and address future work.

COMMUNITY CONTENT ON PUBLIC DISPLAY

Plasma Posters are large-screen, interactive, digital community bulletin boards that are located in public spaces

[1]. Underlying the Plasma Posters is an information storage and distribution infrastructure, the Plasma Poster Network. The Plasma Poster Network is a client-server system that has been designed to make it easy for content creators to distribute information to their community. People can post digital documents to public displays via straightforward Web- and email-based interfaces. Content typically consists of URLs, text, images and short movies.

Usage logs, user surveys and interviews over the 17 months that 3 Plasma Posters have been available within FXPAL have revealed: 1) there is considerable interaction with content at the Plasma Posters; 2) comments are sent to authors regarding their postings; and 3) postings can be threaded (a posting is sent in response to one previously posted). These threads and comments demonstrate the ways posted content becomes a nexus of conversation.

These findings, coupled with instances of PDA used for sharing comments in focused collaboration, meeting and educational situations (*e.g.,* [2,6]), have inspired us to extend the Plasma Poster Network to support capture of posted content to a personal device such as a PDA, creation of annotations for that content on the PDA (with text, graphics, and audio), and reposting of the annotated content to the system and thus to the Plasma Posters. There are precedents for assuming people will post personal content on situated, public displays from personal devices [7]. To date, however, these technologies do not support inline annotation of existing content and have so far have focused on what has been called "person-to-place" publishing. We wish to extend this notion to "person-to-place-to-people-to-persons" content annotation, augmentation and publication.

ANNOTATION
Annotation involves marking of content where the original remains unchanged. Most examples of digital annotation deal with annotating text, but some do include annotation of audio or video content. Most annotations are text-based or ink-based, although some are audio and pictorial.

We characterize annotation systems as falling broadly into 3 categories: 1. annotations for personal use; 2. collaborative annotations; and 3. public/social annotations. In the first category, the goals are typically to support active reading (*e.g.,* [3,6]), to help with content retrieval (including summarization, search and classification), for new document retrieval and for content reuse in composition of new documents. In the second category, collaborative annotation, the goal is usually to point someone else to interesting parts of a document, as a method of activity coordination, as a method of ongoing note-sharing in a working situation, and for serendipitous sharing. Finally, social or public annotation is less team-directed than collaborative annotation, allowing people to leave comments for others to happen across. In the last case, most are Web-based (*e.g.,* [2,4,6]).

Examples of current uses of public annotation can be found in several applications on the World Wide Web, including Web-based discussion forums and bulletin boards or "blogs." Most are designed to be accessed, contributed to and read by lone individuals from PCs. Our challenges have been to design easy-to-use and appealing methods for

Figure 2: The Plasma Poster (left), the posting being annotated via the PDA scribble tool (center), and the Plasma Poster with new annotation (right).

such annotation from mobile devices (Figure 2), and to produce interfaces that effectively display those annotations in public fora. Using our system, people can attach text-, ink- and audio-based annotations to content posted to a digital bulletin board, the Plasma Poster.

ANNOTATING COMMUNITY CONTENT: A Scenario
Before detailing the technical aspects of our demonstration, we present a scenario of the system in use at a conference.

While listening to a talk on a new, shared note-taking application, Jane, a conference attendee, overhears someone near her talking about how they have just implanted a tracking device in their dog. She opens her laptop and does a quick Google search on "rfid dogs" and e-mails the first link she finds to the address of a nearby Plasma Poster, giving the posting the title "Is rover going robo?" Another attendee, Jason, passing by the Plasma Poster in the lobby nearby, notices the post and wants to add that such tracking devices are highly controversial as their safety has not been fully proven. He presses the "comment" button on the display and uses the scribble pad to attach an annotation ("not my dog!") to the display, adding a pointer to a URL to a Web site where the tags are discussed more critically. Later, another attendee, Jeffrey, who has just been to a talk on ambient displays, sees same posting. He approaches the display with his PDA and presses the "grab posting" button, and downloads the current posting to his PDA using the WiFi connection. After he sees a web page on his PDA showing the content from the posting and the comment left by Jason, he

wanders off to another talk, sketching a response along the way.

Later, other attendees gather around the display and talk about the post. They read the comment left by Jason and look through the site he recommended, and conversation begins to focus on where exactly they implant the tags. After scouring the article, they locate the paragraph that describes where the implants are positioned ("usually in the fleshy area of the neck…"). Some of the folks near the display use a gesture to highlight that paragraph and attach annotations to that region (*e.g.*, "where they implant it…"). Later, Jane is passing by the Plasma Poster and sees all the annotations that have been posted over her original content. She is amused to discover her post has caused so much response and debate and forwards the recommended URL to her home email so she can read it later.
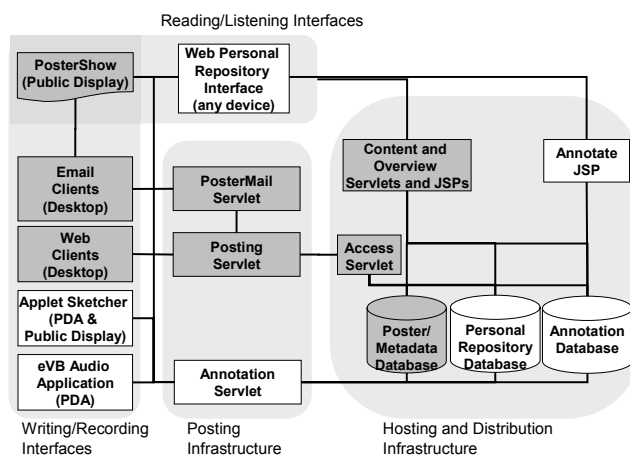

Figure 3. The Plasma Poster Network Architecture with Annotation components shown in white.

System implementation and architecture

The Plasma Poster Network is a client-server system for distributing content and metadata in a community (Figure 3). Server components provide the collection and hosting infrastructure. The server consists of a relational database (*e.g.*, MySQL from MySQL AB) and Java servlets and Java Server Pages (JSPs) that run in a standard Web server (*e.g.*, Tomcat from the Apache Software Foundation). Client components provide content displays and interaction mechanisms. A PosterShow Visual Basic application provides a cyclic view of posted content suitable for display and navigation on a Plasma Poster client platform (*e.g.*, large plasma display or personal computer).

We extend previous systems for access to publicly shared content through personal devices [3] by bringing together an infrastructure and range of client applications that support a collage of devices (public and personal), working across multiple media types, and focusing on associating annotations with community posted content. Annotations may be immediately introduced into the system or on a

personal device where sufficient contextual information is stored to allow offline annotations to be made and later uploaded into the system. The Annotation Servlet accepts annotations on posted content from both sketch-based and audio annotation clients. A link to the posted content is stored along with the annotation's media type, a link to the posting author (defaulting to "anonymous" when user information is not available), and the on-screen location of the annotation interface at the time the annotation was authored. The servlet can specify that a particular annotation is a reply to a previously posted one and that a set of annotations are related and should be shown simultaneously, allowing multimodal annotations. The Annotation servlet also stores postings of interest to individual users in their own personal repository. Stored content can include a complete posting, parts of a posting, annotations or any combination of these.

Client-side support for annotations on personal devices includes an *anchoring tool*, a *sketching tool*, and an *audio-recording tool*. The anchoring tool is implemented as a Java applet and allows users to interactively select an area of the posted content to which they wish to anchor their annotation. The tool presents the user a screen capture of the content that the user can scroll using the PDA pen. The user sweeps out a rectangle around the desired anchor text. The tool automatically indexes the rectangle's position to content text. The sketching tool is implemented as a Java applet and allows users to draw responses to comments. Once a user has selected a posting to annotate, the sketch applet allows use of the PDA stylus to input simple annotations. The audio annotation tool is implemented as an Embedded Visual Basic application and allows users to record a brief comment using the device's built-in microphone. Comments are uploaded to the Annotation Servlet using the WiFi enabled PDA.

The Annotate JSP provides client-side interfaces for annotations on public displays. The JSP dynamically displays annotation icons next to their associated postings. In this way, users may scroll through and open annotations using simple gestures. Users may also sketch annotations on the public display using a version of the sketching tool for that device. A Web-based interface allows users to manage their personal content repository. Users can review postings and associated annotations collected from public displays or store new content to post at a later time and from elsewhere.

USER EXPERIMENTS

We used both a lab experiment and a field experiment to evaluate the functional annotation system. We are planning a more extensive deployment to explore whether people believe there is utility in using such a system.

Lab experiment

We used the first working version of the system as a prompt in a collaborative brainstorming session with four study participants. Participants were interviewed about

their current use of the Plasma Poster, shown the annotation interface and asked to use the interface and elaborate on new designs and use scenarios. During the study, all users wanted more control of the interface when standing next to it ("the poster should not change while [the user is] adding an annotation") and desired more feedback on the poster of the actions they take on the personal device. Furthermore, three users indicated that they would want to scroll through postings on their personal device to keep in touch with their community when remote from the display. Individual users also identified other "important feature(s)" including anchoring annotations to specific parts of each posting as well as bookmarking postings to review later on PCs. Finally, we found that each user had a different media preference (one participant said he would "only use scribble and text" whereas another preferred audio annotations).

Field experiment

Two conference attendees used our system at the 2003 Ubiquitous Computing conference. The users registered with our system beforehand and were asked to peruse and post content. We provided a means for any conference member to create and post a collage of photos from their camera. We described posting and annotating content, via both the public and private display, to each attendee, and both posted a trial annotation. Both viewed content and posted a few annotations via their mobile device during the conference, and one requested a mechanism to post content to the display from the mobile device. Notably, neither attendee returned to the public display but instead used the private display exclusively to view content and post annotations. This was due in part to the location of the display (in a room other than the main conference room).

Discussion

These experiments show that our system is useful but that it is crucial to integrate content capture, aggregation and annotation. Mobile devices have limited UIs, making these features difficult to integrate while maintaining usability and without co-opting nearby displays. However, given that users expressed interest in saving bookmarks to review and edit later, mobile devices may not need to support content aggregation.

FUTURE WORK

The user studies have shown that users find this a useful and appealing way to annotate public information and to maintain awareness of the public display remotely. However, several social and user challenges remain.

Social challenges

Scaling the system to support a larger community or set of communities represents a significant challenge. In particular, we are working on ways to represent large conversation threads, whose individual entries could each refer and be anchored to different pieces of content on a public display. We are also investigating ways to link the public display to online communities, supporting different views of the data for each medium.

User challenges

Users found it important to be able to anchor annotations to content. More work needs to be done to support purely gesture-based anchoring as well as inline representation of annotations. Both of these issues represent significant technical challenges. In particular, because much of the content being annotated is Web-based, annotation anchoring should be robust to small changes in the underlying content as well as document reflow.

Furthermore, the system should be context sensitive. Users in the lab experiment used the public display peripherally (to monitor system state) while completing tasks on the private display. Users in the field experiment used the private display exclusively. This disparity compels us to examine adjusting the interaction style of the system based on the user's proximity to the public display.

CONCLUSION

We need to investigate new methods of facilitating many-to-many content distribution and discourse to address the increasing prevalence of multimedia content in public places. We explore that question here via an experimental system that allows individuals to attach digital graffiti annotations to publicly posted content. User studies encourage us to scale the system to larger communities, facilitate annotation anchoring, and support proximity-based interaction styles.

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