

# Pulp Computing

Tim Kindberg, Rakhi Rajani, Mirjana Spasojevic, Ella Tallyn

Mobile and Media Systems Lab

Hewlett-Packard Labs

Palo Alto, CA 94304 USA

{timothy, rarajani, mirjana, etallyn}@hpl.hp.com

## ABSTRACT

We are investigating the integration of paper artifacts into personal and inter-personal computing environments. We will demonstrate portable paper interfaces to media collections and active photos that allow users to access annotations in both web-based and printed representations.

## Keywords

Paper interfaces, hypermedia, physical hyperlinks, mobile computing, World Wide Web

## INTRODUCTION

The Pulp Computing project at HP Labs [7] is investigating how to integrate paper artifacts into personal and inter-personal computing environments. Our basic research question is: given that paper plays such an important role in our lives [9], how can we best enable people to work between their collection of paper-based artifacts and the digital resources stored on the web and in their PCs?

Our approach to paper is to view it as a compelling type of “UbiMedia”: the intersection of ubiquitous computing and hypermedia [1]. What we mean by that is, first, that we can print physical hyperlinks [4] to digital resources on paper, in the form of optical tags such as barcodes and glyphs, or the form of electronically readable tags using conductive inks, such as those developed by the Paper++ project [6]. Those physical hyperlinks can reference any content or services available on the Web. Not only can users insert tags into their documents – providing electronic functionality in the printed versions – but virtual objects can print references and even interfaces to themselves on paper, for access by users with various types of “smart pen” as a reader.

Second, paper is very portable, and so it is suitable for exchange between people, and also for transport into and out of ubiquitous computing environments. Ideally, users should be able to take advantage of their smart paper artifacts and acquire useful smart paper artifacts wherever they go. For example, a user can take a print-out of a meeting back to the office to find links to the attendees and the content that was presented. Smart paper should just “work” in any given environment.

Many have investigated augmenting paper with electronic functionality, including notebooks [11], post-its [5] and

photographs [3]. Our distinct emphasis is (a) on interaction models for working between paper and electronic resources that apply even when the user is nomadic; and (b) empowering non-technical users to author hyperlinks between paper and electronic resources. We aim to support spontaneous usage of smart paper, as opposed to relatively long-term form-filling and augmented-book applications [10].

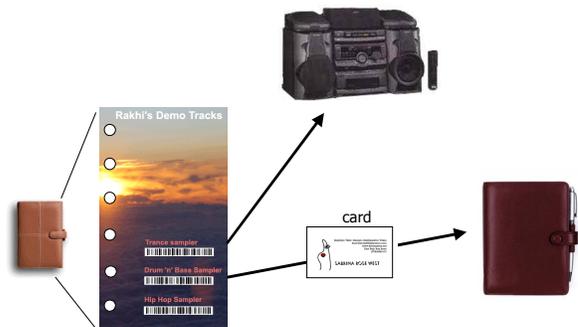


Figure 1: Fil-o-media

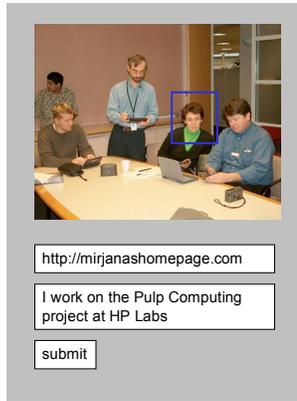
## DEMONSTRATIONS

To illustrate the first steps in our research, we intend to demonstrate both the following prototypes.

### Demonstration 1. Fil-o-media:

#### Portable Paper Interfaces to Media Collections

The demonstration will be of (a) a “fil-o-media” (c.f. fil-o-fax, a portable ring-binder for diary entries etc. [2]) – which contains paper links to a user’s music, graphics, video and document collection; and (b) a model for users to exchange content via personal cards. The demonstration will involve the paper artifacts plus off-the-shelf handheld wireless devices for dereferencing the hyperlinks. We will demonstrate how to transfer content from one user’s fil-o-media to another (Figure 1). One user selects content from their fil-o-media, and “binds” it to a personal card: that is, they place a reference to the content in a hyperlink on the card. Then they give the card to the other user, who can later bind the content into their own fil-o-media – or simply keep the card – to play on output devices of their choice.



**Figure 2:** Dynamic annotations of web-based images

**Demonstration 2. Active Photos**

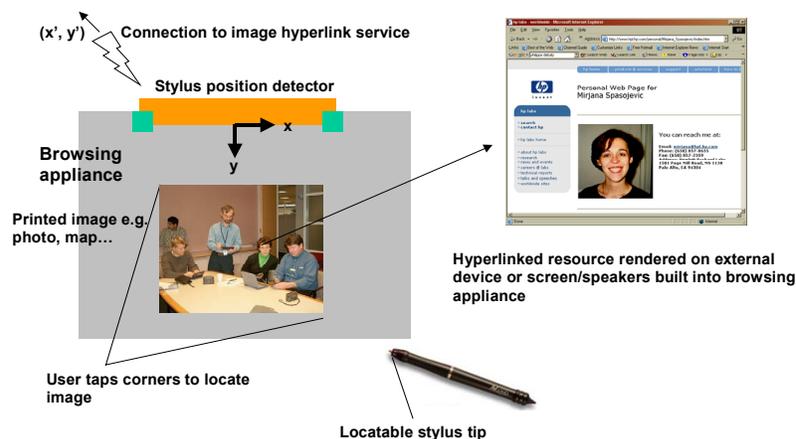
An “active photo” is one with both web-based and printed representations, each of which has links to annotations in the form of text, audio, video or hyperlinks to web pages. The annotations may apply to the entire image or parts of the image. The photos can be taken and annotated on the fly, e.g. during a meeting or at a conference (Figure 2). The annotations can be viewed from prints of the photos as well as on the web.

We shall demonstrate how a conference attendee can annotate themselves in a group photo with text such as their home page, or a spoken message. Those annotations can be experienced on a public display at the conference or at any time from the printed “informal proceedings” of the conference (Figure 3). Printed images have certain advantages such as being of higher resolution, and easy to pass around and share. Our current implementation uses the

Seiko InkLink technology [8] for identifying “hot spots” in a printed image.

**REFERENCES**

1. Barton, J., Goddi, P., and Spasojevic, M. Creating and Experiencing Ubimedia. HP Labs Tech report HPL-2003-38, 2003.
2. Filofax home page: <http://www.filofax.com/>.
3. Frohlich, D., Kuchinsky, A., Pering, C., Don, A., and Ariss, S. Requirements for photoware. Proceedings of the 2002 ACM conference on Computer supported cooperative work, November 16-20, 2002, New Orleans, Louisiana, USA.
4. Kindberg, T. Implementing physical hyperlinks using ubiquitous identifier resolution, in proc. 11th International World Wide Web Conference.
5. Ljungstrand, P., Redström, J. and Holmquist, L. E. Webstickers: Using Physical Tokens to Access, Manage and Share Bookmarks to the Web. In: Proceedings of Designing Augmented Reality Environments (DARE) 2000, ACM Press, 2000.
6. Paper++ site ETH Zurich: <http://www.globis.ethz.ch/research/paperpp/index.html>
7. The Pulp Computing home page: <http://purl.org/net/PulpComputing/home>.
8. Seiko InkLink. <http://www.siibusinessproducts.com/>.
9. Sellen, A., and Harper, R. The Myth of the Paperless Office.
10. Siio, I., Masui, T., and Fukuchi, K. Real-world interaction using the FieldMouse. Proceedings of the 12th annual ACM symposium on User interface software and technology, 1999. pp 113-119.
11. Stifelman, L. Augmenting Real-World Objects: A Paper-Based Audio Notebook. In proceedings CHI '96.



**Figure 3:** Accessing annotations from a printed image