



## Active Photos

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## ABSTRACT

In this paper we describe an investigation into linkages to multimedia content from individual items in photographs and other printed images. We describe prototypes for authoring and playing such “active photos”, and give the results of informal trials. We conclude with lessons learned and next steps.

## Categories and Subject Descriptors

H.5.1 Artificial, augmented, and virtual realities: Multimedia Information Systems.

## General Terms

Design, Experimentation, Human Factors.

## Keywords

Paper interfaces, hypermedia, physical-virtual, web.

## 1. INTRODUCTION

The Pulp Computing project at HP Labs [6] 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?

Many have investigated augmenting paper with electronic functionality, including books [4][7], notebooks [10], post-its [5], and photographs [2]. In this paper we are also concerned with prints of photographs and other images. However, unlike [2], we wanted to enable links from individual people and objects in the images, each of which could benefit from related digital media that could describe, explain, or enhance it in some way. An obvious example is a group photograph at a dinner, meeting or conference, with links from the individuals in the photograph, from the background (the place where the group assembled), and

from any interesting objects present.

Ionescu et al [3] record digital content presented during meetings in the Stanford iRoom using links from photographs of the meetings, in particular from shots of the screens on which the content appears. But the choice of what needs linking is made according to a static policy, whereas we wanted to enable users to make their own choices of what to link from and to in their images. The “fotowiki” web site [1] allows users to upload images and link to arbitrary content from specific regions within them.

Our distinct emphasis in this paper is to achieve functionality broadly similar to fotowiki, but for prints of photographs. In particular, we wanted to investigate design constraints and opportunities for both authoring and “playing” the linked photographs.

## 2. ACTIVE PHOTOS

An “active photo” is an image that has links from individual regions to text, web pages or any other web-accessible multimedia content, including audio, images and video.

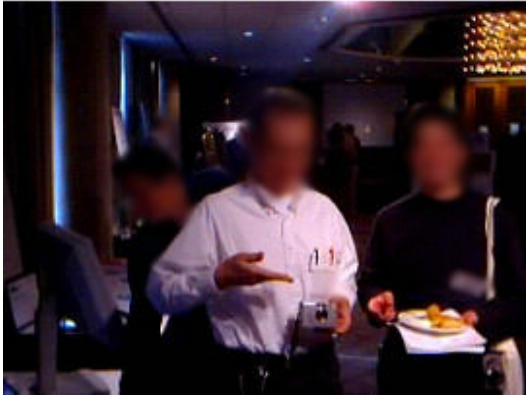
The principal form of an active photo is a printed artifact that functions like a web image-map. When the user indicates a part of the image with a pointing device, an associated playing appliance (which we shall describe) renders the corresponding content to the user. Our motivation is to enable users to electronically augment existing silver halide prints as well as prints of digital images.

The physical affordances of prints enable richer types of sharing than screen-based interactions. However, an active photo also has a web representation as an image-map – one with links to authoring functions. The user can view the links’ locations on the image and edit and add links. This can be thought of as the image-map equivalent of a wiki page [1].

Because of our initial interests in photographs, we refer to these artifacts as “active photos”. However, they may be any image: not necessarily one captured from a camera. For example, a map can also be augmented in the same way.

## 3. THE STUDIES

We carried out two informal studies with a set of six users drawn from technical staff at HP Labs. The initial study probed the users about the concept of active photos and how and whether active photos would or should appear different from ordinary



**Figure 1. Part of a record of UbiComp 2003 (anonimised by facial blurring, hotspots not shown).**



**Figure 2. A garden record, with hotspots.**



**Figure 3. An augmented postcard of London, with hotspots.**

prints. In the first study we also gathered background information about the users' digital-photo printing practices. In the second study, we tested our prototypes by having the users author (with our help) and play some active photos based on some of their own digital photographs. We used interviews and observations to gather our data.

### 3.1 Uses for Active Photos

In the initial interviews with our six users we probed for possible uses for active photos. The main uses that emerged were:

**Collective recording and recall.** Not surprisingly, group photographs, or photographs in which many interesting objects appear, were considered suitable active photos. In fact, we subsequently demonstrated active photos of this type at the UbiComp 2003 conference (Fig. 1), where we photographed small groups who visited the stand, and invited them to annotate themselves or objects they had with them. Some users recorded audio notes, others simply entered a small amount of text or gave a link to their home page. This use illustrates the potential value of ad hoc annotation: while some users might want to go back – perhaps after the conference – to provide a link, it may be desirable to provide links very soon after (or during) the event, while it is fresh in the users' minds. The example also shows the need for albums of active photos. Indeed, some of our interviewees wanted an album to tell a story with active photos.

**Personal recording and recall.** One of our users wanted an active photo as a personal record of the garden his father had worked on (Fig. 2, with a shed and bench linked to media). Another user wanted an active photo as a factual record of how they had grown the individual plants in their garden over the course of a summer.

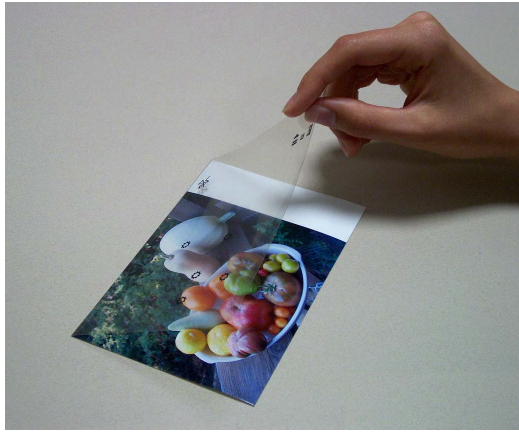
**Sending an experience.** Another type of use the interviewees suggested is sending an active photograph to convey an experience. In one example (Figure 3), a user provides content such as voice-over, music and linked photographs for various locations on an image or map of where the other user will visit, and sends this as a postcard.

### 3.2 Marking the Photograph

For a photograph to have links or "hot spots" raises questions about whether and how those links should appear. We know that users keep conventional (silver halide) photographs, and we wanted to be able to make such photographs active – without, of course, adulterating them in any way, since they often have special value as the only print in existence. That led us to ask how acceptable it would be to electronically mark or otherwise manipulate digital images in order to best present their electronic functionality as active photos.

As part of our initial study, we interviewed our six users about their existing uses for prints of digital photographs, and about ways in which they might be marked to serve as active photos. Our principal questions and findings were:

1. *When (if ever) and why do users print their digital photos?* Our subjects printed their digital photographs infrequently; when they did so, it was for display or to send to friends or family, sometimes in the form of a greeting card or invitation. When they printed photographs, the individual prints were highly valued, even though most felt that it would be straightforward and cheap to print another copy.
2. *How acceptable would it be to mark the hotspots on digital photographs, and how should they appear?* We showed the interviewees marked copies of the digital images they had selected to become active. Figure 2 is an example of using "targets" to show the hotspots, one of several symbols we tried to denote a large or irregular object. We also tried drawing various shapes around hotspots, brightening the hotspots, and blurring all parts of the image but the hotspots. The users had issues with all of those methods, although they thought some methods were suitable for some purposes



**Figure 4. A photograph with a transparent flap that shows the hotspots.**



**Figure 5. Active-photo appliance, with content rendered on a laptop.**



**Figure 6. Stand-alone active-photo appliance, with speakers and exposed iPAQ screen.**

– implying that we should provide a variety of methods. Some users felt it should be obvious which photos were active; but equally that the indication should be removable in inappropriate circumstances. That suggests a transparent envelope or (as we prototyped) a transparent flap that

showed the hotspots when the photograph was placed in or under it (Figure 4).

#### **4. PLAYING ACTIVE PHOTOS**

We built two prototype active-photo appliances (Figures 5 and 6). They are designed to be portable: they fit on the lap and are light enough to be passed between users. Each has enough space for two 4x6 (-inch) photos or one 8x10 photo.

The appliances are based on Seiko's InkLink technology [8], which we chose in part to accommodate existing silver halide prints, since it works solely by determining (x, y) coordinates in the image's plane. We adapted the InkLink's pen as a pointing device; we attached the clip (normally attached to the end of a piece of paper) to the top of the appliance's surface.

Each appliance has an iPAQ that processes the pointer's coordinates and communicates wirelessly with other services, including the web. The active photo is identified via a barcode stuck on the reverse (an RFID tag might be more convenient, if more expensive). The user places the active photo on the surface and points to the top-left and bottom-right corners of the image. Thus we allow images of various sizes to be placed in any orientation on the surface. The appliance has a slightly sticky plastic surface to help keep the photo in place.

Once the active photo has been registered on the appliance, the user can point at hotspots and experience the content. The two appliances differ in that respect: the smaller of the two (Figure 5) is associated with another device that renders the content; we intend that device to be a multimedia home entertainment centre, but we currently use a laptop. The iPAQ used for processing and communicating the pen events is hidden inside the appliance. The second appliance (Figure 6) is stand-alone: the iPAQ also renders the linked media; its screen is next to where the user places the active photos, and it is connected to speakers at the upper corners.

We tested our appliances with our six subjects. We had previously asked them to select content and regions for the photos they chose in the initial study. They thus constructed active photos using our authoring software – with some help from us – and played them with the two appliances.

We printed the users' active photos with the hotspots unmarked. We found that some users had forgotten where they had placed their hotspots about a week before, and found it difficult to locate them since the only action is to place the pointer in a specific location and wait to see whether any content appears. One way to fix that simply would be to enable the user to bring up the web version of the active photo, showing the locations of the hotspots.

With regard to the types of media associated with an active photo, some users valued the active photos as an index into visual content: images, video or web pages. However, one user remarked on how visual content associated with the image distracted them from the image itself, whereas audio allowed the user to remain concentrated on the image while having the contents of the photo explained to them.

The users felt that each of the two appliances would be appropriate in different circumstances. The stand-alone appliance is more suitable for personal playing since it renders the linked content close to the photos, which the user is principally looking at; but it is the bigger appliance and has a small screen. The other

appliance was felt to be more suitable for sharing: it can be passed between users more easily, and the rendered content can appear at a location that is more accessible to a group of users. However, the appliance would need to be enhanced with a way to remotely click on hyperlinks in the linked content.

The users found the pointing device – the InkLink pen, which is about the same size as a fountain pen, but with its nib disabled – to be too fine. The hardness of the tip together with its fine size caused indentations in some photos, and some users disliked the feeling of poking at people in a photo. It would be straightforward to use a blunter, softer tip.

Finally, we quickly realised that the appliances are the wrong size. They should either be desk- or coffee-table sized – allowing the user unfettered access to hotspots on potentially many images arranged around the working area – or they should be smaller than our prototypes, say the size of a 4x6 photograph or postcard. A 4x6 appliance would be highly portable; and it would work well for this common case: the user would not have to designate the corners of a photo if it fitted exactly on the appliance.

## 5. AUTHORING ACTIVE PHOTOS

We decided to present authoring functionality in web pages associated with individual active photos. That has the advantage of widespread access to image-linking. However, it became clear that a web browser is not well suited to the task. Standard web browsers (with Javascript enabled) allow the user to rubber-band a shape at or around a hotspot; but of course they do not have integrated features for recording audio, or dragging a file such as a video clip to be a linked to a location – which would have made the authoring task much easier.

Another option, favoured by our users, would be to adapt a playing appliance so that it also supported certain types of authoring directly onto a print, perhaps during a group photo-viewing session; for example, the user could gesture with the pointing device to create and delete hotspots, and record audio using an attached microphone. Somewhat further out in terms of practicality would be to adapt a camera with a screen and microphone on the back.

## 6. NEXT STEPS

Our next goal is to create a 4x6 active photo appliance for the reasons we have already stated. Also, our users had a relatively poor experience of the “point and wait for content” operation of the appliances. We would like to experiment with an active-photo experience that is not only less frustrating, but aesthetically richer and more distinctive. We will therefore produce a version in which the user can roll the pointer over the active photo to find out what is there and, through audio volume and image brightness, we will provide them with “hot and cold” information to find the hotspots.

In one variation, wherever the user puts the pointer on the image, the output will be a mix of the active photo’s content weighted by the pointer’s distance from hotspots. For example, the user might hear a collection of faint voices with the pointer at the edge of a group of people, but could focus on one by moving the pointer until they clearly heard a particular person. That design

should make a virtue of the augmented content’s latency; the image will not need to be marked except, where desired, with symbols in the margin that show the photo to be active and perhaps indicate the types of content present.

## 7. CONCLUSION

We have described a preliminary investigation into digitally augmented photographs – and other printed images – that contain links from individual regions within the image. Our informal study of user reactions to the idea and to working prototypes suggests that our active photos may have value principally for personal communication and experience-sharing (the augmented postcard of central London) and for collective and personal recording and recall (the group photograph and the record of a garden).

Although we have made a promising start, considerable work remains if we are to provide sufficient value and usability to sustain an everyday experience with active photos. We have explained the steps we are taking to redesign the playing appliance so that it can be used more effectively for postcard-sized photographs (and postcards). We are also investigating the design of purpose-built authoring tools, since we consider authorship by non-specialist users an important part of the paradigm.

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