

Wearable Computing

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Capturing Experiences Anytime, Anywhere

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Several years ago, one of us (Daniel Ashbrook) was in Kyoto, Japan, for Gion Matsuri, the most famous Japanese festival. In one of the festival's highlights, hundreds of volunteers push huge floats in the shapes of shrines through the city, a tradition dating from the year 869. In marked contrast to the giant mobile shrines were the tiny mobile phones that dozens of tourists were using to take photographs.

Anytime, anywhere experience capture is becoming the norm, especially capture involving multimedia. Digital cameras are ubiquitous and continually increasing in image quality. Mobile phones without built-in cameras are increasingly rare. High-quality, solid-state MPEG video recorders scarcely larger than a mobile phone are now available. Capturing multimedia on the go is getting easier and cheaper.

What's the future of mobile experience-capture technology? For example, if a company were to make a small, white, beautifully designed capture device with an "i" in front of its name, what would it be? Let's explore this question by examining three technologies: one that's currently available, one that could be here tomorrow, and one that could be a product in the future.

TODAY: LIFELOG

The publishing of Web logs, or blogging, has become common in the past few years: blog-tracking service Technorati currently indexes 31 million blogs. While most are single-writer, single-

reader affairs, blogging hasn't escaped industry's notice: numerous blogging services have been created, including ones sponsored by industry heavyweights Google and Yahoo. While most blogging services focus on desktop use, some companies are working to make blogging on the go easier. Nokia recently released a piece of software called LifeBlog for its Series60 line of phones. LifeBlog is an integration application. It combines media that the user has collected (for example, videos, photos, short text messages, and multimedia messages) into a timeline. The user can then quickly export parts of this timeline to form a blog entry. On the move, LifeBlog lets users take a photo with a camera phone, attach some text, and upload it to any supported blog service.

One problem with mobile blogging is that it requires a lot of user interaction: the user must manually record some media, annotate it with text, and upload it to a server. While applications such as LifeBlog enable this process, there's still room for improvement.

TOMORROW: SENSECAM

One potential way to lessen the burden on the user is to automate capture. This is the goal of Microsoft's SenseCam project (http://research.microsoft.com/sendev/project_sensecam.aspx). SenseCam is a small camera you can wear as a pendant; it also contains a passive infrared (IR) heat sensor, a light sensor, a temperature sensor, and an accelerometer used as a tilt sensor. The

purpose of these extra sensors is to trigger image capture during interesting events, such as walking through a door (light sensor), encountering another person (IR sensor), or stopping to look at something (accelerometer). The technology needed to implement SenseCam, with the possible exception of the IR sensor, is already present in several of today's mobile phones. By adding wireless data transfer capabilities, SenseCam could semiautomatically blog for the user. (Some filtering would still be necessary to avoid embarrassing situations.) Combining SenseCam technology with a good user interface could allow for much more efficient on-the-go blogging.

THE FUTURE: ASSIST

In the not-too-distant future, we can imagine SenseCam taken to the n th degree: always on, always with you, automatic, continuous, and simultaneous mobile capture from an assortment of on-body sensors. To be useful, such systems would have to make it easy to automatically access and present data that users want to remember or share.

A vision of one such project is presented in the call for proposals (www.darpa.mil/ipto/Solicitations/open/04_38_PIP.htm) for a US Defense Advanced Research Project Agency program called ASSIST (Advanced Soldier Sensor Information System and Technology). While ASSIST is intended to help soldiers write reports after returning from patrol, many of its goals are compatible with

consumer-level technology. Hopefully requiring little to no interaction, the system would record information such as location, photographic, audio, video, motion, and other data via on-body sensors and then use it to help write the report.

One of ASSIST's goals is to help soldiers more quickly navigate through collected data. For example, a soldier could select all the pictures taken in a certain region and include them in his report, or display a map of all places where there was shouting. This kind of data could be given to superior officers or shared with other soldiers who were about to go to the same areas.

THE ITOURIST

While everyday use of an always-on mobile capture system might sound overwhelming, imagine using one for special occasions such as vacations, family gatherings, or birthday parties. The ability to capture experiences automatically using a hands-free system would let users enjoy the event, no longer worrying about recording it for posterity. Suddenly, the user could have fun too.

Imagine such a system, which we'll call the iTourist, packaged in a small, white box with rounded edges and glowing white lights. It would weigh no more than an average mobile phone and hang around your neck on a lanyard. Like SenseCam, it would have a high-resolution camera, light sensors, and tilt sensors. It would also incorporate a GPS receiver and digital compass and communicate wirelessly with a wristband containing biometric sensors and an accelerometer. On the back would be a large, high-resolution LCD screen.

Imagine taking the iTourist on vacation to Kyoto for Gion Matsuri. Before the festival starts, you tour shrines in various parts of the city. Most of the time you let the iTourist automatically record pictures for you, sensing whenever you stop and look at something for a couple minutes. Whenever you see a scene you'd like to photograph, you use your iTourist like a regular camera—

using the LCD as a viewfinder, composing the scene, and shooting the photo. In the early afternoon, you stop for lunch at a shop where you have a delicious, huge parfait for dessert. During the festival, you watch drummers beat on huge drums. Thinking that this would be fun to watch again, you reach up and touch the iTourist's surface. The recording video light on top starts blinking, and you continue to watch the drummers. After the festival, back in your hotel, you sit down to update your travel blog. Taking the iTourist from around your neck and plugging it into your laptop, you notice that the record-

With the ability to capture experiences automatically using a hands-free system, users would no longer have to worry about recording them for posterity.

ing light is still blinking. Remembering that you were standing still for most of the drumming performance, you use the iTourist software to quickly jump from the beginning of the movie to where the iTourist detected you were walking. Scrolling back slightly, you find the end of the drum performance, cut off the video there, and place it on your blog.

The rest of the blog is already templated for you (see figure 1). The iTourist hardware and software automatically created the template on the basis of where you went and when, what sights you spent a lot of time at, and correlations with other visitors' behavior at the same sites. Standing and looking at something or manually taking a photograph trigger blog entries, as does sitting down in one place for a while. Visiting a popular destination causes the iTourist to create a blog entry and populate it with information gathered from

other visitors to that area, such as a shrine's name, an area of the city, or even historical details on annual events such as Gion Matsuri.

The iTourist also shows maps of your travels. The trip outline, pictures you took, landmarks you saw, and other events are marked on each map. The device records your lunch stop as a place where you spent half an hour not moving around much. Your biometric wrist sensor notes your startle response when you saw a really strange car, and the resulting picture is included.

The blog mentions your lunch stop but has no pictures, and you'd like to show your dessert to your friends. You click on that blog entry and quickly pick from the pictures that the iTourist took while it detected that you were sitting down and eating. After filling in some text about your impressions, you upload the blog entry to your site.

CHALLENGES AND OPPORTUNITIES

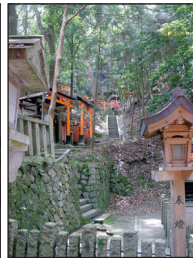
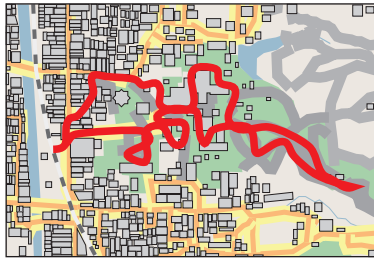
The iTourist is just an idea now, but we'll likely see something similar in the not-too-distant future. Several problems remain to be solved, and the research community is actively investigating most of them.

The problems of miniaturizing technology and making it mobile are well known, so we won't go into them; miniature computers such as Gumstix (<http://gumstix.com>) are advancing technology in that area. Many researchers are working on algorithms to discern activity from sensors such as accelerometers¹ and GPSs,^{2,3} and interest is growing in the social component of activity recognition. Marc Davis's Mobile Media Metadata project,⁴ for example, inspired the fictional iTourist's "what have other people called this" functionality.

A system such as iTourist raises privacy and legal concerns; when a system automatically records images, sound, and movies, many may feel threatened. Over time, however, those concerns may fade into the background. How many of us worry about making sensi-

My trip to Kyoto, Japan, July 2012

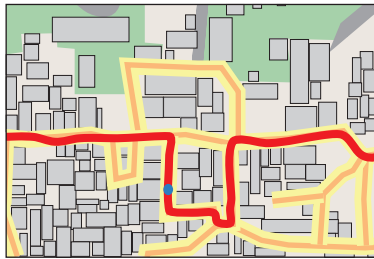
Fushimi Inari shrine—Saturday morning



I visited the Fushimi Inari shrine Saturday morning, spending about 3 hours walking around.

The most amazing thing about the Fushimi Inari shrine is the hundreds of brightly painted red gates, each with a different sponsor. Sponsoring a gate is believed to bring luck to a business.

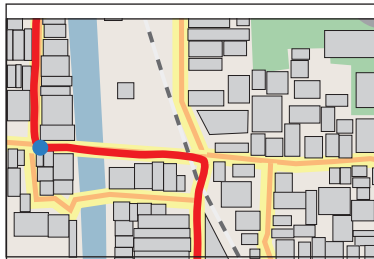
Takayama Street—Saturday afternoon



I had lunch here around noon.

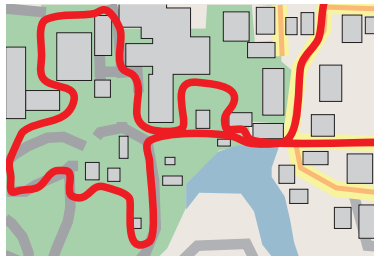
The Zaru Soba (cold buckwheat noodles with sesame seeds and dipping sauce) was really good, but the real highlight of the meal was my giant parfait for dessert!

Biometric Trigger—Saturday 3:35 p.m.



I was surprised to see this!

Heian Jingu temple—Saturday afternoon



On Saturday afternoon, I saw the Heian Jingu temple and gardens. I spent about two and a half hours there.

The gardens were really beautiful. Despite signs warning visitors against feeding the fish, every time I got close to the edge of a pond a horde of fish would appear, clearly used to people feeding them!

Gion Matsuri festival, Gion—Saturday afternoon and evening



Saturday afternoon and evening, I saw the Gion Matsuri festival. It took over three hours to see everything.

The festival was incredible! There were thousands of people, but it was worth fighting the crowds to see all the different things going on. The best part was the main shrine, all lit up with lanterns in the darkness.

Figure 1. An iTourist blog. The black text represents pretemplated information that the iTourist has figured out automatically.

tive phone calls on our mobile phones while in public places? How many of us avoid going to ATMs or driving through toll booths for fear of having our faces or vehicles captured on film? These scenarios pose important privacy concerns, yet the benefit of being able to communicate on the go or to access bank account information remotely often outweighs the inherent privacy risks. In the same way, the privacy concerns associated with mobile capture might also disappear as mobile capture systems become more prevalent.

Access is another issue: our fictional iTourist device needs another computer to let the user modify and update the blog. An alternative is to use the device itself for this purpose. This is quite a design challenge, however. The first step should be to allow easy mobile access to captured data. Creating the experience-capture analog of using your digital camera's LCD to show your friends the pictures you just took is an interesting research opportunity.

While showing off snapshots to friends is quite easy, scrolling through hours and hours of captured video to find one spot is not. How can mobile access for sharing be made simple? ■

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