



## Lifelogging: You're Wearing a Camera?

*Katrin Wolf and Albrecht Schmidt, University of Stuttgart*

*Agon Bexheti and Marc Langheinrich, Università della Svizzera Italiana (USI)*

**T**he number of surveillance cameras a person encounters on a daily basis is massive. Most of these cameras are owned by businesses and institutions. People generally know about the cameras, but most don't consciously think about them or change their behavior because of them. It seems that our society is now used to ubiquitous surveillance cameras—and we assume that nobody ever really reviews the recorded material.

However, as surveillance cameras become affordable, more individuals are setting up their own cameras in personal environments—in homes, on car windshields, or even on their clothing. The reasons for using such cameras are manifold: to have evidence in case of an unforeseen event (such as a break-in, an accident or assault, or officer misconduct), to monitor safety-critical situations (involving the elderly, infants, or pets), to provide healthcare assistance (in the form of personal memory aids or introspection), or simply to record memorable events (such as a holiday trip or a birthday). Yet use of such cameras by individuals rather than disembodied institutions often radically alters the perceptions of those being recorded.

Steve Mann, one of the pioneers of wearable camera technology, coined the term “sousveillance” for individual-controlled recordings,<sup>1</sup> positioning wearable cameras as

a distinct grassroots pushback to institutional surveillance, with the potential to alter the prevalent power structure of surveillance. Yet recent developments in pervasive computing research have re-positioned such cameras from an activist device to a consumer product. In particular, the SenseCam Project has shown how wearable cameras can be realized and how they can aid human memory.<sup>2</sup> Today, numerous devices are commercially available that enable ubiquitous image-based lifelogging. These

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relatively cheap off-the-shelf devices let individuals continuously capture what they see and do, including all their encounters with others. Here, we give a brief overview of image-based consumer lifelogging devices and the implications of such technologies for society.

### **Image-Based Lifelogging Technologies**

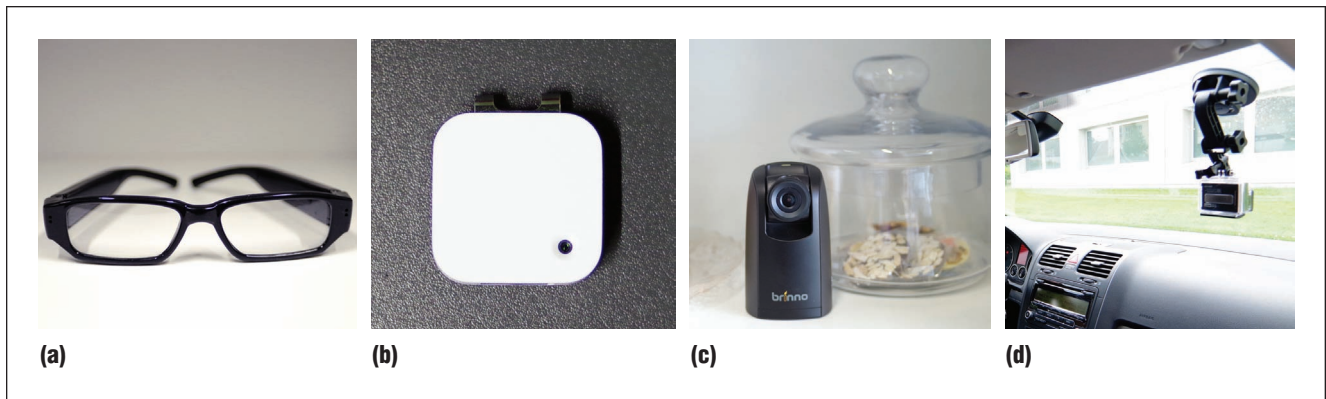
Whether recording or being recorded, people often want to know three things:

- Where is the camera?
- When does the camera capture data?
- What is recorded?

Typical camera placements are on the user's body or mounted to an object or place in the environment. For lifelogging, continuous-capture forms are most relevant, and the spectrum ranges from cameras that are always recording (movies) to cameras that take pictures in fixed intervals (such as every 10 seconds) to cameras that are triggered by sensors, events, or user interaction. Regarding what's recorded, in addition to images or movies, many cameras sense additional data, such as location, acceleration, and audio data.

Figure 1 shows a range of devices that can be used for lifelogging. Figure 1a shows a pair of glasses with a concealed camera. The glasses are marketed as a “spy camera,” and they record continuous high-definition video and audio onto a secure digital card. These devices are available for less than US\$50, but the notion of a spy camera points to ethical, legal, and acceptances issues.

The Narrative Clip, shown in Figure 1b, is a small, wearable camera that includes location sensing (<http://getnarrative.com>). It's  $1.42 \times 1.42 \times 0.35$  inches and weighs approximately 0.7 ounces. It takes a five-megapixel photo every 30 seconds, capturing time and acceleration data, which can be downloaded from the device



**Figure 1. Commercial capture devices: (a) camera glasses, (b) the Narrative Clip, (c) the Brinno time lapse camera, and (d) the GoPro camera with a suction cup.**

via USB. The battery lasts for roughly two days. The Autographer is a similar device ([www.autographer.com](http://www.autographer.com)) with a slightly larger form factor and a few extra sensors. While the Autographer has a built-in GPS sensor, the Narrative—in order to save the battery—only captures signal strength information that needs to be uploaded to the “Narrative Cloud” in order to translate it into actual position data. Both devices are modern, much lighter, and more compact versions of the pioneering SenseCam.

The Brinno TLC200 is a stationary time-lapse camera (see Figure 1c). The user can set the time interval in which photos are taken. With a set of batteries, the camera can capture 270,000 frames. This covers approximately 90 days when set to an interval of 30 seconds. Typical use cases for such time-lapse recordings are to create a memory of how a house was built or to capture growing plants.

The GoPro camera records full high-definition video (MP4 format, H.264 codec), with the ability to extract individual images. The manufacturer provides accessories so that the video camera can be mounted to many different objects, including cars, helmets, kites, or skateboards (see Figure 1d). This lets the users set up the camera in different ways—for example, creating a first-person view or selfie perspective to

capture oneself when driving, skating, or surfing.

### WHERE TO WEAR YOUR CAMERA

Where the camera is worn is significant in terms of social acceptance, usability, and the resulting images (see Figure 2). Cameras that are embedded in glasses or attached to clothes are unobtrusive and almost invisible. People recorded might consider this as a breach of trust or even as spying, given that the continuous recording isn’t apparent. This, of course, implies that they notice—which is actually not that easy. Note that although strapping a GoPro to your chest or head is much more obvious, it doesn’t imply that people will have a better reaction!

The camera position is often driven by product design—embedded into glasses or mounted on the body using accessories. Comparing the images that are captured with wearable cameras (see Figure 2) indicates that different camera positions produce specific image characteristics. For example, a camera worn on the neck or chest will often capture the hands and arms of the user (see Figure 2b and 2c), while a wide angle camera that’s embedded in glasses might accidentally capture the user’s nose or cap (see Figure 2a). The most natural images are achieved with cameras that are close to the user’s

eyes, capturing what the user sees, but mounting the camera on the body avoids head movement and thus produces more stable images.

### WHY RECORD YOUR LIFE?

Capturing moments of our life has its tradition in souvenirs, diaries, and drawings. Technical inventions, such as photography and cinema, let us capture situations in real time and in great detail. When these technologies became consumer products, they were used to capture personal experiences. With today’s digital cameras, which can easily record hundreds, if not thousands, of photos on memory cards, many photos are taken that no one ever looks at again. What would be the benefit of capturing even more photos and videos?

People might want to capture their entire life in the form of a video, but obviously nobody would have time to watch it. We hypothesize that we will use technology to help us sort, select, and watch recordings of life moments we want to remember. Algorithms already enable face and motion recognition. Metadata—such as location, time, and physical state—give additional hints to detect moments of fun, fear, or excitement. Thus, our future diaries will likely be multimodal and automatically written. They also might have search functions that help us better recall a particular moment in life.

## INNOVATIONS IN UBICOMP PRODUCTS

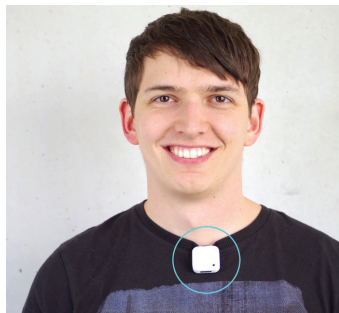


Camera integrated into glasses

(a)

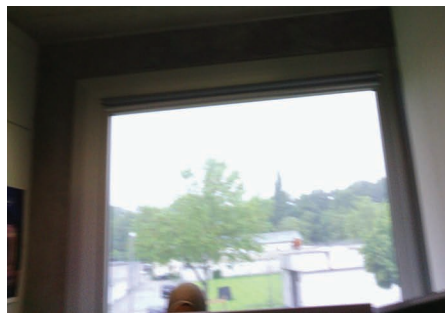


Pictures taken with a glasses-embedded camera

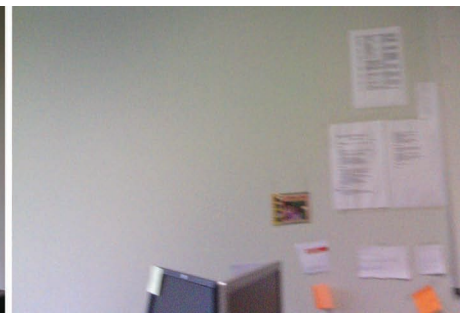


Camera worn on clothes (neck)

(b)

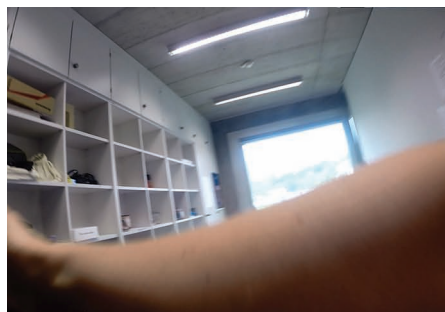


Pictures taken with neck-worn camera

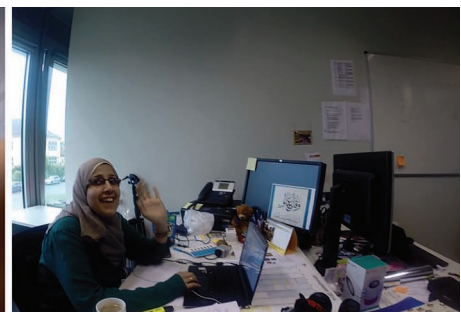


Camera worn on clothes (chest)

(c)



Pictures taken with chest-worn camera



**Figure 2.** Where the capture device is worn strongly impacts the perspective and usefulness of the resulting pictures: images taken with the camera worn near the (a) eyes, (b) neck, and (c) chest.

Looking at lifelogging pioneers and research in this field, many other motivations can be found. One central theme is to increase our ability to remember, including not only short-term utilitarian tasks (to help us, for example, find our keys) but also longer-term and more fundamental endeavors (such as self-reflection). On a scientific scale, revealing more

about personal patterns and activities provides the potential to gain entirely new insights into processes. For example, the cognitive scientist Deb Roy wired his house with video cameras to catch every moment of his son's life to understand how children learn language.<sup>3</sup>

Lifelogging technologies not only support episodic memories by helping

the wearer review the collected aspects of the past but also motivate future behavior with the help of carefully prepared memory cues. Mathew Biondolillo and David Pillemer did a memory-based experimental intervention in an attempt to help participants exercise more.<sup>4</sup> They found that thinking about a positive memory had a significant effect on increasing



subjects' wellbeing. Consequently, a systematic exploration of lifelogged data and memories could affect future behavioral changes.

## LEGAL AND ETHICAL ISSUE

Wearing a camera in public clearly raises ethical, if not legal, questions. In many countries, it's legal to take pictures and videos in public places for personal consumption—such as for sharing with friends and family or even for posting online for noncommercial purposes (commercial use is a different matter). However, laws vary widely, even within EU member states. For example, although capturing public scenes in Denmark requires no consent, the same activity is illegal in Greece. Swiss lifeloggers, in principle, require consent, unless the captured individuals only appear incidentally—which would be the default for such lifelogging images. Wikimedia.org provides a comprehensive overview of consent requirements worldwide for photography at <http://tinyurl.com/d6b6fco>. Note that capturing officers, military installations and personnel, and governmental buildings is often not tolerated, even if it's technically legal.

The fact that something is legal doesn't make it socially acceptable. Although US laws don't require an individual's consent for images or video taken in public places, many people feel uncomfortable when encountering automated capture equipment—in particular, video-capture devices, such as Google Glass or Steve Mann's Digital Eye Glass. Mann—a pioneer of wearable lifelogging cameras—was assaulted in July 2012 in a fast food restaurant in Paris for wearing his Digital Eye Glass,<sup>5</sup> and in February 2014, a blogger was verbally abused and physically assaulted for wearing Google Glass in a San Francisco bar.<sup>6</sup>

Clearly, it makes a difference when the device is operated hands-free (and thus covertly) or functions automatically (see the "Practical Experience in Wearing a Camera" sidebar for more

## PRACTICAL EXPERIENCE IN WEARING A CAMERA

In our research with the European Project Recall (<http://recall-fet.eu>), we experimented with different wearable and stationary camera setups. The awareness of being recorded and of recording others and the environment fades rapidly. For most participants, it took only hours to forget they were recording. Even though signs on bathroom doors reminded people to take off their cameras, many bathroom visits were documented. On a potentially more serious note, one researcher in the experiment wasn't aware that he was still wearing the capture device when going through airport security—an area where all kinds of cameras are typically forbidden. Luckily, security personnel simply asked the researcher to remove the device, instead of requesting to inspect the images taken.

Wearing cameras in public and semipublic situations—such as in public transport or restaurants—prompted several people to inquire about the camera's function. Telling people that it automatically takes photos every 30 seconds often led to rather negative reactions. Even the explanation that the images were only for personal use often didn't help to assuage these concerns. This echoes similar experiences with the SenseCam.<sup>1</sup>

A further issue that we encountered was data loss when participants lost their cameras. Because wearable cameras are small and lightweight, and some are only clipped to a blouse or shirt, it's hard to notice when they get lost. Losing the camera is bad, but without any sort of authentication and encryption in place, anybody who finds it can access captured personal moments.

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information). Numerous people take pictures everyday using regular cameras or smartphone cameras—usually without any problems. For example, traditional video recordings are tolerated if they occur in a socially acceptable situation—such as at a school concert (if made by parents or school staff), on the slope using a mounted helmet camera, or at iconic touristic places. Google has published guidelines for its "Glass Explorers" about the do's and don'ts of wearing a Glass device, including not being a "Glasshole" and respecting other's wishes to take off the device (see <https://sites.google.com/site/glasscomms/glass-explorers>).

Beyond concerns for capturing lifelogging images are questions related to sharing, ownership, and security. Are you "publishing" the images when sharing them with "friends" on Facebook? What if the image is then shared in a country that doesn't require the subject's consent prior to commercial use? Finally, given how small such

devices have already become (consider the Narrative Clip in Figure 1b), it's easy to lose them—on the slopes or subway, for example. Although such a loss wouldn't be as critical as losing a government USB flash drive (see [http://en.wikipedia.org/wiki/List\\_of\\_UK\\_government\\_data\\_losses](http://en.wikipedia.org/wiki/List_of_UK_government_data_losses)), it nevertheless means that the finder of such a device has unrestricted access to potentially very private imagery. Incidentally, Narrative recently posted a blog entry on how to avoid losing the clip.<sup>7</sup>

Note that recording audio is usually much more regulated, because such recordings are often intimate nature and don't qualify as "public." Because recording devices are much easier to hide than camera devices, covert audio recordings are illegal in most jurisdictions.

The appearance of a new generation of highly portable, maybe even fashionable image-based lifelogging devices



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has the potential to disrupt our current understanding of what is “socially acceptable” in the same way that the Kodak Camera did over a century ago. Back then, it prompted society to reflect on an individual’s “right to privacy.” Soon, our lifelogging devices will require us to revisit such rights and maybe find a compromise between a right to privacy and a “right to remember.” ■

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**Katrin Wolf** is a senior researcher at the University of Stuttgart. Contact her at [katrin.wolf@vis.uni-stuttgart.de](mailto:katrin.wolf@vis.uni-stuttgart.de).



**Albrecht Schmidt** is a professor of human-computer interaction at the University of Stuttgart. Contact him at [albrecht.schmidt@vis.uni-stuttgart.de](mailto:albrecht.schmidt@vis.uni-stuttgart.de).



**Agon Bexheti** is a PhD student at the Università della Svizzera Italiana (USI). Contact him at [agon.bexheti@usi.ch](mailto:agon.bexheti@usi.ch).



**Marc Langheinrich** is an associate professor at the Università della Svizzera Italiana (USI). Contact him at [marc.langheinrich@usi.ch](mailto:marc.langheinrich@usi.ch).



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