Monitoring the mundane: wearable computing and our growing e-legacy

by Jamie A. Ward

If you were to die today, what information about yourself would you leave behind? If you use the internet - and who doesn't these days - then it's likely that the answer to that grim-sounding question is, `a lot'. Photos, emails, contact lists, notes, shopping records, personal diaries, and - increasingly - home videos; for many of us these things are not only stored electronically, but are also online.

And this is just information that you yourself generate. It does not include the vast amount of information about you - about all of us - kept by commercial and state organisations. Retail outlets and Visa know all about our shopping habits - what we bought and when; mobile phone operators know all about the phonecalls we've made and received (when and where and with whom). Our government (or some departments thereof) know the tax we've paid and the benefits we've drawn; they know whenever we board a boat or plane; they even have videos of us as we walk around town.

All of this information - from what you create and manage yourself to what is held about you by someone else - will probably still be around even when you are not. And with every new technology that emerges, this volume of information increases at a rate which is, literally, exponential.

One particular technology that promises to add vast amounts of data to our information legacy (or, at the risk of resurrecting the already dated fashion for prefixing anything to do with technology with an `e': our 'e-legacy') is wearable computing.

Wearables

A wearable computer (or simply, *wearable*) is a computing system worn on your body that is designed to help you in your day-to-day life.

An important requirement of a wearable is that it is aware of your context. It needs to be able to know what you are doing at all times so that it can act if and when its services are required. Where a traditional computer requires input from a keypad or mouse, the wearable gets its input from watching you.

The ways in which a wearable might do this are multifarious. With sensors on your body, such as cameras, microphones, electrodes or motion sensors, it might be able to detect details of your environment, your interactions with other people, your movements or your physiological state. It might also use GPS or WiFi to determine your location. Combining all of these, your wearable should be able to compile historical records of your activities so that it might predict how you will respond in future situations and adjust its behaviour accordingly.

The ideal wearable would be a `little brother', if you like, who watches your every move, learning from you, and helping you out when and wherever it can. (See sidebox on *What your wearable might do for you*).

From little brother to Big Brother

Such talk of a wearable recording your every move raises the inevitable spectre of surveillance by the state (and other undesirables). This is not a concern to be brushed aside lightly: as the information about you grows, so too do questions of ownership and who has the right to see it.

Will not your wearable, your `little brother,' make it even easier for others, perhaps the ominous, 'Big Brother,' to invade your privacy?

The only truthful answer is,`It might.' But those same privacy violations may well be even worse without wearables.

How so?

The fact is that the amount of information about you will continue to grow whether you use a wearable or not - and there is not much that the average person can do to stop that.

What you can do, however, is prevent the state (and other organisations) from holding the monopoly on this information.

This is the argument given by Steve Mann, a wearables user who's been plugged into his computer since the early 1980s[1]. He sees wearables as the logical democratic answer to external surveillance: they provide a means for `sousveillance', or `watching from beneath'.

If the state, for example, is the only one pointing cameras at people and is the only one collecting information on them, then there is no-one to challenge it's assertions should they be, in fact, wrong. The wearable, a strictly personal device, lets you redress this by acting as an information counter-weight: you, the citizen, can be watching them too.

Wearable life recording

One consequence of your wearable's ability to record such vast amounts of detailed - and personal - information about you, will be the possibility for you to go back at a later date and retrieve information from your past.

Thad Starner[2], another long-term wearable user (he's been wearing his wearable since 1993), is one of several researchers who envisage `remembrance agents', a kind of electronic memory augmentation. This is where your wearable picks up important pieces of information and events from your day-to-day - names, addresses, directions, random facts - and reminds you of them when appropriate.

The agent could also be used to record visual and audio data. In a study on long term life monitoring undertaken while at MIT, Brian Clarkson strapped some gyroscopes, a microphone and a couple of fisheye cameras onto his backpack and clothes, and began recording himself for 100 days.

This experiment yielded over 500 gigabytes (500 x 1'000'000'000 bytes) of raw data.

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1   Mann is often credited, among other things, of being the first human cyborg. See his website on http://www.wearcam.org.
2   http://www.cc.gatech.edu/fac/Thad.Starner/

Seems like a lot? But with the current rate of technological advancement[3] that volume of storage will be cheap and small enough for most of us within the next few years.

What this shows is that it may soon be possible to use a wearable to record your entire life. All of the places you've been, all of the things you've seen, all the people you've met, what you've said, what you've done...

Assuming the average wearable recorded data at an equivalent rate as in Clarkson's experiment, and assuming you live for about 80 years, then nearly 150,000 gigabytes, or 150 terabytes would be required[4]. A small footprint, technically speaking, for an entire lifetime.

Our e-legacy

But why would we want to record our life - and why in such detail?

One only has to look at the growth of all those websites where angst-ridden youths pour out every detail of their lives for everyone and anyone with a web browser to see. Most of us, I suspect, myself included, want to leave a mark on the world. We want to show our peers that we are interesting; we want to remind future generations that we existed. And we, as humans, are fundamentally and irrepressibly obsessed - with ourselves.

In days gone by, when information was expensive, the only lives that got recorded were those of infamy or artistry, or both; only the poet, the architect, the illustrious Pope or the bloodthirsty King got to leave their mark.

But technology changed all that. You probably have a photo or two from when your grandparents were young; from your own youth there is probably an album or three; now, with flickr and YouTube, you can have thousands of photos of yourself, reams of heartfelt verbal ramblings, and hours of streaming video - and all for the world to see, should they wish to.

Who's to say, perhaps in ten years from now we'll all be uploading our wearable-recorded highlights of the day. And hoping, just hoping, that someone will want to look at it after we've gone.

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3   Moore's law, named after Intel's Gordon Moore, implies that storage capacity will double roughly every 18 months - an exponential increase. And as capacity goes up, storage cost and device size comes down. He predicted it in 1965 and remarkably, over 40 years on, it still holds.
4   According to google, 150 terabytes was the space required to store the entire world wide web in 2005. But according to Moore's law, this should be the size of most hard-disks within a decade.

Sidebox: What your wearable might do for you

There are, roughly, four main application areas commonly envisaged - in healthcare, work, lifestyle and home. Here are some samples of what form these might take[5].

Healthcare-

With many types of cardiovascular complaint, serious problems can be predicted days in advance simply be monitoring a patient's ECG signals. But for this to happen, readings needs to be carried out continually. A wearable heart monitor would allow this data to be collected in a natural and continuous way - and without the expense and inconvenience of high-risk patients being confided to a hospital bed.

At work-

Industrial tasks, particularly those carried out by mobile maintenance or assembly workers, increasingly require adherence to stringent regulations regarding how the task is done and what safety measures are taken. Using wearable sensors embedded in a worker's clothes, it should be possible to infer what task he is currently engaged in - and where. This opens the possibility for several applications ranging from automatic tutorials and reference manual access, to safety monitoring and task validation.

Imagine an aircraft engine maintenance scenario. It is essential that the mechanic places certain bolts in their correct position. If he gets distracted and forgets to do this, his wearable, which has been monitoring his progress, should be able to remind him.

Lifestyle-

As the `baby-boom generation' edges into retirement, many people start to look for technologies that might hold back the process of ageing and enhance their quality of life.

For those concerned about their diet, a future wearable may be able to monitor what you have been eating. By comparing this information to your physical exertion, the wearable should be able to approximate your
overall calorific intake.

To fend off the curse of back pain, there will soon be wearables to help detect and prevent your bad posture (perhaps with an electric jolt to your spine, `Sit up!').

And the hearing aid, perhaps one of the first and most well-known wearable computers, will soon be joined by wearable navigation and reading aids to assist the blind and partially sighted.

At home-
Imagine you are about to bake a cake but you don't know how. Programmed with the correct instructions, your wearable, perhaps in liaison with the kitchen facilities and an interactive video screen, could monitor and guide you through the recipe.

Another application is the wearable financial assistant. Because your wearable is always with you, it will be able to automatically keep track of everything you buy.

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5   Many of these ideas are taken from current research at ETH Zurich, see http://www.wearable.ethz.ch

It could control access to your bank account, credit cards, phone bills, etc. It would be able to keep you informed on how much money you have and whether the new washing machine you are considering can be found cheaper somewhere else.