Computerised clothing will benefit textile manufacturers

Cliff Randell predicts opportunities for textile manufacturers who can integrate sensing and display technologies into their products, so enabling consumers to interact effectively with wearable computers.

Almost every day we learn about new computing devices (such as mobile telephones, Personal Digital Assistants (PDAs), MP3 audio players) that are designed to be carried around by the user.

Today, these products are a mere fraction of the size of their functional equivalents of ten years ago: a state-of-the-art computer that sat on the business executive's desk in 1990 had the same processing power as the onHand PC that can be worn on the wrist today. Scientists at the Massachusetts Institute of Technology are currently investigating the potential uses of computer processors that are the size of a grain of sand.

Already garment manufacturers are seeing the need to accommodate this new technology in their products. Pockets designed to carry mobile 'phones are being designed into jackets and trousers – Levis/Philips have even included a control system for mobile 'phones and MP3 players in their latest range of outdoor clothing. The demand for technically smart clothing will grow as applications for networking computer-based devices on the body are developed.

Potential applications go beyond communications, mobile email, listening to music and ebooks, and organising personal data – in the future body worn computers will be able to learn about the user's day to day activities and anticipate the user's needs.

Context Aware Applications

We are used to our computers knowing **who** we are. Every time we switch on, or log into, our computer it returns to our preferred settings and offers the previous pieces of work which we had most recently been addressing. Our bookmarks are available, as can be our address book, diary and personal accounts. In the future our computers will also know **where** we are, **what** we are doing and **how** we are feeling.

Already mobile phone applications are providing location-based services, and we are also able to use the Global Positioning System (GPS) with PDA's and in cars to determine our current location – which can then be displayed on a map. U. S. legislation requires that by the end of this year all mobile phones will be able to make available their position to emergency services with an accuracy of 50m.

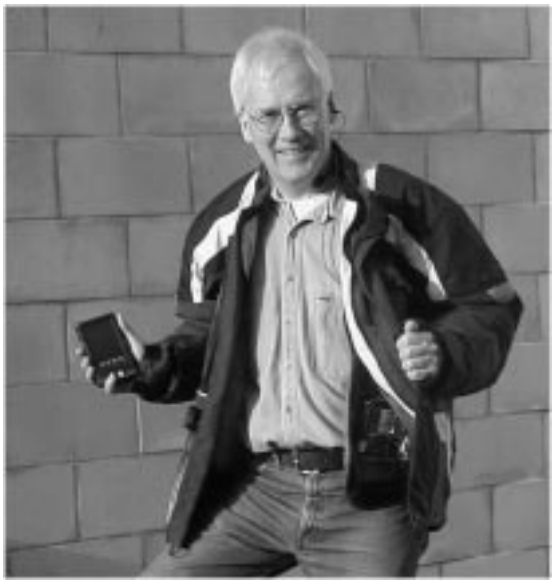
The placement of accelerometers and/or resistive sensor strips in clothing make it possible to determine 'what' activity the user is performing, and to modify a computer's behaviour accordingly. Biosensors, such as heart rate and skin conductivity monitors, are able to measure 'how' well we are. Combinations of this contextual data can enable body-worn computers to react to the user's behaviour and condition to provide timely and useful information both to the user, and in extreme situations, can even call for assistance.

The Bristol CyberJacket

The Bristol Wearable Computing project – a collaboration between the University of Bristol, U.K. and Hewlett-Packard Research Labs, Europe – has developed a 'CyberJacket' which provides a platform for developing and testing wearable computing applications. The CyberJacket is based on a heavy duty Hein Gericke outdoor leisure jacket. Built into it's lining is a network computer along with a number of context sensing devices including a GPS receiver, ultrasonic indoor location sensors, an electronic compass and accelerometers. The user interface includes speech recognition and audio playback, and displays can be handheld, headmounted or worn on the sleeve.

We have developed a Tourist Guide which uses GPS data to determine the location of the wearer and an accelerometer sewn into a pocket to monitor the user's activity. When the CyberJacket detects that the user is approaching an interesting place a short audio message is played through an earpiece. If the user reacts by stopping, a page of relevant information appears on the sleeve.

Another application senses the proximity of a shop and, using a wireless link, sends the user's shopping list to the shop's database. If the shop has any of the items on the list, the user is alerted and a list of the items available – with their prices – is displayed on the sleeve of the CyberJacket. We are interested in developing this further to bring more information on products to the user as she moves around the shop – and also to enable payment for items purchased to be made automatically on leaving the shop. There is also potential for shops to alert the user to special offers, though we also recognise the need for the user to be able to switch off some of these features!



The author, Cliff Randell, seen wearing the Bristol CyberJacket

Our research is continuing on applications that bring information from the 'virtual world' to the user in the real world. There already exists a large amount of data relevant to everyday life, much of it available on the world-wide-web, our goal is to make this readily accessible – providing the right information at the right time and in the right place. This could be giving directions to the nearest vegetarian restaurant – or providing improved vision to the partially sighted.

Garment Properties

It is unlikely that a user would want to wear a fully equipped CyberJacket for much of the day. Already we see people carrying different combinations of electronic devices depending on their activity – a mobile phone and PDA are useful for the office, but the PDA is left behind and a digital camera carried for a trip out with the family. An MP3 player helps reduce the tedium of long journeys. We expect that computing devices and sensors will become integrated into the clothes associated with particular activities:

- a pair of running shorts monitoring and recording heart rate, activity level and location;
- a business suit with a phone interface in the lapel and PDA display on the sleeve;
- an anorak with location sensing, electronic compass and altimeter.

Garments will need to support these devices in many different ways. We have already seen the introduction of pockets for computerised technology, and experiments have been carried out with electrically conductive fibres, such as silk organza, and with fabrics incorporating

metals for hygienic purposes as well as for interconnectivity. There are three other aspects which researchers are investigating which could transform the ways in which we use our clothing. These take advantage of:

- the proximity of our clothes to our hands - to provide control input surfaces;
- the shape and movement of our clothes - to monitor our actions; and
- the visibility of clothes – to provide display surfaces.

Input Surfaces

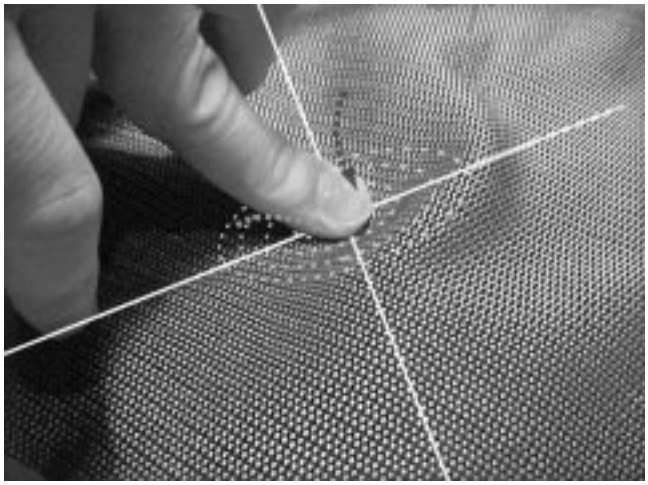
The conventional computer keyboard is obviously unsuitable for day-to-day wear. Using speech to control our wearable computer is an ideal solution, however we are many years away from achieving user independent continuous speech recognition in noisy environments. Indeed once adequate speech recognition has been achieved, we will still want to be able to control our wearable computers in a more discrete manner. The solution to our immediate needs, and for future discrete control could lie in touch sensitive fabrics.

WRONZ, a New Zealand-based textile research and development organisation and electronic materials company Peratech Ltd. of Darlington, County Durham, UK, have jointly developed a product called Softswitch (see also *Technical Textiles International*, September 2000 pages 18-19). Using this technology they are able to create electronic interfaces that appear and perform like quality textile fabrics, without compromising the feel or the fashion elements of the garments it is built into.

Activity Monitoring

An important aspect of wearable computing is ensuring that the computer on your body only alerts the user at the appropriate moment. Constant interruptions from a poorly programmed machine would inevitably lead to irritation and rejection of the technology. The ability to monitor the users activity is thus a key factor and our clothes are best placed to provide this information.

Fibres that can detect pressure and orientation could provide data to help derive facts about the user's activity. In practice the user would have to train the clothing to recognise various activities and thereafter the computer would be able to judge the appropriateness of alerting the user to potential valuable information.



ElekTex™ is a smart fabric that provides pressure readings according to force and area. For instance, this allows the computer to differentiate between separately identified inputs ranging from high-speed impact to gentle stroking.

ElectroTextiles is a switching and sensing company that combines expertise in electronics, software, fabric structures and production engineering. ElekTex™ is a smart fabric that provides pressure readings according to force and area. For instance this allows the computer to differentiate between separately identified inputs ranging from high-speed impact to gentle stroking.

The fabric structure can be designed to be sensitive to fluctuations in pressure within the required range for a given application. Pressure response ranges can be targeted anywhere from 0.2psi to 30psi currently, with development progressing on ranges suitable for up to 100psi. Using multiple layers, fabrics can respond to multiple ranges of pressure, or other variations of force and area.

Displays

Current displays for wearable computer are generally head-mounted or hand held. Neither of these options are ideal – head mounted displays interfere with normal everyday activities and interaction with others. Handheld displays are often inconvenient, especially when the user's hands are already busy. A sleeve mounted – or integrated – device could provide a display at a suitable distance from the eyes without undesirable side effects.

Du Pont and Cambridge Display Technology are actively researching wafer-thin flexible displays made of light-emitting conductive polymers that could replace newsprint. The daily newspaper could be downloaded from the Internet and read at leisure in much the same way as we read newspapers today. This technology could also be incorporated into clothing to produce conveniently located displays with none of the disadvantages of head-mounted or hand held displays.

The ability of fabrics to act as displays not only has uses for the wearer, but also for others. A display or fabric showing the user's mood could encourage – or discourage – others to approach the user. A warm red glow indicating contentment, or a dark blue to warn colleagues that the user has had a bad start to the day! Already heat and moisture sensitive dyes have been used by fashion designers to produce dresses that change colour according to the wearer's body temperature and environment.

More will follow

Continued development of computer technology is leading to the feasibility of intelligent devices that can be embedded into garments. Research into the application of these devices has revealed a number of potential uses that will be of appeal to consumers. Already applications are being developed which are likely to create a demand in the marketplace. The consumer has shown willingness to adopt computer technology as part of everyday life and we foresee a multitude of devices and applications that will employ textiles in new and exciting ways. The opportunities for textile manufacturers to integrate sensing and display technologies into their products to enable users to interact effectively with wearable computers.