How touching

Computing: "Haptic" technology is gradually bringing the neglected sense of touch into the digital realm

THE smooth, touch-screen display on Apple's snazzy new iPhone, unveiled in January and due to go on sale in June, has gadget fans salivating. In place of the usual keypad, the iPhone uses the screen as an input device, displaying different buttons and icons depending on the task at hand. Rival devices from other handset-makers, including LG and Samsung of South Korea, take a similar approach. Replacing physical buttons with virtual ones certainly makes for greater flexibility—but might it make the phone trickier to use? You can tell when you've pressed a real button because you can feel the subtle "click". But typing on the iPhone, in contrast, is said to be rather fiddly, because there is no such tactile feedback with a touch screen.

That is why Samsung's touch-screen phone, despite being less well known than Apple's device, is worth watching. The SCH-W559 handset, which is so far available only in China, fools the user's sense of touch and mimics the feeling of pressing a mechanical button, even though the surface is actually completely flat. It is the latest example of a new breed of "haptic" technologies that do for the sense of touch what lifelike colour displays and hi-fi sound do for eyes and ears.

Haptics is the science of simulating pressure, texture, vibration and other sensations related to touch. The term is derived from a Greek word meaning "able to lay hold of". Devices that exploit haptics have been around for decades: many modern aeroplanes, for example, have haptic control columns that shake or vibrate to warn the pilot of an approaching stall. The technology has also found its way into video-game consoles, where it adds an extra layer of realism. Players can feel when they are veering off course in a driving game, or when they have been hit in a shooting game. Force-feedback technology, another offshoot of haptics, is used in robotic telesurgery and in surgical simulators to enable surgeons to feel resistance as they move their surgical instruments around, just as they would in conventional surgery.

Even the "vibrate" mode on a mobile phone, which discreetly alerts the user to an incoming call or text message, is an example of haptics. But today's technology fails to take full advantage of the sense of touch. It has particular potential in relaying information to people when their other senses are occupied, as when walking or driving, says Karon MacLean, a researcher at the University of British Columbia in Vancouver, Canada.

Vic Viegas, the boss of Immersion, a company based in San Jose, California, agrees. His firm owns important patents in the field of haptics, and the touch-screen feedback in Samsung's new phone relies on the latest incarnation of Immersion's VibeTonz technology. In previous handsets, the technology was used to provide force-feedback effects when playing games and to provide "vibrotactile feedback" when playing music. "It feels like a sub-woofer," says Mr Viegas.

Feel the force

The new phone goes much further, using very precise actuations of its built-in motors to produce realistic, button-like clicks whenever an onscreen button is pressed. "Using a touch-screen, you normally lose the tactile confirmation you get from pressing a button," says Mr Viegas. But with haptic feedback, on-screen buttons can be made to feel real and are easier to use. "You get the feeling that you have somehow really touched this object on the screen," says Tapani Ryhanen, head of strategic research at Nokia, the world's biggest handset-maker, who has been investigating the idea of adding haptics to Nokia's phones as well.

Most of today's haptic devices rely on motors that either prod or vibrate the skin, but a new technology is emerging that is an even more flexible and effective means of stimulating the sense of touch: skin stretch. By laterally stretching the surface of the skin (without pushing or pok-1

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ing into it) it is possible to mimic the feeling of complex shapes and sensations. This is because the sense of touch seems to depend far more on the way in which the skin is deformed and stretched than it does on the degree of pressure applied. So it should be possible to recreate sensations purely by stretching skin, says Vincent Hayward, a researcher who first developed such a device at the Centre for Intelligent Machines at McGill University in Montreal, Canada.

"It's analogous to watching a TV screen," he says. The human eye can be tricked into seeing a range of colours on a video display, even though it really only consists of tiny red, green and blue dots. In much the same way the sense of touch can be fooled into feeling shapes and textures that are not there, says Dr Hayward. In one dramatic example Mexican and Italian researchers showed that a flat surface could be made to feel sharp. The effect was so realistic that subjects were able to match different configurations of simulated sharp edges to corresponding images, says Gabriel Robles-De-La-Torre, a neuroscientist and computer engineer based in Mexico City who carried out the experiment and is the founder of the International Society for Haptics.

What a feeling

When someone moves a finger over a sharp surface, typically both vertical and lateral forces are applied to the skin, says Dr Robles-De-La-Torre. Using a haptic interface called GRAB, which was developed by Carlo Alberto Avizzano and his colleagues at the Scuola Superiore Sant'Anna in Pisa, Italy, the researchers showed that a realistic sensation can be created using skin-stretch alone, and leaving out the vertical forces. The device consists of a thimble on a motorised arm. Using the motors to apply short bursts of very precise resistance it applies slight lateral stretches to the skin of a fingertip passing over the thimble, giving the impression of a sharp edge.

The ultimate aim of this sort of research would be to find ways to simulate any kind of shape, sensation or texture, says Dr Robles-De-La-Torre. "The holy grail for me is to do fur," says Dr MacLean. There is a long way to go, but it should eventually be feasible, she says. One of the difficulties of simulating textures, says Dr Hayward, is that the sensation of texture depends on the interaction between the surface and tiny ridges in the skin at the fingertips. In theory, it should be possible to stimulate these ridges individually using micro-electromechanical systems (MEMS) technology, but so far nobody has tried, says Dr MacLean.

For his part, Dr Hayward has been experimenting with other uses for skin stretch, and has developed a new type of haptic switch for use in mobile devices. The THMB (pronounced "thumb") takes the form of a sliding button on the side of a handheld computer or mobile phone, like those used to adjust the volume or scroll through a list of contacts. But the THMB can also communicate information back to the user, since its surface consists of an array of 64 tiny rods, each of which can be moved in relation to its neighbours. When a thumb is placed on the device, the rods are computer controlled to move and stretch the skin just enough to fool the nervous system into feeling various sensations.

Dr Hayward's idea is that such switches could be used to convey information to the user without the need to look at the device. Skin stretch could be used to present the tactile equivalent of icons to the user, rather like a simple form of Braille. So far Dr Hayward has shown that people can indeed learn to recognise symbols through touch, though it is unclear how many symbols they can accurately distinguish between. Nokia has been following the research closely, says Dr Ryhanen. It might, for example, someday be possible to tell who is calling your phone just by reaching into your pocket or bag and touching it, he says.

Exactly what haptic devices will be used for is still unclear, but they seem destined to become more widespread in future. In the short term, one trend in particular will drive adoption, Mr Viegas predicts. "The world is rapidly moving towards having touch screens in most devices," he says. The launch of the iPhone will accelerate this trend, since it is bound to spawn many imitations. "It's going to have a huge impact," says Mr Viegas. Strategy Analytics, a consultancy, predicts that 40% of new mobile phones could have touch screens by 2012—though if haptics takes hold, perhaps "touchy-feely" screens would be a better description. •

Fonte: The Economist, v. 382, n. 8519, p. 24-25, 10 Mar. 2007.