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ScienceTalk

Electronic skins – fiction or reality?

Advanced stretchable electronics open doors to skin-like devices that could potentially personalise beauty regimes, track health indicators and make robotics smarter.

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Skin is our interface to the physical world. It not only protects us from harmful environmental effects, but also provides the touch sensations needed for our daily activities.

In addition to touch, our skin senses temperature, humidity and even gentle breezes, giving us a rich experience of the physical world.

Our skin also lets us communicate socially, such as via a warm and firm handshake to form an emotional connection with someone new. In fact, when you lose the sense of touch – as can happen in accidents or from chronic health conditions like diabetes, or chemotherapy-induced nerve damage – the numbness can be debilitating.

Today, scientists and engineers in Singapore and worldwide are creating technologies that realise the potential of making electronic devices behave like skin. This forms a relatively new and emerging field of research: electronic skins.

Inspired by skin, we can make electronic devices soft and compliant. This means we may no longer need to have rigid and bulky mobile phones in our pockets. Instead, we can have skin-like phones directly integrated into our clothes.

There are already some examples that point to such a future; for example, the tie-up between technology companies and traditional textile apparel designers, such as Google and Levi's, or upcoming foldable phones. The ability of electronic devices to behave like skin and transmit touch feedback can also facilitate faster and easier human-robot interactions.

One of the major difficulties in creating robots that can collaborate safely with humans is the lack of accurate and fast touch sensations. As a consequence, most of today's robots are confined to relatively simple pre-programmed tasks.

Robots have yet to be able to quickly self-learn new tasks or correct errant motions elegantly, because they do not have the rich sensations that an electronic human skin analogue provides.

Providing rich sensations via a robotic skin can allow them to rapidly learn new skills, especially when coupled with new machine learning techniques.

Such electronic robo-skins can enable the factories of the future to have robots that can be trained in a day, with highly skilled humans working alongside robots that intelligently take care of many menial tasks.

As these robots prove their worth in more controlled factory environments, they can eventually be deployed to non-factory environments such as healthcare settings, schools, homes and even space travel.

In order for electronics to stretch, twist and bend like skin, new materials, devices and process technologies are needed.

Traditional electronics, such as those found in smartphones, use silicon, which is a relatively hard and brittle material.

However, the transistors found in silicon devices are getting extremely small, such as the recently announced 10-nanometre devices – 5,000 times smaller than the diameter of a single strand of human hair – by Intel and other major semiconductor manufacturers.

This dramatic size reduction of the basic building block of computers creates tremendous opportunities to build digital devices that can be combined with flexible and stretchable materials, such as plastic or rubber, to create skin-like electronics that are high-performance and mechanically robust.

Furthermore, advances in plastic materials open up possibilities of integrating new self-healing functions to these electronic skins. Such efforts may help to reduce waste and promote the sustainable use and development of electronics.

Creating electronic skins can also allow us to better track health and wellness. For example, we can engineer skin patches that record skin hydration levels and chemical exposure, lowering the chances of dehydration in outdoor activities.

These devices can also measure skin elasticity and help to determine how fast your skin is ageing.

These exciting applications will allow cosmetic companies to develop companion skin-wearable devices that help to tailor precise formulations to an individual's lifestyle.

At the National University of Singapore, the Hybrid Integrated Flexible Electronic Systems programme is working with French skincare and cosmetics label Clarins on an exciting research collaboration in this area.

The team is looking into developing wearables that can be used to detect changes in the environment and gain a deeper understanding of its impact on skin health.

The transformation of computing – from giant room-filling supercomputers to one small enough to fit in a pocket, for instance – via materials science and electronics engineering has marked major technological progress and milestones in human history.

The continued advancement of skin-inspired computing devices will be another exciting frontier.

This effort brings together researchers across disciplines like medicine, engineering and design to create impactful technologies and applications that are far more than skin deep.

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