DIY electronics: This sensor with a multi-touch surface can be cut into virtually any size or shape using a pair of scissors – all the while retaining full functionality.
Displays
Straight from the Printer

His research looks hip and colorful. The prototypes are made from wood, paper and plastic. Cut, printed or pressed. But there’s more to them than meets the eye: Jürgen Steimle and his team at the Max Planck Institute for Informatics and at Saarland University in Saarbrücken are concentrating their efforts on a fully interconnected world in which, for example, computing devices are activated via skin-worn sensors.

TEXT GORDON BOLDUAN

aped to the office wall is a science poster informing readers about miniature screens on fingernails. Mounted next to it is a pegboard with screwdrivers, pliers and even hammers. Suspended from the ceiling is a camera system composed of aluminum insertion rails and six infrared cameras, and across the rough gray carpet, numerous electric cables snake their way around stacks of transparent plastic boxes.

One of the tables is covered with myriad notepads surrounding a black keyboard and a flat-screen monitor. At the very center stands the balsa wood prototype of an apparatus, back to back with a structure consisting of acrylic glass, micro-controllers, circuit boards and colorful plastic wires.

These are the kinds of contrasts that Jürgen Steimle brings together, not only in his laboratory, but also in his research. The sign on the door reads “Lab Space.” Steimle set up this area for his students and doctoral candidates at Saarland University’s Cluster of Excellence on Multimodal Computing and Interaction, where he heads the independent research group on Embodied Interaction. He also conducts research at the Max Planck Institute for Informatics, which is within walking distance of the university building.

COMMUNICATION IN AN INTERACTIVE WORLD

Jürgen Steimle and his students are convinced that, a few years from now, every object will contain a computer. That’s why their focus lies on the principles that make it possible to work and communicate with the hidden electronic components in such a completely interactive world.

Mobile terminals with impractical designs not only irritate users in day-to-day life – they also become the object of ridicule. Social media platforms such as Facebook are full of popular posts predicting how clunky smartphones or the Apple Watch would look if engineers had designed them a decade ago with the technology available to them at that time.

What the scoffers fail to account for, however, is that even the most modern technological possibilities are often far from ideal for users. “Today, if I want to activate my smartwatch via touch input, I have only a small display available, and most of it will be obscured by my fingers,” explains Jürgen Steimle, referring to what his colleagues call the “big thumb problem.”

The 35-year-old computer scientist studies what happens when product development focuses solely on what is technologically feasible, and seeks to tackle the problems that arise as a result by nipping them in the bud: “The shape of devices must not be restricted to the limits of today’s technology! Only then can we develop customized
forms of interaction that can be integrated into items and objects that we use in our real world in so many different ways,” explains Steimle. One of the tools he uses for this purpose is user studies. His goal is to develop the modes of interaction of the future.

**BASIC RESEARCH ON TWO LEVELS**

“Printed electronics is the key technology for us right now. It allows us to develop electronic components that have entirely new properties and are ultrathin, shapeable and even stretchable. They no longer bear any resemblance to conventional computers,” says Steimle. By adopting this approach, he conducts basic research on two levels at the same time: based on systematic surveys, he designs completely new modes of interaction; and he implements the latter using technologies that themselves are still in the development phase.

A huge shelf divides the “Lab Space” into two parts, with the right half being reserved for the workbenches and electronic equipment. The members of Steimle’s group – three doctoral students and two master’s candidates – have gathered in the left half of the room. They’re sitting at two tables that were pushed together in front of a wall, and stuck to that wall are a number of round, yellow cue cards with handwritten notes; on one of the tables, Steimle placed a workshop kit filled with colored markers and pieces of construction paper cut to size.

Steimle sits at the table with his back facing the window, which offers a view of Saarbrücken’s informatics campus, including the Max Planck Institute for Software Systems, the Intel Visual Computing Institute and the Center for Bioinformatics.

Using creative techniques and the right tools to find answers to questions in a group setting is a method that the researcher became well acquainted with during his time at the Massachusetts Institute of Technology’s Media Lab,
Working on the future: The research conducted by Jürgen Steimle (left) and his team focuses on developing electronic components with entirely new properties. This includes the iSkin sensor, which detects touch input on the user’s skin. The sticker pictured on the right was designed for the forearm and is used to activate a digital music player. The researchers integrated a number of touch keys – for “Play/Pause,” “Fast Forward,” “Rewind” and “Volume.”

where he worked as a visiting assistant professor in 2012 and 2013. Steimle’s career began in 2009 when he published his doctoral dissertation, which the German Informatics Society (GI) distinguished as being the best in the German-speaking countries.

Since 2013, Steimle has been working as an independent head of a junior research group at the Cluster of Excellence in Saarbrücken. The Cluster of Excellence introduced this position to grant its currently 15 researchers the freedom to set up or expand their own groups and define their own agenda. In order to ensure that they have the scientific liberties they require for their work, each team receives a budget. Furthermore, all heads of junior research groups are allowed to supervise their own doctoral students.

Daniel Gröger is the newest member of Steimle’s team. Since October of last year, the doctoral student has been working on a completely new three-dimensional printing method. So new, in fact, that Steimle swears his students to secrecy and urges them to refrain from broadcasting the news to the international tech-blogger community via Facebook or Twitter.

AN ELASTIC SENSOR WORN ON THE SKIN

Speaking in English and using short, precise sentences, Jürgen Steimle outlines his expectations regarding the upcoming brainstorming session. He’s looking for applications for the components that can already be printed in three dimensions. The group’s task is now to jointly come up with ideas. Everyone grabs one of the colored, rectangular cue cards. For the next few minutes, the only sound heard in the room is that of markers scribbling away.

However, in the case of the most recent project, iSkin, with which Steimle’s doctoral student Martin Weigel is currently causing a stir around the globe, the researchers opted for a different approach. “We made a conscious decision not to start out with the technology, but to use the skin as a natural medium instead,” says Steimle. Skin has a larger surface area than any smartwatch. They conducted a survey among 22 participants – 25 years old on average – and asked them what kinds of actions they would perform on their skin if it could serve as an input sensor for mobile terminals.

“Interestingly enough, an additional dimension came to light: expressive interaction. When physically interacting with their skin, the users didn’t just touch it – they also pressed it firmly, pulled it or even twisted it,” says Steimle. Based on these insights, the researchers developed a prototype of a sensor.

“It is the first elastic, skin-worn sensor that can be used to interact with computing devices,” says Steimle. The elasticity posed a considerable challenge, he recalls, because it requires conductors that don’t break when stretched. To solve this problem, the computer scientists from Saarbrücken collaborated with materials scientists from Carnegie Mellon University in the US. The latter had devised a method of combining different types of silicone that would be suitable for this kind of sensor.
Furthermore, silicone is a skin-friendly material that can easily be affixed to the skin using a medical adhesive. Pressing a particular part of the sticker would allow you to take an incoming phone call or adjust the volume of your headphones, for example.

AESTHETICS MATTER, TOO

Yet the scientists from Saarbrücken didn’t content themselves with merely solving the device’s functionality issues – not by a long shot. “Our goal was to create a sensor that truly takes a person’s individual sense of aesthetics into account. This means it needed to look good and make a visual statement that the respective wearer can identify with,” says Steimle.

For that reason, the researchers also developed procedures that allow designers to turn lines, shapes and silhouettes into iSkin sensors according to their own personal taste. The result: when placed on the skin, the semi-transparent control interfaces look like artistic tattoos and no longer bear any resemblance to conventional control elements.

Back in the brainstorming session, the members of Steimle’s team are now taking turns presenting their ideas by holding up their cue cards to show the drawing and explaining it in a nutshell. Next, the cards are stacked at the center of the table and everyone takes a few to add their own notes and then hand them to the person on their right. The cards are passed around the table for the next 15 minutes. Many of them make Steimle smile, and some of them even prompt him to grab a new card so he can add additional thoughts in small letters using a broad marker.

This method of continuous reflection is also evident in his projects. Another major goal that Steimle’s group has set itself is devising a simple method that would allow average users to adapt technology to their own personal needs. Steimle and his doctoral student Simon Olberding have already come up with a solution to this problem by building a prototype of their project called PrintScreen. The prototype is set up on a separate table for demonstration purposes.

A postcard depicting a vintage automobile serves as an example. When a button is pressed, the rear axle and steering column light up in the same color. This is made possible by two segments of a flexible display that have the same shape as the car parts. Steimle’s group
Our world is becoming increasingly interconnected. Researchers predict that virtually every object will contain a computer in the near future. Printed electronics are currently regarded as being a key technology. Thanks to these components, scientists can develop computing devices that boast entirely new properties and are ultra-thin, shapeable and even stretchable.

Jürgen Steimle and his team study the principles of working and communicating with these embedded computers. The scientists are researching a new method for printing personalized computing devices, for example. In another project, they focus on human skin as an input sensor for mobile terminals.