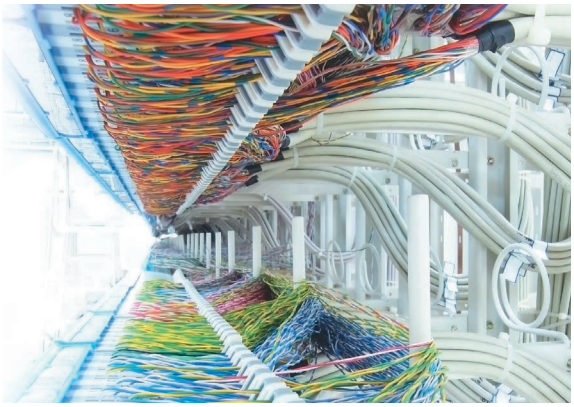
Gestural Technology: Moving Interfaces in a New Direction



Lee Garber

Gesture-based interfaces—which let users control devices with, for example, hand or finger motions—are becoming increasingly popular.

Earlier this year, Leap Motion released a highly publicized device that lets users control applications on nearby computers via hand and finger gestures.

While industry observers differ over just how useful the controller is, the sale of the product—along with the release of the Microsoft Kinect game controller three years ago—marks a step forward for commercial gestural-interfaces use.

These interfaces utilize gesture-recognition algorithms to identify body movements. The systems then determine which device command a particular gesture represents and take the appropriate action. For example, moving a hand sideways might mean that a user wants to turn a page on an e-reader screen.

Proponents say gesture recognition—which uses computer vision, image processing, and other techniques—is useful largely because it lets people communicate with a machine in a more natural manner, without a mouse or other intermediate device.

Although the technology has long been discussed as a potentially useful, rich interface and several gesture-control products have been released over the years, it has never achieved mainstream status.

That may be in the process of changing, though, as a number of new products and research projects are using gesture recognition and advancing the technology.

But the process will face challenges. For example, some experts say there aren't enough compelling applications yet for gesture recognition to make the approach commercially viable.

WHAT'S NEW?

Gestural interfaces have been the subject of research for more than 40 years.

Microsoft's 2010 release of the highly popular Kinect motion-sensing input device for the Xbox 360 game console and Windows computers marked a major step forward for gestural interfaces in the marketplace. The company sold 8 million of the devices in the first two months they were available.

Growing interest

Gestural-interface technology is experiencing increased interest for several reasons.

"People are carrying around technology wherever they go," said Michael Zagorsek, Leap Motion's vice president of product marketing. "They want it to be easier to work with. I think that's why there's this groundswell of support."

Also, technology advances have made gesture detection more feasible and affordable, said Fanie Duvenhage, director of the Human-Machine Interface Division at Microchip Technology, a maker of microcontroller and analog semiconductors.

These advances are in areas such as performance in low-cost, low-power processors; algorithms; 3D cameras; and signal processing, he noted.

Unlike a few years ago, embedded-computing platforms can now handle the processing required for machine vision, a critical part of gesture recognition, said Amnon Shenfeld, vice president for R&D at gestural-interface vendor Eyesight Technologies.

Rob Enderle, principal analyst with the Enderle Group, a market research firm, said gesture technology is becoming more popular primarily because it's yet another feature vendors can use to make

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their products seem more desirable to potential customers.

Leap Motion Controller

Leap Motion (www.leapmotion.com) released its long-awaited first product earlier this year. The Leap Motion Controller is a small peripheral that plugs into a USB port and sits on a desk or table in front of a Windows- or Mac-based computer.

Using two cameras to capture motion information and three infrared LEDs as light sources, the system tracks the movements of hands, fingers, finger joints, pens, or several other objects in an area 2 feet in front of, to the side of, and above the device, as Figure 1 shows.

Whereas Kinect traditionally tracks large full-body movements, the $79.99 Leap Motion Controller detects small, subtle motions and is accurate to within 0.01 mm.

According to Leap Motion's Zagorsek, some gestural systems use large cameras that extract a lot of data from an area, requiring considerable computational analysis, which can cause latency. The company's controller has little latency because it uses a small camera and its algorithms extract only the data required for the task at hand, he explained.

Other algorithms let the system precisely recognize small objects and their movements, he added, which enables increased accuracy and the use of small gestures.

Because the system is small and largely software based, it could be embedded in many types of devices.

The company has agreements with Asus and Hewlett-Packard to install its technology in their computers in the near future, and is exploring the same type of arrangements with mobile-device makers.

Leap Motion has created the Airspace Store, from which users can buy, download, and launch about 100 free and paid apps developed for the company's controller.

Figure 1. The Leap Motion Controller (foreground) lets users control computers by moving their hands, fingers, finger joints, or various objects.

WiSee

University of Washington researchers have developed the WiSee gestural interface (http://wisee.cs.washington.edu) to control office or household systems such as TVs, computers, thermostats, and lights.

The system sends out a stream of Wi-Fi signals. Hand or whole-body gestures that people make in a room with such a device disturb the signal stream and cause small frequency shifts, explained University of Washington PhD candidate Sidhant Gupta.

The WiSee researchers determined how to identify a set of nine gestures by the nature of the shifts they cause. They developed algorithms that amplify the disturbances, which normally are too small to detect easily, Gupta explained.

Because the system works with Wi-Fi signals, it doesn't require cameras or device instrumentation.

In addition, Gupta noted, Wi-Fi signals travel throughout a structure and don't require users to be in sight of the device they want to control, as is the case with camera-based systems.

Also, Gupta said, users perform a start-up sequence of gestures before making command gestures. This enables the system to avoid taking action based on casual gestures.

The researchers—who aren't currently developing WiSee for commercial use—tested their technology in an office and a two-bedroom apartment and found that it could identify its nine gestures with 94 percent accuracy, Gupta noted.

eyeSight's Touch Free

This software-based technology (http://eyesight-tech.com/technology) uses real-time image processing and machine-vision algorithms to track users' hand gestures and convert them into commands for a device.

Touch Free processes images from a standard 2D video camera, infrared sensors, or 3D sensors, and looks for any object it has been trained to detect such as a hand, finger, or face, noted eyeSight's Shenfeld.

The system—which can be embedded into almost any type of device—then tracks and identifies motions, and converts them into commands, he explained.

"Ours is the most commercialized gesture company in terms of volume," said Shenfeld. "We're in almost all forms of consumer electronics: mobile devices, tablets, PCs, televisions. We even have air-conditioning units coming out with our technology."

tural interface for use on the Xbox One game console, slated for release later this year.

The new Kinect uses a 1080p full high-definition, wide-angle, time-of-flight, range-imaging camera that determines distance by measuring how long it takes a light signal to travel between the device and the subject. It is faster and more accurate than the previous Kinect version, and can work in the dark thanks to an infrared sensor.

Technology advances have made gesture detection more feasible and affordable.

Microchip Technology's GestIC

GestIC (www.microchip.com/pagehandler/en_us/technology/gestic) is a low-cost, low-power chip, embeddable in a broad range of devices including laptops, tablets, cars, and consumer electronics. It uses an *e-field* approach.

"Basically, the chip we developed generates an electric field," said Microchip Technology's Duvenhage. "If a hand [or any conductive object or body part] is within the field, we can sense the disturbance and extrapolate an x, y, z position." This enables the system to control devices over a distance of up to 15 cm (5.9 inches) without cameras or video processors.

"We run pattern-recognition algorithms to recognize preprogrammed gestures, like swipes and circles," Duvenhage added.

Makers of devices that incorporate GestIC could program the system so that gestures represent any command they want.

Algorithms help GestIC distinguish intended command gestures from other motions, Duvenhage noted.

Other gesture interfaces

Microsoft has updated its camera-based Kinect gestural interface for use on the Xbox One game console, slated for release later this year.

The new Kinect uses a 1080p full high-definition, wide-angle, time-of-flight, range-imaging camera that determines distance by measuring how long it takes a light signal to travel between the device and the subject. It is faster and more accurate than the previous Kinect version, and can work in the dark thanks to an infrared sensor.

Other new products, such as the Kreyos Meteor smartwatch (www.kreyos.com), offer gestural interfaces. The $95 watch, expected to be on sale later this year, connects over Bluetooth to an iPhone or an Android or Windows 8 phone.

Users employ gestures, such as a hand wave, to answer an incoming call or have the watch—which has a three-axis gyroscope, accelerometer, and other internal sensors for detecting wrist motions—read a text message.

Apple has developed a camera-based system for its iOS 7 beta that lets users control their iPhones via gestures such as hand swipes or head movements.

Omek Interactive's Grasp (www.omekinteractive.com/products/grasp), which consists of middleware and a set of tools, processes data from 3D cameras and lets developers create hand- and finger-based tracking and gestural interfaces for applications and devices.

BENEFITS

People want to eliminate traditional interfaces that serve as barriers between them and their technology, according to Leap Motion's Zagorsek. "They want to interact using things they were born with, like their hands," he said.

"Gestures are a normal human way of communicating," explained Microchip Technology's Duvenhage. "It comes very naturally to people."

The interfaces let users make normal real-life motions, such as flipping a page, to perform similar functions on a device, he added.

Moreover, he said, they eliminate the need to have intermediate devices—such as a mouse or keyboard—to control computers.

"It's not called a natural user interface for nothing," said eyeSight's Shenfeld. "Hitting keys isn't the natural way we communicate. The natural communication of people includes body language. And people get a lot of satisfaction from this type of interaction."

The Enderle Group's Enderle said gesture technology's main benefit is that it speeds up and simplifies commands.

Also, it frees up screen space for content because you no longer need on-screen buttons or other symbols to make commands, said Raluca Budiu, senior researcher with the Nielsen Norman Group, a computer interface and user experience consulting firm.

The technology is also fun and lets users focus on the screen, rather than on mice, keyboards, or remote controls, she added.

APPLICATIONS

Proponents say that gestural interfaces could be useful in many applications. For example, they frequently cite hands-free control of consumer-electronics devices.

According to Leap Motion's Zagorsek, the technology could make gaming more interactive and immersive.

And, said the Nielsen Norman Group's Budiu. "users spend a lot of time with a game, and they are willing to learn the interface and be trained."

"Simpler interfaces that work with a smaller set of gestures could be useful for interaction with large displays such as TVs and information kiosks," she added.

People who are disabled could use gestural interfaces to work with devices they could not otherwise operate.

Vehicles represent another potentially successful application. Motions could control radios, windshield wipers, lights, and other types of equipment without users having to take their eyes off the road to look for knobs, buttons, or switches, said Microchip Technology's Duvenhage. Ford Motor Co. already has vehicles that open a rear hatch if drivers wave a foot underneath it.

Gestural interfaces would let doctors or nurses control displays, computers, or other devices without touching them, said Leap Motion's Zagorsek. This is an important factor in operating theaters or other medical settings in which personnel must maintain hand cleanliness, or in rooms in which some equipment is not within reach.

Many facilities could also benefit from technology that would let workers control machinery and other devices they can't reach.

CHALLENGES

Gestural interfaces face potential obstacles to success in the marketplace.

For example, said the Nielsen Norman Group's Budiu, they are not always accurate enough to be truly useful.

And they are not always easy to use because they are often designed by engineers without the help of human-interaction experts, stated the Enderle Group's Enderle.

If a gestural system is too complex to learn and use, users won't want to deal with it, explained eyeSight's Shenfeld.

Also, he said, camera-based systems have limited fields of view, which restrict the area in which they are useful.

And in some cases, camera-based systems experience problems because of issues with lenses or sensors, or because limited or inconsistent lighting makes the resulting images less useful. Also, objects in the foreground or background of a scene may block the target or make recognition of it more difficult.

The gesture-control market is relatively new, so the technology has little standardization. Systems use different interfaces, cameras, gesture sets, and algorithms. This limits interoperability and the ability of users to work smoothly across different systems.

Frequently, noted Microchip Technology's Duvenhage, gestural interfaces don't operate over a long enough range to be useful for many applications.

And some systems have trouble distinguishing between a deliberate control gesture and normal or accidental movements, he added.

Leap Motion's Zagorsek said the biggest challenge is getting developers to design more applications that work with gestural interfaces. Many developers, he explained, are used to traditional interfaces and don't see gestural controls' potential.

MOVING FORWARD

In the future, said Zagorsek, people will explore alternate ways of interacting with computers and begin using a combination of new interface approaches, including those involving gestures, voice, and eye tracking.

This will continue with the advent of new computing and communications machines, including wearable devices such as Google Glass, he predicted.

According to Zagorsek, gestural controls won't replace traditional interfaces such as mice and keyboards but instead will be used along with them when they are most beneficial.

The Enderle Group's Enderle said young people in particular will take to gestural controls, and as they get older, the interface will become more commonplace.

In the future, he predicted, gesture controls will advance beyond finger and hand motions, which are most common now, and include, for example, head and eye movements.

A key will be making gesture technology natural and fun to use, stated eyeSight's Shenfeld. He said this will avoid problems experienced by voice-recognition technology, which requires users to train systems to recognize their voice and which is not particularly easy to use.

Educating the public about gestural interfaces' benefits will be important to the technology's future, said Microchip Technology's Duvenhage.

Zagorsek said, "I think a number of [gestural-interface] use cases will emerge that people can't live without. People will rely less and less on the traditional tools and more on these new tools."

However, he cautioned, gestural technology's future will depend in part on how widely and quickly software developers build applications that work with it.

"I think it will be a kind of slow adoption, unless someone develops a killer app, a mainstream consumer app," said Duvenhage. "But I'm reasonably optimistic."

Shenfeld said gesture technology's popularity has accelerated 10 times as fast as was the case with voice recognition. "In about three years, machine vision and gesture [technology] will be where voice recognition is now after 30 years."

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