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An Idea with Muscle

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Do you get stiff when you have to sit at your workstation for hours on end? Maybe your doctor recommended that you get more exercise, but you find that working out at the gym is just too tedious. Playing games on your mobile phone is much more engaging, but there isn't much exercise in that. Or is there?

Just ask Arto Holopainen, a Forum Nokia Champion. Holopainen serves as director of research and development (R&D) and vice president of eHIT Ltd., a small Finnish company that makes mobile software for telemedicine. At eHIT, Holopainen became familiar with Mega Electronics Ltd., a Finnish company that specializes in biosignal-monitoring devices. In particular, he was intrigued by the possibilities of Mega's electromyography (EMG) sensors. EMG is the process of graphically recording the electrical signals that muscles generate.

Holopainen envisioned combining the EMG sensors with mobile phone software: "I came up with the idea of controlling a mobile device using your muscles." The concept involves EMG sensors on the body, Bluetooth communication, and software on the mobile phone for translating sensor signals into phone actions.

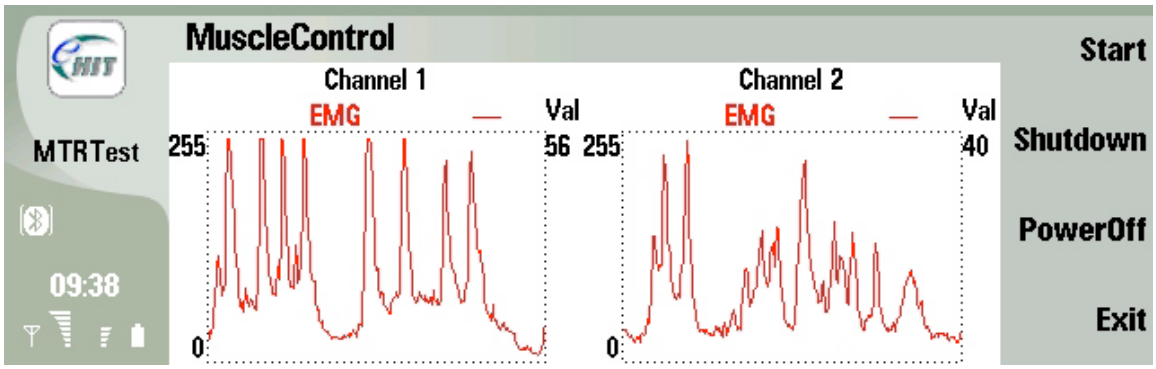
When eHIT's Arto Holopainen got the idea that muscles could control mobile phones, "it did sound quite far-fetched," he says. But by the end of 2006, he was demonstrating a system prototype.

"Sometimes you are just hit by an idea that you know will work perfectly. You could say that you are kind of hit by lightning," says Holopainen, who has been developing products for wireless devices since 1996. He was hit with exactly that kind of lightning in September 2006.

Lightning strikes

Holopainen initially designed an application that displays graphs of muscle activity, similar to the way electrocardiograms record heart activity. "The application can provide a lot of valuable information for the user — muscle stress, muscle balance, counting the number of actions, and more," he says. "That makes it ideal for fitness- and sports-related activities."

But Holopainen didn't stop there. He thought, Why not create a controller application that would map specific muscle activity to certain phone operations? Holopainen envisioned mobile phones' responding to electrical signals from muscles, just as they respond to key commands. "It did sound quite far-fetched at the time," he admits.



A screen from the controller application depicts muscle activity.

In essence, he thought, a user's body would serve as an input device for a mobile phone. At a minimum, the phone would function as an informative display, showing muscle activity at a given moment. Patients going through muscle rehabilitation, for example, could use this capability to monitor and pace their exercises.

As it turns out, mobile health technology is poised to become a hot market segment. The overall market for digital home-health products in the U.S., for example, is projected to grow at an average rate of 36 percent per year and reach $2.1 billion in 2010, according to Parks Associates. The Dallas-based research firm says the market is being driven by rapid expansion of wellness-monitoring programs as well as online patient/physician messaging.

Human joystick

The information from muscles is analog by nature. "The signal strength is directly proportional to how strongly you are using the muscle," Holopainen says. So when a mobile phone is running a game, he thought, the player's body could become the joystick. Flexing the left arm might activate the left arrow, flexing the right arm might activate the right arrow, and flexing both at the same time might control either the up or down arrow or activate the space bar. Because the signals are analog, the user could, for example, control the throttle of a driving game by exerting relative muscle strength. It would be a matter of mapping each incoming muscle signal and its strength to the correct device command. Putting an EMG sensor on the main muscle of each arm and leg would create multiple-command possibilities.

Flexing a muscle, however, is not the same as, say, waving an arm. “Measuring muscle activity is not like an accelerometer that registers hand movement. Rather than waving your hand or nodding your head, you must actually flex a particular muscle to get readings,” Holopainen explains. It is the muscle flexing, and not any resulting movement, that generates the EMG signal. That is why exercise became the obvious first application for Holopainen’s idea.

For many people, exercise is tedious. However, because people do like playing games on their mobile devices, Holopainen was inspired to combine his controller-application idea with mobile game playing. He reasoned that people would be motivated to work specific muscles if their efforts controlled game action.

Making it work

At the heart of this system for enabling muscle-controlled game playing is Holopainen’s application that filters the EMG data stream from each sensor and maps it to phone actions. The application lets the user define which muscle he or she wants to use to initiate a particular action and maps it to the appropriate phone command. Holopainen designed and developed the system for devices based on the S60 platform and the Series80 platform.

Although the idea sounds straightforward enough, implementing some of the technology proved tricky.

Access to sensor technology and expertise was not one of the issues, thanks to eHIT’s relationship with EMG-sensor maker Mega Electronics. And games themselves weren’t a problem. “I could play any standard game in the phone without any changes to the actual game,” Holopainen says. “My application simply runs in the background, receives muscle activity, and maps it to the different commands.” For an early prototype, he used the classic snake game, and players controlled left, right, up, and down movements of the snake with their muscles.

But deploying the sensors posed a challenge, even with Mega’s help. Users would have to stick a sensor onto each muscle whenever they wanted to play — not a simple prospect because of the need for wires and exact sensor placement. So Holopainen came up with the concept of a tight elastic sleeve that contains the sensor, power supply, and Bluetooth communications — one for each limb.

Bluetooth technology also posed a problem. “The obvious problem with Bluetooth is power consumption,” says Holopainen, though Bluetooth 2.0 chips have improved the situation. Channel capacity presents another concern. “I believe current Symbian devices can handle, theoretically, up to seven separate Bluetooth connections, so you could have up to seven separate sleeves generating signals,” he says. But depending on the sampling rate, muscle activity, and other factors, contention for channel capacity could be an issue. Resolving it requires optimizing the transmission for Bluetooth frame sizes.

The S60 platform and Series80 platform, by contrast, presented few challenges. “Software for the mobile phone is quite straightforward,” Holopainen says. “We just needed some basic digital-signal-processing algorithms.”

After conceiving the idea and design, Holopainen worked with two colleagues at eHIT to build a prototype, while Mega worked on the sensor sleeve. By the end of 2006, he was demonstrating a prototype at Nokia events.

People who know Holopainen’s track record should not be surprised that, despite his vice president title, he continues doing hands-on development work. “My real enthusiasm and intuition lie with developing — doing actual software and hardware development with my own hands. I really enjoy this,” he says.

In 1999, Holopainen worked with radiology professionals to design what is believed to have been the first GSM-smartphone-based teleradiology terminal that was fully compatible with Digital Imaging and Communications in Medicine (DICOM) standards. He used the Nokia 9110 Communicator in the implementation. And, through a project called AH Creations, he developed several applications, such as Graphic Point, that enabled users of the Nokia 9110 Communicator and Nokia 9210 Communicator to create and manage operator logos, picture messages, and ring tones. “This was before any multimedia messaging and public media providers,” Holopainen notes.

His recent Forum Nokia Champion recognition opens new possibilities. “Since I’m working in a quite unknown and marginal sector of health-care and health-related applications, the Champion program has given me a unique opportunity for presenting ideas and spreading knowledge,” he says.

eHIT has made his controller application part of its development and product roadmap. Now Holopainen hopes other developers will create health-care, therapeutic, and entertainment applications to take advantage of his muscle-controller system. Then, people won’t just be playing games; they’ll be getting a workout.