Navigating the shopping center

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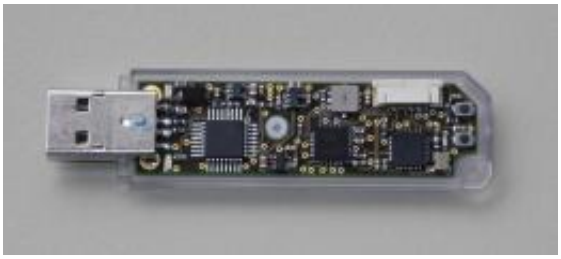
The virtual 3-D interior model of the building is displayed on the monitor. The location and the distance covered are marked in the map. Credit: Fraunhofer IPA

With a GPS receiver in your smartphone, you can navigate your way over highways and streets with certainty. But once you get inside a building, it provides no further assistance. That's why Fraunhofer researchers, together with the Bosch Corporation and other partners, have engineered a navigation system for interior spaces. Thanks to a clever combination of sensors, the module tracks the movements and position of its user in precise detail. At the Sensor+Test trade fair in Nuremberg from May 22-24, 2012, researchers will deliver a live demonstration of how this new interior-space navigation operates.

A smartphone with GPS functionality is a delightful tool. It guides its owner safely and with certainty through the streets of an unfamiliar city. But after arriving at the destination, all too often the orientation is gone,

because as soon as you enter a building, you lose contact with the GPS satellites. Then you are on your own – whether in the interminable hallways of the trade fair complex, or inside one of the branches of the local megaplex shopping mall. “Wouldn‘t it be helpful,” Harald von Rosenberg thought to himself, “if at such moments the smart phone could quickly shift to an interior space navigator, and point the way through the rows of shops and stairwells?” Well, that is absolutely possible, as the project manager for “motion control systems” at the Stuttgart-based Fraunhofer Institute for Manufacturing Engineering and Automation IPA now demonstrates through the “MST-Smartsense” cooperation project from the German Federal Ministry for Education and Research BMBF. The project is a joint collaboration that also brings together companies such as Robert Bosch GmbH, Bosch Sensortec GmbH, Binder Elektronik GmbH, AEMtec GmbH, and Sensitec GmbH with the Fraunhofer Research Institution for Modular Solid State Technologies EMFT and the Fraunhofer Institutes for Reliability and Microintegration IZM and for Electronic Nano Systems ENAS. These partners developed a sensor module for navigating interior spaces that is the size of a fingernail – and thus predestined for use in a smartphone.



The sensor module is barely larger than a fingernail. Credit: Fraunhofer IPA

Sensors detect length of stride

Similar to conventional pedometers, the module registers how fast and how far a person is walking. That said, it is much more precise and intelligent than the customary devices found on the market, because it even registers the direction in which the user is walking. “There has never before been a device so small that can accomplish so much,” says von Rosenberg. Basic pedometers initially have to be programmed. Body height, length of stride – all these data must be stored by the user before he or she starts to walk. That could be a hindrance if multiple individuals use the same counter. Moreover, conventional devices are not very accurate. Unlike the new navigation sensor from Stuttgart: located right inside the tiny module are several sensors which are processed combined. These include an acceleration sensor that registers the motion of the body, and a magnetic field sensor that measures the alignment of the body through its position in relation to the earth‘s magnetic field. In tandem, they map a highly precise movement pattern. “Sensor fusion” is the term von Rosenberg uses to refer to such intelligent coupling of multiple sensors. The fascinating thing is that the module does not have to be calibrated by the user. On its own, it detects if the individual has long legs, or is just taking baby steps. This is possible because von Rosenberg initially trained the software using the stride patterns of various individuals. The sensor instantly registers how an individual is walking and can estimate the stride length exactly.

Display indicates the ideal walk route

Naturally, the interior space navigator only functions if it knows the building. For this purpose, soon smartphones will automatically download three-dimensional building plans from the Internet. These are coupled with the sensor module to display a user’s, current position on the smartphone. Even more: the ideal walk route also appears on the display. Building plans can also be fed automatically to the cellular device as soon as you enter a building. It would also be possible to apply a two-dimensional QR code on the layout plan at the entrance of the

building. Users could then scan the code with their smartphone, to download the corresponding map.

And there is yet another element that distinguishes the new sensor module. It has its own small microcomputer that processes the sensor‘s measurement values into clear data – like a degree figure for visual orientation, or the length of a segment of travel. These can be used directly by the smartphone. By contrast, conventional sensors only produce basic raw data that another processor has to calculate into discrete data. “Unlike what we typically find, the MST-Smartsense Sensor can be installed directly into a smartphone or tablet computer without any additional elements, and supply apps with data,” says von Rosenberg. Since the sensor module works autonomously, it does not have to rely on the computer capacity of the smartphone‘s built-in processor. It uses its own small processor that needs substantially less power. That relieves the device‘s battery.

A demonstration of the new indoor navigation can be seen at the trade show Sensor+Test 2012 from May 22 to 24 in Nuremberg, at the Fraunhofer joint exhibition booth in Hall 10, Booth 202. There, IPA researchers will present another example of a successful sensor fusion system: a navigation module for robots and mobile measurement systems that, using the human eye as its model, additionally secures its position through a camera image.

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