FURTHER READING

Page 1293, 'Detecting outdoor coexistence as a proxy of infectious contact through magnetometer traces', Seungho Kuk, Yongseok Jeon and Hyogon Kim

Using smartphone magnetometers to identify people who have been close to an infectious source

infection detection with magnetometers

Researchers in Korea extend their previously featured work in *Electronics Letters* and report the use of smartphone magnetometers to identify people who have been within a given proximity to a disease carrier or infected individual.

Infection detection

With an increasing world population and high-speed global travel, a global pandemic caused by a completely new virus is becoming ever more probable. "Many experts have been consistently warning that 'the big one' is coming," says Seungho Kuk, of Korea University. "People like Bill Gates even say that we should prepare technologies for such pandemics as we do for a war. We want to respond to such calls, and to continuously expand our technical arsenal applicable to the detection of infection events, ultimately helping control the epidemic should it happen."

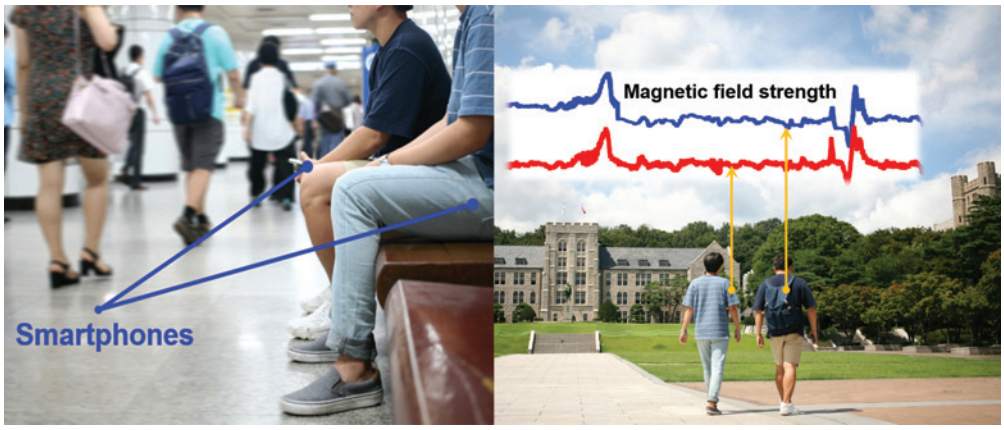
There are many possible approaches to detecting people who may have been in close contact with an infected person. Various signatures such as GPS positions, Bluetooth proximity, Wi-Fi fingerprints and identical mobile network cells have been proposed or used for detecting this kind of 'coexistence'. In particular, these have been used to track fast-spreading, infectious diseases like flu and Ebola.

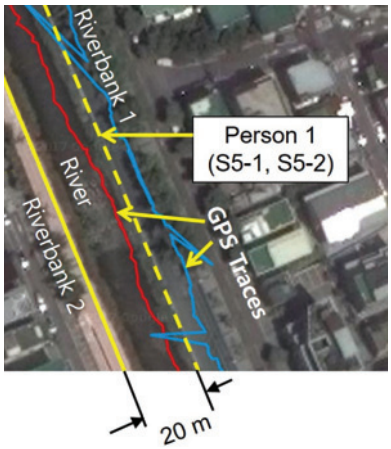
Unfortunately, Wi-Fi and cellular fingerprints are very coarse methods and cannot provide the meter-level resolution needed for human contact events. They also require a nearby communication infrastructure. GPS is exempt from this infrastructure requirement but it also does not reliably provide sufficient spatial resolution. Alternatively, Bluetooth communication reveals the identity of the beaconing device, raising potential privacy concerns.

Magnetometer traces

In this issue of *Electronics Letters*, Kuk and colleagues within Korea University's School of Informatics present what they believe is the first attempt to use smartphone magnetometer traces for infectious coexistence detection to remove the bottlenecks and limitations associated with these other technologies.

"The most fundamental requirement in coexistence detection is that smartphones should be able to sense the 'common environment'; where people in the infection distance are situated. The ambient geomagnetic field is a good example of the common environment," explains Kuk. "The geomagnetic field can be disturbed by ferromagnetic structures, such as pillars and bridges. When people walk together past the structures their ambient magnetic field is disturbed by passing cars and other metallic objects, their magnetometer traces record similar field fluctuations, witnessing to their coexistence."





TOP: Indoor (left) and outdoor (right) testing of the magnetometer-based coexistence detection technology.
BOTTOM: The limitations of GPS: the red and blue lines show GPS traces from two smartphones carried next to each other in the same bag along the dotted path. This kind of data cannot reliably detect coexistence within a metre or two.

Magnetometers are already present in smartphones, but as a technology they have not previously been used for coexistence detection. In a previous Letter, this team reported wireless technology using smartphone accelerometers aimed at detecting coexistence in the same railway carriage. Unlike the accelerometer approach, the magnetometer technology can easily identify two people walking side by side and works both indoors and outdoors because geomagnetism is ambient and ubiquitous.

The Korea University team see different approaches like these as complementary. Kuk said, "One would wish for a universal sensing method that detects coexistence in every possible situation, but the reality is not so simple. That's why we should expand our arsenal of techniques."

The Future ...

In the long term, as the magnetometer technology develops and matures in quality, the authors think that it will take a significant burden off the shoulders of disease control and emergency response authorities. For example, in the development of an application that could be downloaded and allow for automatic testing of encounters, with confirmed infection cases following magnetometer trace submissions to the disease control authority. The risks of failing to trace infectious contacts rapidly and efficiently is too great not to consider making the most of technology that is already in our pockets.

The technology has the potential to be used for more than just coexistence detection. The authors anticipate the technology will also be used in social studies of human interactions, for example, to observe social behaviours in schools and even social games. By simply installing a magnetometer trace recording application on the students' smartphones, researchers may be able to obtain new information about human interactions throughout early-years and adolescent development.

Kuk observes that, "it's been only 10 years since the iPhone first appeared. Smartphones have come a long way since then. In particular, more and more sensors are being added. 10 years from now, we do not even know how many will be on this versatile device and what they will do for us. One thing we know for sure is that researchers, including us, will be there to explore with the new sensors and see what they can do to help us understand various aspects of human life."