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GPS Not Working? A Shoe Radar May Help You to Find Your Way

The prevalence of Global Positioning System (GPS) devices in everything from cars to cell phones has almost made getting lost a thing of the past. But what do you do when your GPS isn't working? Researchers from North Carolina State University and Carnegie Mellon University (CMU) have developed a shoe-embedded radar system that may help you find your way.

There are situations where GPS is unavailable, such as when you're in a building, underground or in places where a satellite connection can be blocked by tall buildings or other objects," says Dr. Dan Stancil, co-author of a paper describing the research and Professor and Head of NC State's Department of Electrical and Computer Engineering. "So what do you do without satellites?"

One solution is to use inertial measurement units (IMUs), which are electronic devices that measure the forces created by acceleration (and deceleration) to determine how quickly you are moving and how far you have moved. The technology works in conjunction with GPS, with the IMU tracking your movement after you lose a GPS signal -- and ultimately providing you with location data relevant to your last known location via GPS. For example, if you entered a cave and lost your GPS signal, you could use the IMU to retrace your steps to the last known GPS location and find your way back out.

However, IMUs have traditionally faced a significant challenge. Any minor errors an IMU makes in measuring acceleration lead to errors in estimating velocity and position -- and those errors accumulate over time. For example, if an IMU thinks you are moving -- even as little as 0.1 meters per second -- when you are actually standing still, within three minutes the IMU will have moved you 18 meters away from your actual position.

But, "if you had an independent way of knowing when your velocity is zero, you could significantly reduce this sort of accumulate error," Stancil says.

Enter the shoe radar.

"To address this problem of accumulating acceleration error, we've developed a prototype portable radar sensor that attaches to a shoe," Stancil says. "The radar is attached to a small navigation computer that tracks the distance between your heel and the ground. If that distance doesn't change within a given period of time, the navigation computer knows that your foot is stationary." That could mean that you are standing still, or it could signal the natural pause that occurs between steps when someone is walking. Either way, Stancil says, "by resetting the velocity to zero during these pauses, or intervals, the accumulated error can be greatly reduced."

In other words, the navigation computer compiles data from the shoe radar and the IMU and, by incorporating the most recent location data from GPS, can do a much better job of tracking your present location.

The paper, "A Low-Power Shoe-Embedded Radar for Aiding Pedestrian Inertial Navigation," is published in the October issue of IEEE Transactions on Microwave Theory and Techniques. The leader author of the paper is Dr. Chenming Zhou, who did the work while a postdoctoral research associate at CMU. Co-authors are Stancil, and CMU's Dr. Tamal Mukherjee and James Downey. The work was supported, through CMU, by the Air Force Research Laboratory and the Defense Advanced Research Projects Agency. This release is approved for public release, distribution unlimited.

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