Researchers use passive UHF RFID tags to detect how people interact with objects

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Disney Research has demonstrated that battery-free, radio frequency identification (RFID) tags can be used to cheaply and unobtrusively determine how people use and interact with daily objects, enabling new types of interactive play, smart homes and work environments, and new methods for studying consumer shopping habits.

RFID tags are designed to simply report an identifying code when energized by an RFID reader, but a Disney Research team directed by Dr. Alanson Sample showed that the radio frequency signals transmitted by these tags provide a unique RF signature which can be used to determine whether a tagged item was being touched or moved.

The researchers found that with their system, called IDSense, they could simultaneously track 20 objects in a room and infer four classes of movements with 93 percent accuracy. They will present their findings at CHI 2015, the Association for Computing Machinery's annual Conference on Human Factors in Computing Systems, April 18-23 in Seoul, South Korea.

"An effective means of identifying people's activities in their homes, schools and workplaces has the potential to enable a wide number of human-computer interaction applications," Sample said. "Whether it's reading a book to a child, cooking a meal or fixing a bicycle, the objects that we use both define and reflect the activities we do in our daily lives."

One common approach has been to attach wireless sensors to objects, he noted, but the size of the sensors, their relatively high cost and the need for battery replacement has limited their applications. RFID tags, by contrast, are commercially available technology, cheap and easy to apply to a wide range of everyday objects.

Sample, along with Disney Research's Can Ye and Hanchuan Li, a Ph.D. student in computer science and engineering at the University of Washington, employed ultra high frequency (UHF) RFID tags, which can return signals up to 10 meters. They found that by observing changes in the signals emitted by the tags - received signal strength indicator (RSSI), radio frequency (RF) phase and Doppler shift - they were able to make inferences about the object to which the tag was attached.

RSSI is a measurement of signal power received at the receiver and is predominantly affected by the distance between the tag and the reader. RF phase - the angle between the carrier signal emitted by the RFID reader and the return signal from the tag - is sensitive to small changes in distance, while the Doppler shift is a radio frequency shift caused by the speed of a moving object.

"The key insight is that these low-level channel parameters represent a snap shot of the RF environment that is unique to each tag," Sample said. "By measuring changes in these signals over time we can infer how someone is interacting with the object."

By using machine learning algorithms, which identify patterns in data, the researchers were able to associate changes in these communication parameters with certain states of the object, such as whether the object was still, whether the object was being rotated or moved, or whether the tag was covered, such as when the object was being held.

The Disney team demonstrated how IDSense could be used by applying

RFID tags to stuffed toys, enabling an interactive storytelling game in which rocking or petting a toy lion triggered actions by digital characters. In another demonstration, they used IDSense to monitor 10 commonly used items, such as a drinking glass, a milk container and a cereal box, to show how information about daily living activities could be gathered, and they showed that the tags could be used for studying the browsing behavior of consumers in a retail store.

Other possible applications include detecting occupancy of seats or, in security scenarios, detecting the opening and closing of windows and doors.

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