Wi-Fi Becomes Sound Backbone for Motion Sensing and Smart-Home Monitoring

Service providers should look to their already deployed Wi-Fi networks to support emerging motion-sensing and smart-home monitoring services.

By Oleksiy Kravets / *Cognitive Systems*

Motion detection has countless uses, from grocery store doors to streetlamps. As consumer expectations continue to skyrocket, motion-detection solutions must evolve at a similar pace.

Typical motion-sensing devices such as passive infrared (PIR) sensors and cameras have a major limitation – they require dedicated hardware. What if the benefits of motion sensing were available without needing to buy and install equipment? What if it were possible to leverage an existing network to sense motion? The path to simplification lies in plain sight.

WI-FI'S BROAD UTILITY
Few technologies are more ubiquitous than Wi-Fi. It's cheap and it's used everywhere – from homes to cafés to airplanes. Despite its omnipresence, Wi-Fi's capabilities are drastically underutilized. Wi-Fi is not just for internet connectivity – it can be leveraged as a robust motion-detection network as well.

When a Wi-Fi access point (AP) communicates with connected Wi-Fi receiver devices, it uses radio frequency (RF) waves that reflect off solid objects on their path. In the motion-sensing context, the sum of these reflections is typically what the devices can "see." When all physical objects along an RF path are static, such as furniture, the receiver sees a relatively static picture, impacted only by environmental and system noise and interference from other transmitting devices.

When at least one object starts to move – such as a human moving around a home – a unique signature of changing RF reflections is created over time. Wi-Fi sensing detects such patterns and processes them to exclude all unwanted phenomena. These can include contaminated RF signals due to interference, mechanical motion patterns created by things such as ceiling fans, and even non-human motion, such as what pets generate. Analyzing these environments is complex, but technology has evolved to be able to screen out irrelevant detections and report only motion that users care about.

Gateways, single APs or mesh routers can act as extensions of the monitoring system. With

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WI-FI SENSING USES		
Smart Home	**Security**	**Wellness Monitoring**
• Use smart devices, such as thermostats, that automatically adjust to room entry and preferences • Turn smart devices on and off through gestures	• Receive notifications of when and where motion occurs and when it's unusual • Know how many people are in a home and when they enter and leave	• Monitor activities of elderly people or children through motion notifications • Monitor vital signs (breathing), and assess sleep quality

Cognitive Systems' Wi-Fi Motion, for example, no additional hardware is needed because a home's existing internet of things (IoT) devices become the motion sensors. The possibilities for this kind of solution are endless, especially considering that the number of consumer products requiring Wi-Fi connectivity to operate is expected to continue its exponential growth. Gartner predicts that there will be 20.4 billion IoT devices in use by 2020.

STRONG ALGORITHMS NEEDED

An increase in connected devices is a good thing for Wi-Fi motion sensing; however, it also increases the potential for more interference as each device competes for bandwidth. Wireless environments are constantly changing, and home sizes differ, so motion detection through Wi-Fi must rely on strong algorithms that can analyze a complex environment and leverage the strength of many devices linked together. In addition, because every IoT device has a different purpose and priority, devices need to perform motion sensing without detracting from their primary operation.

Cognitive Systems took all these considerations into account when developing Wi-Fi Motion. Much of the company's R&D has focused on improving motion localization and tracking from one device to another.

MULTIPLE CONSUMER APPLICATIONS

The consumer need for whole-home motion sensing is greater than one might think, especially when it can provide users with context about where and what motion is occurring using just the existing infrastructure – without having to install cameras or PIR sensors.

NEXT-LEVEL MOTION SENSING

One major limitation consumers currently experience with their numerous smart devices is that the devices respond only to commands. When predictive analytics are applied to Wi-Fi sensing technology, however, it can learn users' behavior patterns. Over time, as a consumer incorporates more IoT devices into the home, the data from each device is added to the motion algorithms, resulting in more precise motion information. For instance, the Wi-Fi network will be able to sense when someone comes home and adjust the smart thermostat and smart lighting based on habitual behavior rather than requiring users to set manual preferences in an app or through verbal commands.

Wi-Fi sensing is complex, especially when balancing the need for high sensitivity and broad coverage with the requirement of zero (or near zero) false detects. Machine learning classification must achieve better than 99.999 percent accuracy to guarantee less than a second of false detection per month of monitoring. This requires very advanced algorithms, stringent quality control efforts and countless trial datasets collected from a multitude of places. Such advanced statistical analysis can be acquired only through thousands of hours of monitoring, manual labeling and characterization.

LOOKING FORWARD

Consumers expect technology that simplifies their lives and is easy to use. Leveraging Wi-Fi for motion detection is an industry-disrupting solution that uses existing technology for a whole new purpose. For consumers, this added value eventually will become something they cannot live without. For the sensor technology community, this opens doors to even more innovation combining motion detection and Wi-Fi. Innovators must get ahead of this trend now to avoid falling behind customers' expectations. ❖

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