Applying Machine Learning to WiFi Channel State Information for Smart, Safe, Energy Saving Buildings

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It is estimated that the U.S. wastes 61% of its energy consumption, 24% of which occurs in buildings. This project explores the novel idea of using WiFi Channel State Information (CSI) to detect human presence and establish situation awareness critical for smart building management. Accurate human presence awareness will maximize energy saving through the precise control of light and heating/cooling systems, while simultaneously support security monitoring. WiFi CSI, which contains the received signal strength measurement of multiple subcarriers, was collected in both home and office settings for multiple scenarios of unoccupied space and with human presence. Statistical analysis confirmed that CSI data does not follow normal distribution and that data for empty and occupied spaces are statistically different, which allows for successful classification. Machine learning algorithms were adopted to perform both binary and multiclass classification of CSI data. Experimental results showed a consistent classification accuracy of 99%, demonstrating that CSI measurements can reliably identify the location, movement, and number of people inside a building. Using just a few wireless router and receiver pairs, hundreds of millions of CSI data points can be obtained per day and used to establish comprehensive building situational awareness. By leveraging existing WiFi infrastructures, the proposed CSI based scheme for smart management of buildings will drastically cut energy wastage by billions of dollars annually. The same system can simultaneously provide highly sensitive, reliable, and privacy preserving security monitoring with many advantages over traditional surveillance cameras.

Awards Won:

Third Award of $1,000

ASU Rob and Melani Walton Sustainability Solutions Service: Award of $2,500

Association for Computing Machinery: Third Award of $300