

# VERIFICA: ANALYSIS OF INDIRECT MEASUREMENT TO MAKE OCCUPANCY ESTIMATION IN INDOOR AREAS

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## Abstract

Occupancy in indoor areas can be estimated using different technological and methodological solutions, whose complexity increases according to the required performance.

The main approaches can be divided in two categories that use indirect and direct measurements. In this project activity will be analyzed the use of indirect measurements to estimate the occupancy. In this category the occupancy is inferred from the perturbation of indirect parameters like temperature, humidity, and light. The main advantage is the low complexity of the adopted hardware. However, the methodology for data processing is very complex because the correlation between environmental data and people presence is not univocal.

The goal of this project is to analyze some indirect measurements that come from some laboratory environments, in order to detect some strange pattern or behavior of the data that can be used to estimate the person occupancy of every specific area.

**Reference Bibliography:** Wireless Sensor Network and Localization [1]-[4]; Wireless Sensor Network [5]-[7].

- [1] F. Viani, P. Rocca, M. Benedetti, G. Oliveri, and A. Massa, "Electromagnetic passive localization and tracking of moving targets in a WSN-structured environment," *Inverse Problems - Special Issue on "Electromagnetic Inverse Problems: Emerging Methods and Novel Applications,"* vol. 26, pp. 1-15, May 2010.
- [2] F. Viani, P. Rocca, G. Oliveri, D. Trincherio, and A. Massa, "Localization, tracking and imaging of targets in wireless sensor network: An invited review," *Radio Science*, vol. 46, 2011.
- [3] F. Viani, L. Lizzi, P. Rocca, M. Benedetti, M. Donelli, and A. Massa, "Object tracking through RSSI measurements in wireless sensor networks," *Electronics Letters*, vol. 44, no. 10, pp. 653-654, 2008.
- [4] F. Viani, P. Rocca, G. Oliveri, and A. Massa, "Electromagnetic tracking of transceiver-free targets in wireless networked environments," *6th European Conference on Antennas Propag. (EuCAP 2011)*, Rome, Italy, pp. 3808-3811, Apr. 11-15, 2011 (Invited paper).
- [5] F. Viani, F. Robol, A. Polo, P. Rocca, G. Oliveri, and A. Massa, "Wireless architectures for heterogeneous sensing in smart home applications - concepts and real implementations," *Proc. IEEE*, vol. 101, no. 11, pp. 2381-2396, Nov. 2013.
- [6] F. Viani, G. Oliveri, M. Donelli, L. Lizzi, P. Rocca, and A. Massa, "WSN-based solutions for security and surveillance," *40th European Microwave Conference 2010 (EuMC2010)*, Paris, France, pp. 1762-1765, Sep. 26 - Oct. 1, 2010.
- [7] F. Viani, P. Rocca, G. Oliveri, and A. Massa, "Pervasive remote sensing through WSNs," *6th European Conference on Antennas Propag. (EuCAP 2012)*, Prague, Czech Republic, Mar. 26-30, 2012.

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