

# Robust indoor localization via interval analysis

Mohamed-Hédi Amri, Yasmina Becis, Didier Aubry,  
and Nacim Ramdani

Univ. Orléans, INSA-CVL, PRISME, EA 4229, F45072, Orléans, France  
{mohamed-hedi.amri, yasmina.becis-aubry, didier.aubry,  
nacim.ramdani}@univ-orleans.fr

**Keywords:** set inversion, relaxed set intersection, multi-modal data fusion.

Indoor location sensing systems constitute a growing field of research involving both theoretical and applicative challenges. These systems are used in several applications of sensor networks such as tracking and monitoring. The design of an indoor positioning system depends on sensor's technology. The most common positioning systems are based on infrared (IR) technology. Such sensors are low-cost and non-wearable. These are binary sensors that can only detect the presence of a moving object in their visibility range. Pyroelectric infrared (PIR) sensors have been widely deployed in commercial applications, to detect human presence, to trigger alarms or to control lighting. PIR sensors networks are now employed in several advanced applications a.o. to achieve coverage, assist surveillance as well as perform tracking. However, indoor positioning systems using PIR sensors, may have some limitations. It is then desirable to combine them with other modalities to improve localisation accuracy. Dynamic triangulation using Received Signal Strength indicators (RSSI) is a good candidate.

Inspired by the results obtained by [1-4], we developed a method for tracking the location of residents in smart homes using only binary PIR sensors, and also by combining them with ultra wide-band based RSSI. We consider the unknown but bounded error framework and allow for possible sensor failure. Our set-membership estimation

algorithm is the classical interval-based predictor-correcteur algorithm based on the q-relaxed intersection, but with poorly known dynamical model. In fact, the actual mobility model for the inhabitant is unknown, thus we only consider a random walk with maximal velocity. The measurements data are gathered at discrete time instants. The method has been validated with actual data from a living-lab [5] and also as a tool for sensor fault detection and isolation [6].

### Acknowledgement

This work is supported by the French FUI 14 e-monitorage project.

### References

- [1] F. MOURAD, H. SNOUSSI AND C. RICHARD, Interval-based localization using RSSI comparison in MANETs, *IEEE Transactions on Aerospace and Electronic Systems* 2010.
- [2] F. MOURAD, H. SNOUSSI, M. KIEFFER, AND C. RICHARD, Robust interval-based localization algorithms for mobile sensor networks, *Int. Journal of Distributed Sensor Networks*, 7(1), 2012.
- [3] V. DREVELLE AND P. BONNIFAIT, Robust positioning using relaxed constraint-propagation, In *Proc. of IEEE Conference on Intelligent Robots and Systems (IROS)*, 4843-4848, 2010.
- [4] V. DREVELLE AND P. BONNIFAIT, A set-membership approach for high integrity height-aided satellite positioning, *GPS Solutions*, 15(4), 357-368, 2011.
- [5] M.H. AMRI, Y. BECIS, D. AURBY, AND N. RAMDANI, Indoor Human/Robot Localization using Robust Multi-modal Data Fusion, in *IEEE Int. Conf. on Robotics and Automation*, 2015.
- [6] M.H. AMRI, D. AURBY, Y. BECIS, AND N. RAMDANI, Robust Fault Detection and Isolation applied to Indoor Localization, in *Proceedings of the 9th IFAC SafeProcess*, 2015.