Research theme title:
Data fusion for indoor localization system based on UWB technologies

Description:
UWB technology (IEEE 802.15.4a/z) is a technology standard optimized for applications based on micro-localization. Using this technology, it is possible to calculate distance and position indoors or outdoors, with an accuracy of the order of a few centimeters. Distance and position are calculated by measuring the times of flight (ToF) of the radio signal sent by one or more transmitters (tags) towards the receivers (anchors). For the system architecture to be scalable and allow for a greater number of transmitters (tags), one of the main techniques used for localization is the Time Difference of Arrival (TDOA). With such a technique, the quality and accuracy of localization depend on:

- Receiver synchronization accuracy
- Receiver positioning geometry
- Absence of occlusions between the transmitter and the receiver (NLOS)

In complex environments, such as industrial ones, the latter condition is not always verified at the expense of an increase in the mean localization error. To overcome this problem, it is possible to think about sensor fusion solutions, by equipping the tags with an inertial sensor and developing inertial tracking algorithms.
In particular, the research activity connected to the PhD scholarship will include the study and design of localization and data fusion techniques relating to the industrial scenario detailed above, aimed at achieving the following objectives:

- Development of algorithms able to provide speed and acceleration, taking into account the low computational capability of embedded systems.
- Robustness analysis of the proposed algorithms in relation to the main criticalities of the system (drifts, environmental noise, etc.).
- Integration of the data obtained from the inertial system with those coming from the UWB localization.

In support of research activity, the most modern inertial sensors incorporating machine learning cores to optimize the computational calculation can also be used.
The research will be applied to real scenarios provided by E80 Group SpA, an Italian company specialized in automated solutions for logistics 4.0.

References:
F. Zafari, A. Gkelias and K. K. Leung, "A Survey of Indoor Localization Systems and Technologies," in *IEEE Communications Surveys & Tutorials*, vol. 21, no. 3, pp. 2568-2599, thirdquarter 2019, doi: 10.1109/COMST.2019.2911558.
S. Leugner, M. Pelka and H. Hellbrück, "Comparison of wired and wireless synchronization with clock drift compensation suited for U-TDoA localization," *2016 13th Workshop on Positioning, Navigation and Communications (WPNC)*, Bremen, Germany, 2016, pp. 1-4, doi: 10.1109/WPNC.2016.7822846.
A. Norrdine, "An Algebraic Solution to the Multilateration Problem", 2012 International Conference on Indoor Positioning and Indoor Navigation, 13-15th November 2012.
M. A. Al-Ammar *et al*., "Comparative Survey of Indoor Positioning Technologies, Techniques, and Algorithms," *2014 International Conference on Cyberworlds*, Santander, Spain, 2014, pp. 245-252, doi: 10.1109/CW.2014.41.
C. McElroy, D. Neirynck and M. McLaughlin, "Comparison of wireless clock synchronization algorithms for indoor location systems," *2014 IEEE International Conference on Communications Workshops (ICC)*, Sydney, NSW, Australia, 2014, pp. 157-162, doi: 10.1109/ICCW.2014.6881189.

Type of scholarship:
DM 117/2023 – Project on PNRR (Italy's Recovery and Resilience Plan)

Hosting University
Polytechnic of Bari, Italy

Study and research period outside the Hosting Institution:
Study and research period at the company:
E80 Group SpA

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