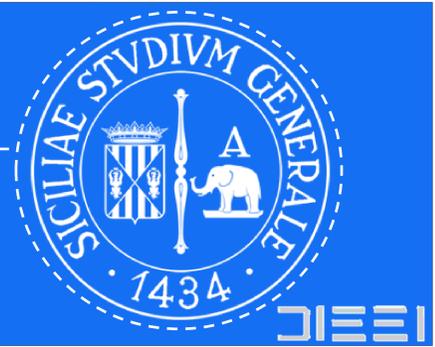


DEVELOPMENT OF SMART MULTI-SENSOR SOLUTIONS FOR THE ACTIVE AGEING AND WELL BEING



Student: Ruben Crispino
Tutor: Prof. Ing. Bruno Ando'
Academic Year: 2018/2019

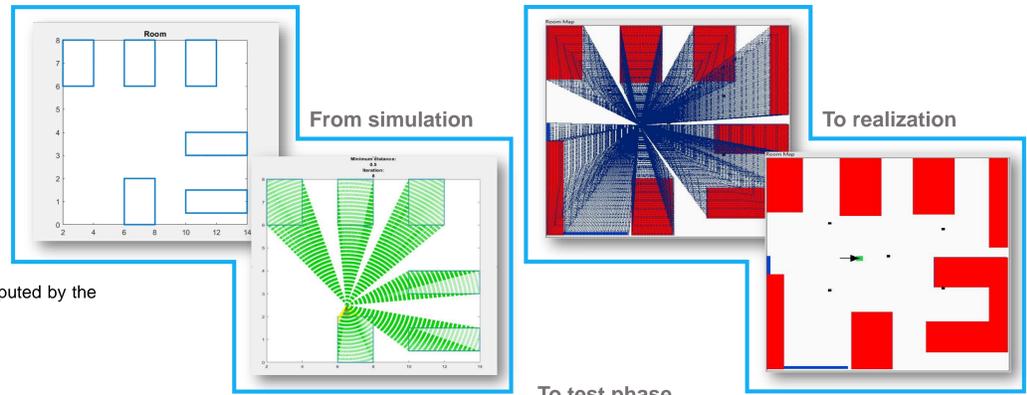
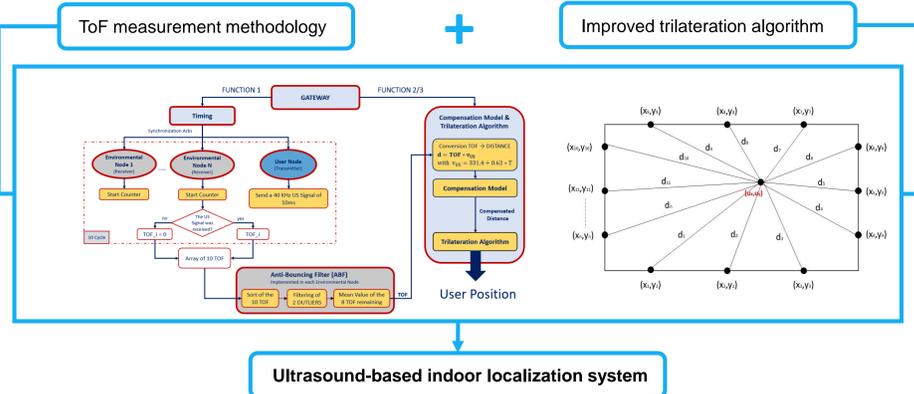
Dottorato di Ricerca in
Ingegneria dei Sistemi, Energetica,
Informatica e delle Telecomunicazioni
XXXIII Ciclo

Indoor Localization System: towards an User-Environment Interaction

- Problems:**
- Monitoring elderly or, more in general, frail people, in their home environment or hospital facilities.
 - People with visual impairments may have difficulties in exploring an unknown environment;
- Objective:**
- To build an indoor localization system while accounting for the user interaction within the environment (UEI).

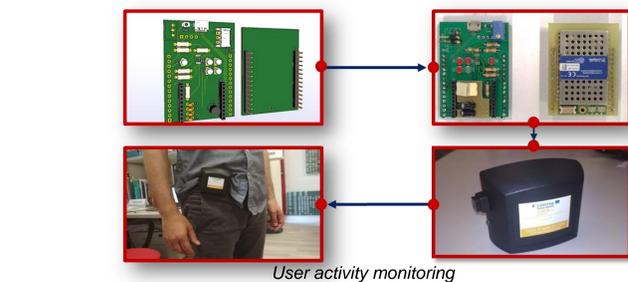
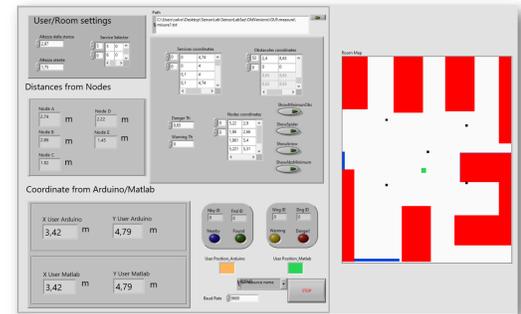
Methodology:

- Use of a ToF measurement system along with improved trilateration algorithm for indoor localization. The information computed by the system is further used to provide useful and strategic information to users while exploring an unknown environment (UEI).

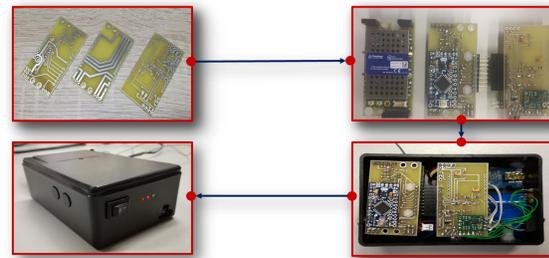


Advantages of the proposed solution:

- Real-time monitoring of patients inside hospital facilities
- Real-time information regarding obstacles and services in the neighborhood of a user



User activity monitoring



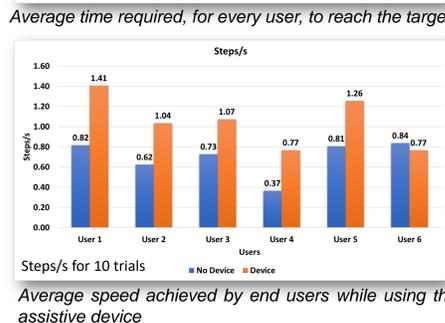
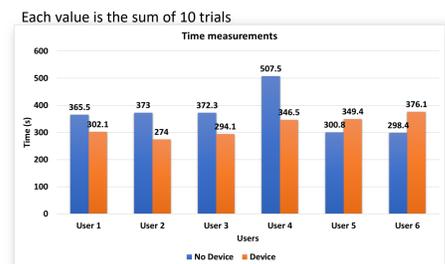
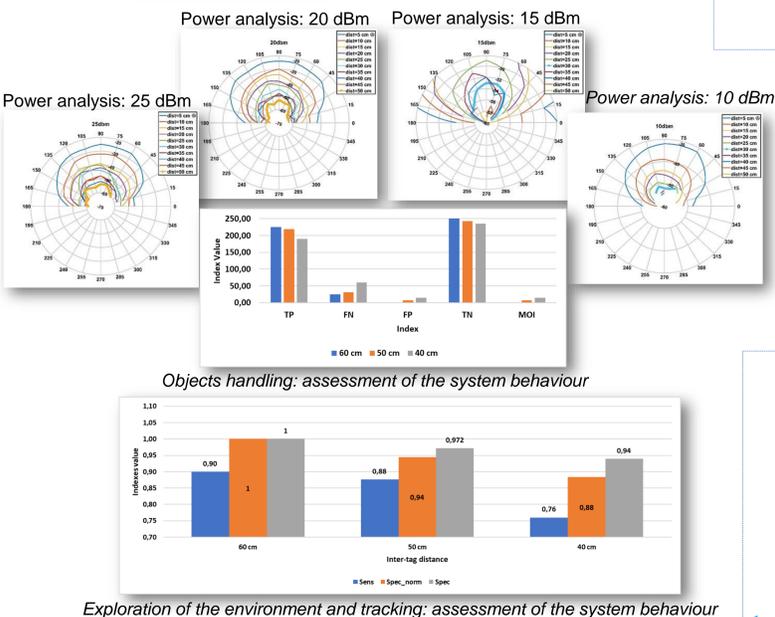
Orientation aid system

RFID-based systems

- Problems:**
- People with visual disabilities may have the need to recognize specific locations while exploring unfamiliar environments. Moreover, they are often challenged by places not designed for their special conditions.
 - Monitor geriatric parameters such as the patient's mobility and the activity rates along with the user's habits. Those aspects are particularly important since a proper lifestyle and a correct nutrition/hydration can reduce the incidence of age-related traumas.

- Objectives:**
- To realize an orientation aid system able to improve visually impaired independence while exploring an unfamiliar environment
 - To monitor the user activity in order to detect, or prevent, potentially dangerous situations for elderly in their home environments.

- Solution and Methodologies:**
- To exploit RFID systems along with passive tags to provide a single architectures for both the aforementioned problems.
- To assess the system utility when used by end-users
 - Reduction in the time required to find a target
 - Average speed of the users when using the device
 - To assess the capability of the system to recognize handled objects or proximity to landmarks



- From top to bottom:**
- The developed device in its various steps
 - Average time needed for the end users to find the target
 - Average speed achieved by end users while using the assistive device

- From top to bottom:**
- The developed device in its various steps
 - Optimize the system power consumption while guaranteeing a suitable reading range for the application addressed
 - Since the system is also meant to be used to monitor user's handled objects when specific conditions are respected, an assessment campaign has been conducted
 - The system performance for its use as user tracking has also been assessed

A system for postural instability and its validation with a gold standard

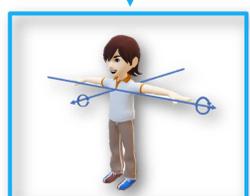
Problems: Postural instability can be an early symptom of a serious neurological disease such as Parkinson's disease. Up to now, the validation is totally dependent on the subjective validation of a neurologist.

- Objective:**
- To have a **reliable** system able to:
 - Monitor the user pathology evolution
 - Validate the pharmacological therapies and rehabilitation strategy.

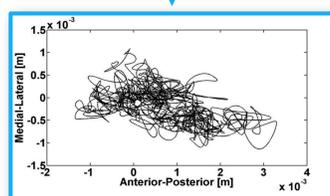
Methodology:

- A low-cost wearable device and advanced signal processing aimed at the continuous monitoring of the user's postural sway.
- System validation using a gold standard

A chest worn **inertial device** can be used to build the **COP** (Centre of Pressure) variation in time.



Antero-posterior and Mediolateral movements



Centre of Pressure

Starting from the COP 7 features have been extracted from both the inertial device and the BTS system



Developed inertial device

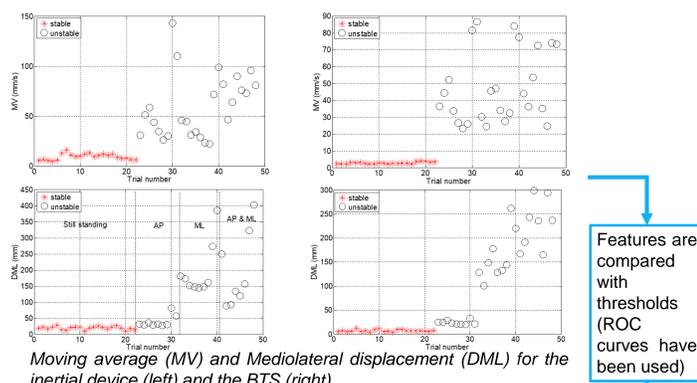


Gait lab. with the gold standard

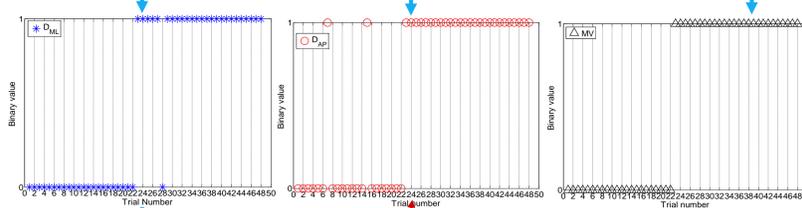


The Gold Standard: BTS SMART-DX system at Policlinico "Vittorio Emanuele", University of Catania, Catania, Italy.

Just 2 features are reported for brevity



Features are compared with thresholds (ROC curves have been used)



OR operator among the entire classes of classification results

