



A Real-Time Tracking, Alerting, and Control System for the Geriatrics Department



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Introduction

Interest in positioning systems for clinical applications has been growing recently. Specialized medical equipments have been successfully tracked using such positioning systems, thus reducing the time wasted by clinicians looking for them through hospital facilities. Extending the location and positioning technology from only equipment to clinicians and patients opens the door to a new set of applications, whose potential for time and cost savings are appealing.

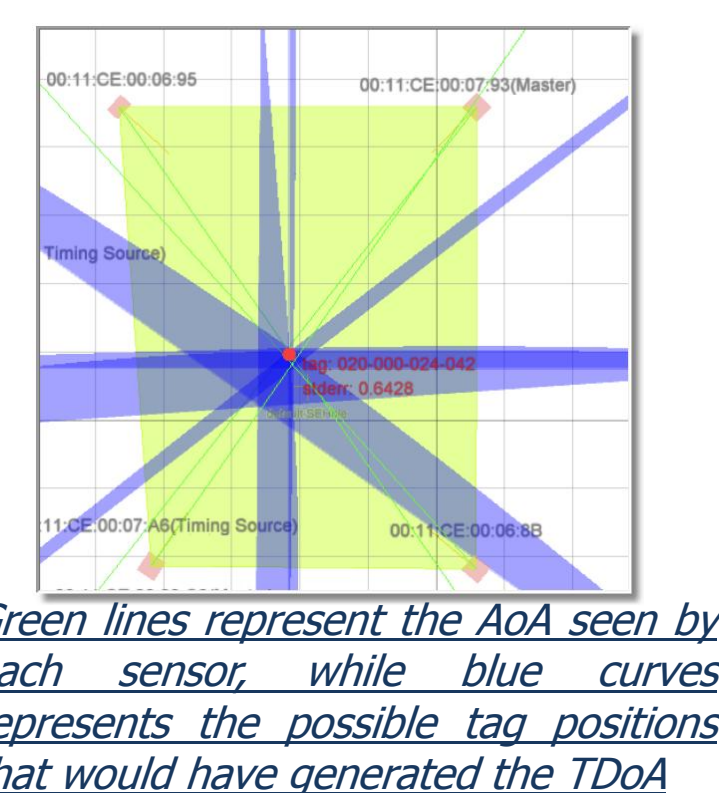
In this research, we aim to develop, design, and deploy a real-time tracking, monitoring, alerting and control system in the Geriatrics Department of the Royal Victoria hospital. The system includes: (1) UWB and WiFi-based positioning algorithms, (2) hybrid wireless/wireline door control system (3) Wireless alert system (4) Application software suites

The goals of the system would be to: (1) Monitor real-time positions of elderly patients (2) Display the location information to the nurses (3) Trigger necessary actions (alarms, door lock,...)

UWB Localization

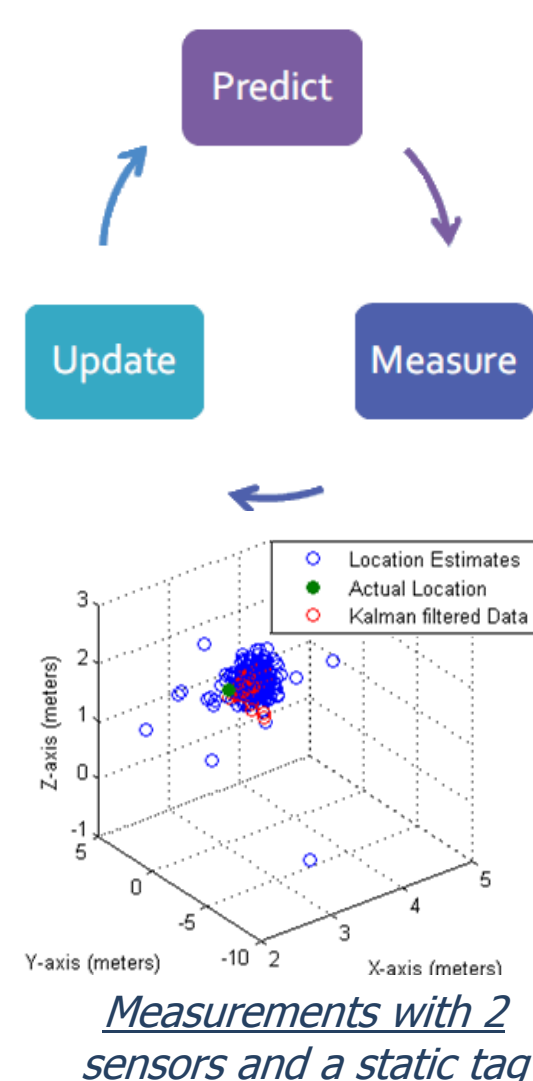
Combined AoA, TDoA technology:

- The system performs measurement of both pseudorange (based on TDoA) and AoA
- More measurements per sensor make the system more robust
- Using both TDoA and AoA means that the location can be determined using fewer sensors



Filter-based location algorithm:

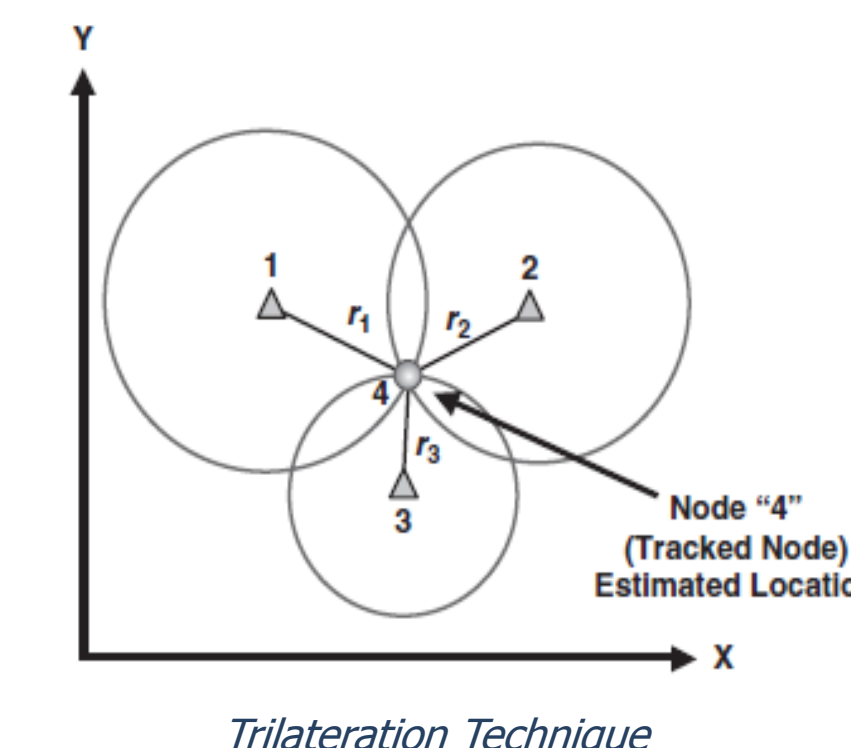
- Sensors include information filters algorithms that use models of object dynamics to enhance location accuracy of dynamic and static objects in a variety of environments, eliminating reflections and ambiguous data
- Algorithm works in an iterative manner by combining the previous estimate of the position with the current measurements



WiFi Localization

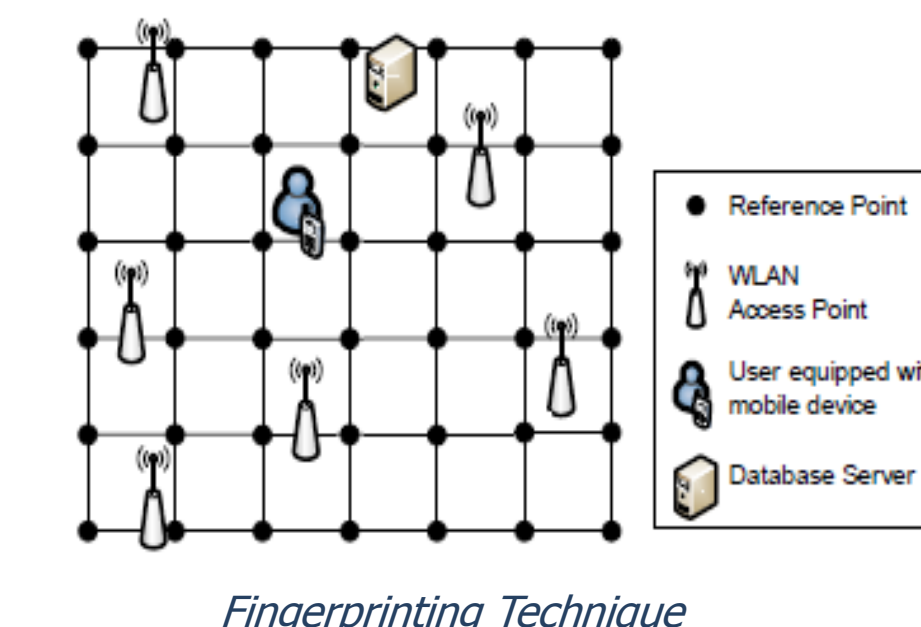
Range-based Techniques:

- A propagation model is used to convert the RSS measurements into distance estimate between the detector and the mobile node.
- If the distance estimates from at least 3 detectors are known, trilateration can be used to compute the position estimate.



Fingerprinting-based Techniques:

- During the offline phase, this method first collects RSS measurements at known positions across the environment, referred as fingerprints.
- During the online phase, the method compares the online measurements with the fingerprints.
- Using pattern matching techniques, the position of the tag can be estimated.



System Setup

Tags

- Transmits UWB radio pulses
- Flexible update rate
- Comes into 2 forms: slim and compact



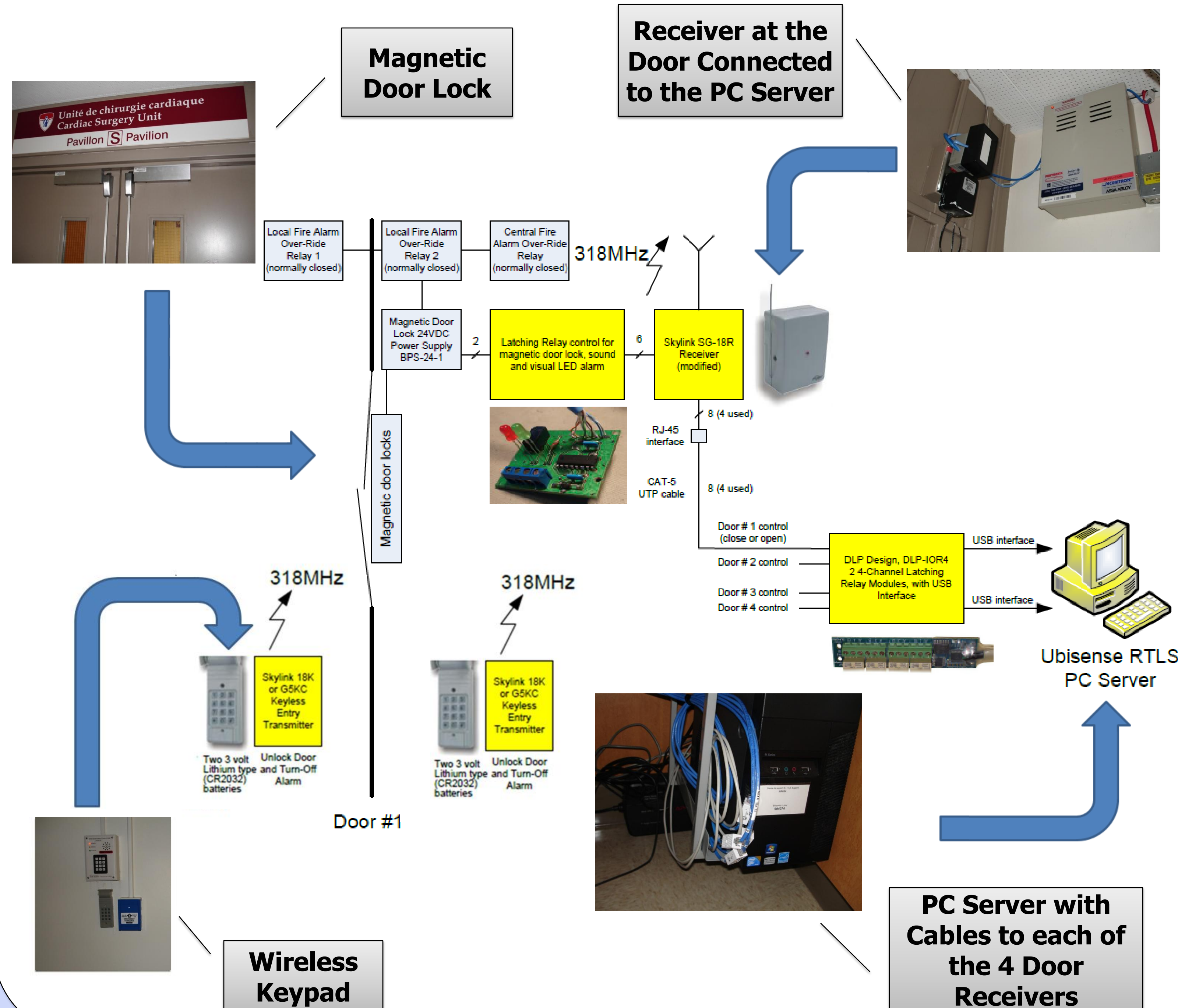
Sensors

- Detects UWB pulses from tags
- Contain an array of antennas which can measure the Angle-of-Arrival (AoA) and Time-Difference-of-Arrival (TDoA) of tag signals.
- Multiple sensors are daisy-chained through a wired link



Detectors

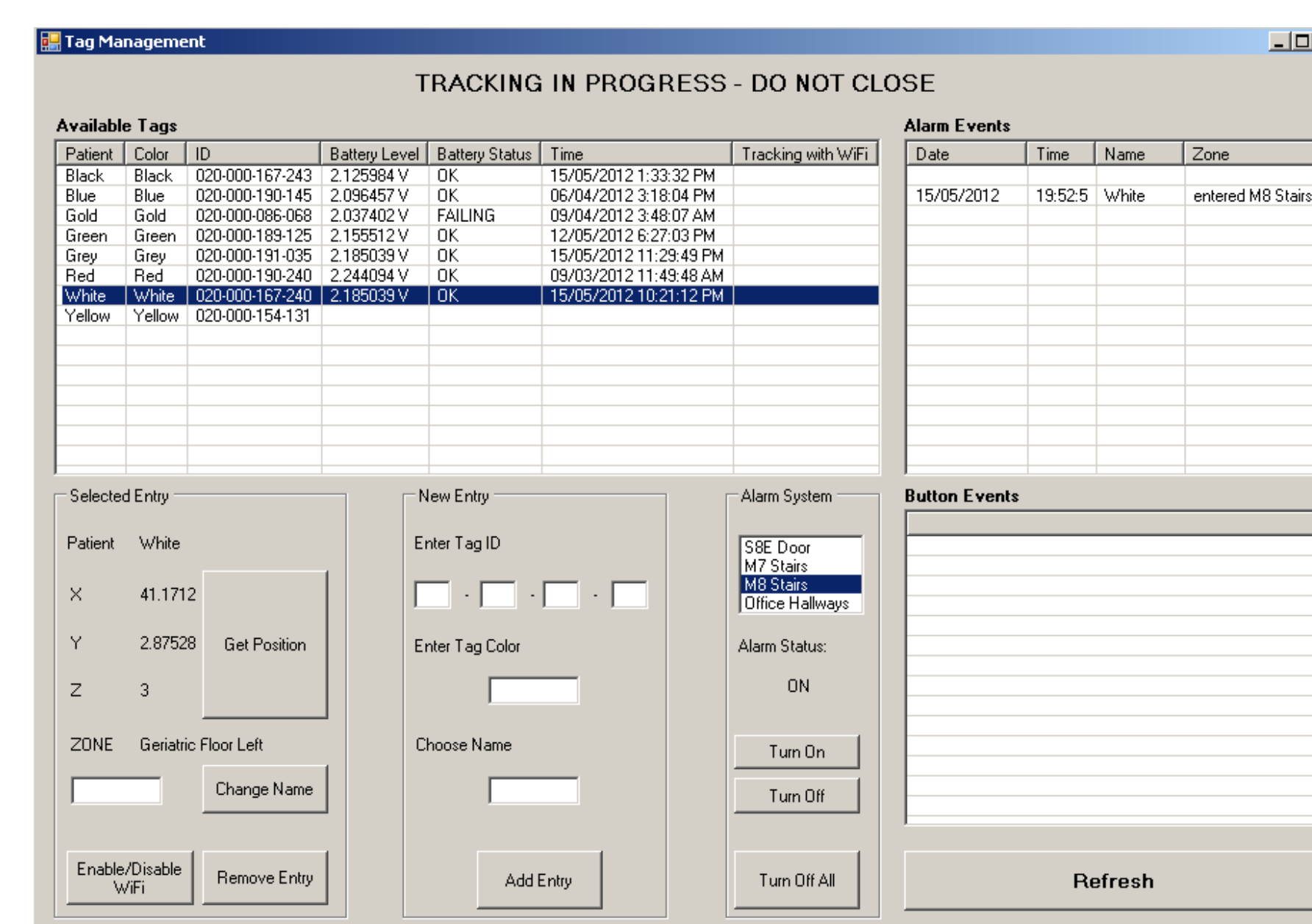
- The detector is a USB device that can detect and collect RSS measurements from tags in the WiFi range.



Applications

Displaying Position Information

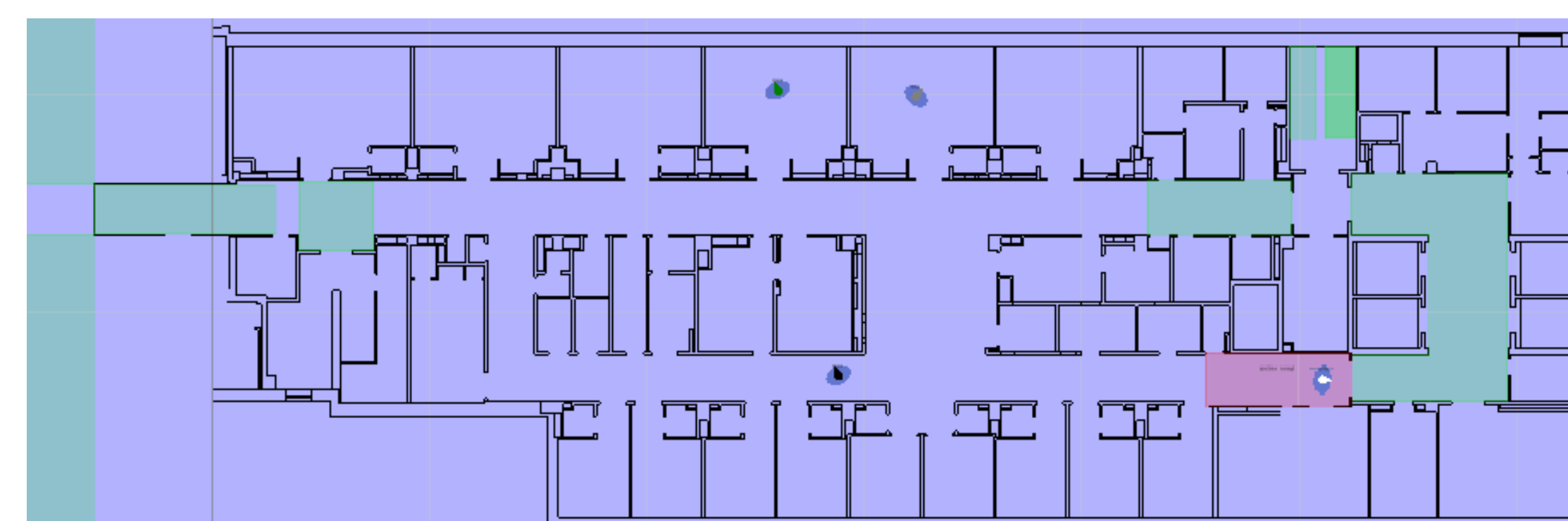
A precise location system would enable staff to track patients in a timely manner, ensuring accurate and consistent delivery of care. A user interface has been developed to display the information to the medical staff in a user-friendly manner.



Graphical User Interface Developed for the Geriatrics Department

Triggering Necessary Actions

Preventive actions can be triggered when patients get close to the exit zones. For example, when a patient is too close to a particular door, the corresponding alarm will sound and the door will be automatically locked. We show below how a patient in the alarm zone was successfully tracked.



Conclusion

With the burgeoning of health care technology, more and more systems throughout hospitals are becoming automated. A localization system would open the door to a new set of applications and gives healthcare facilities better visibility into their processes.

While the UWB positioning system provides the best accuracy, it is a expensive solution. WiFi systems are relatively cheap and can be easily deployed. However, getting reliable position estimation using WiFi is challenging due to the randomness of the received signal strength (RSS).