COLLEGE OF ENGINEERING
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

CPE496/498 Capstone Design

Indoor Localization System (ILS)

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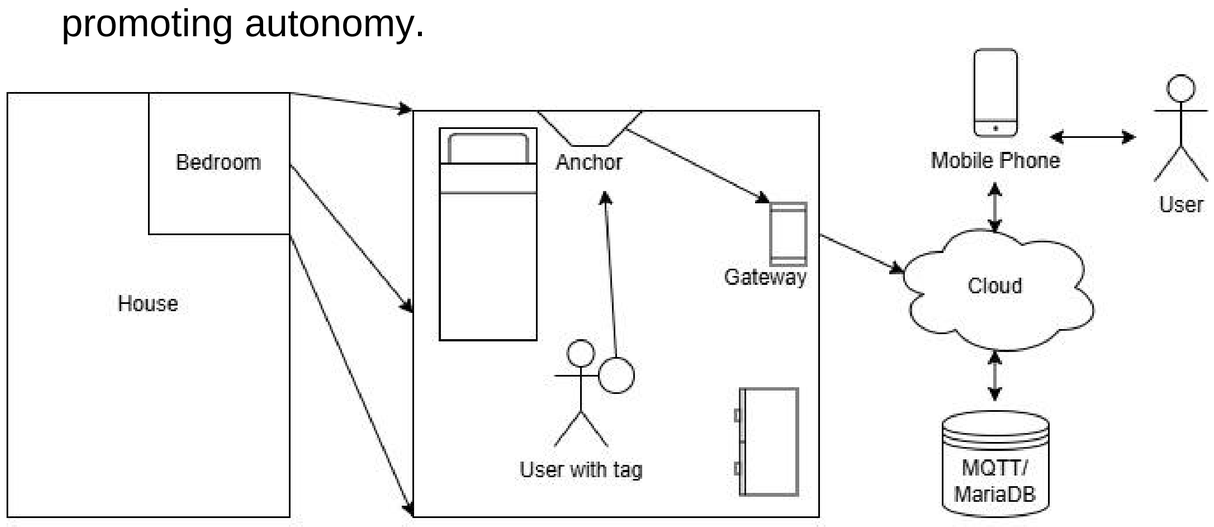
Sponsor: Susan McGrady, Eighth Street Community

Project Overview

- Assist residences with older adults or functionally disabled individuals, such as those with autism spectrum disorders, in managing daily activities and developing routines.
- Using Bluetooth Low Energy and Ultra Wide Band technologies, these individuals can wear a specialized bracelet in order to stay on task via reminders from an indoor location tracking system, promoting autonomy.



Background

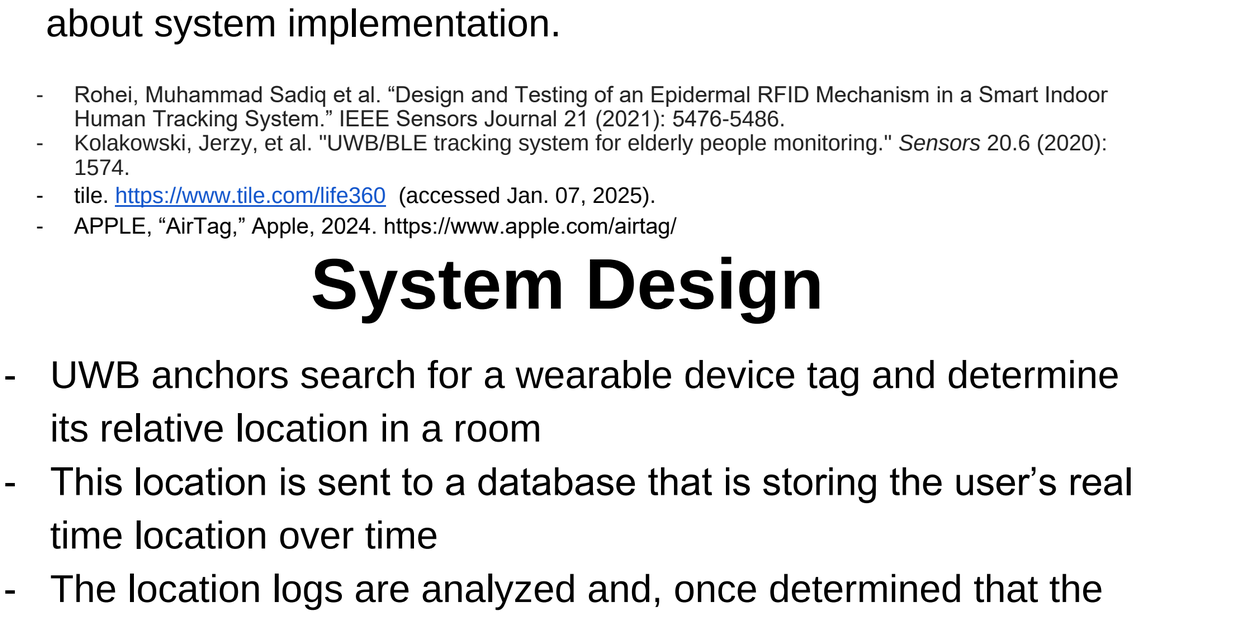
- Commercial products such as the Life360 Tile and the Apple Airtag are limited to tracking one item/person and relies on the proximity to a user's phone.
- Existing papers/journals (epidermal RFID and elderly monitoring) is mostly theoretical and does not contain detailed information about system implementation.

- Rohei, Muhammad Sadiq et al. "Design and Testing of an Epidermal RFID Mechanism in a Smart Indoor Human Tracking System." IEEE Sensors Journal 21 (2021): 5476-5486.
- Kolakowski, Jerzy, et al. "UWB/BLE tracking system for elderly people monitoring." *Sensors* 20.6 (2020): 1574.
- tile. https://www.tile.com/life360 (accessed Jan. 07, 2025).
- APPLE, "AirTag," Apple, 2024. https://www.apple.com/airtag/

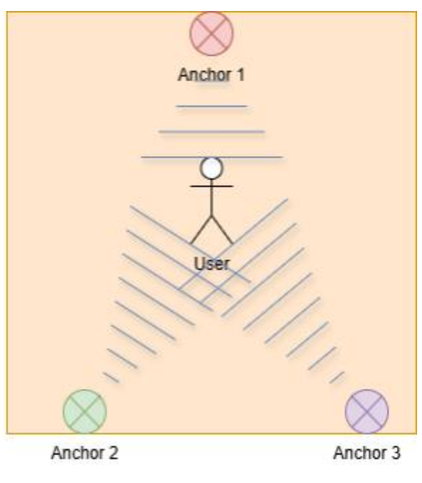
System Design

- UWB anchors search for a wearable device tag and determine its relative location in a room
- This location is sent to a database that is storing the user's real time location over time
- The location logs are analyzed and, once determined that the user has been off task, alerts the user on their mobile application

Design Approach



- The user will carry a programmed wearable device that is sending the user's location information to sensors anchored around the room
- This data is then sent to the mobile app where it is displayed to the user.



Objectives/Tasks

- Developing a non-intrusive mechanism that provides real-time monitoring by a sensor system
- Creating a mobile application that will allow administrators and users alike to manage their location data and preference
- Provides alerts based on sedentary behavior to remind the user to stay on task and not lounge excessively

Requirements

M1	The system shall detect a precise indoor location of a user.	E1	The minimum resolution of indoor position should be 1 m² and displayed in the app.
M2	The system shall use a wearable device, and several indoor receivers to determine the location of the user.	E2	The wearable device will contain a sensor and will be integrated with anchored sensors using BLE, UWB, and trilateration.
M3	The wearable device can be in the form of a bracelet or pendant worn by the participant under the class of users..	E3	The tag must bedesigned in the form of a bracelet with an adjustable band or a pendant with a length of 16-20 inches.
M4	The system shall use Bluetooth or UWB transmissions from the wearable device to assess indoor localization.	E2	The wearable device will contain a sensor and will be integrated with anchored sensors using BLE, UWB, and trilateration.
M6	The system should use a separate class of users and admins to restrict access to the user's location.	E4 E3	The app contains 2 different views depending on if you are an admin or a user. The tag must be designed in the form of a bracelet with an adjustable band or a pendant with a length of 16-20 inches.
M7	The system shall use an external server to collect monitoring information.	E12 E17	The database can persist the data of 2 users per house and at least 3 administrators. All reports generated will be saved to the database and accessible by residents and admins.
M8	The system shall provide real-time monitoring of users in the system.	E7	The anchors poll the location of the user wearing the sensor every 30 seconds throughout the day.

Results

- BLE and UWB sensor testing has been successfully completed.
- Integration with Home Assistant and MQTT is in place.
- The mobile app UI has been implemented.

Conclusion

- BLE and UWB sensor testing has been successfully completed.
- Integration with Home Assistant and MQTT is in place.
- The mobile app UI has been implemented.
- Conclusion:
  - A programmed wearable device sends the user's location to anchored sensors.
  - The mobile app receives this data, displays it, and generates reports to help users build healthy habits.
- Future Implications:
  - Enables independent routines for disabled adults while ensuring safety.
  - Reduces caregiver workload with real-time tracking and efficient assistance.
  - Offers greater precision and customization than Life360 and AirTag.

Acknowledgements

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