CSC2106 Internet of Things: Protocols and Networks [2023/24 T2]

Literature Review (Individual):

Literature Review of BLE/WiFi-based Asset Tracking System in Healthcare

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1. Introduction

The Smart Tracker project focuses on developing a comprehensive Smart Warehouse Inventory Tracker for indoor environments. The system aims to provide precise location information, catering to applications such as indoor asset tracking in warehouses. Utilising communication protocols, such as Bluetooth Low Energy (BLE) and/or WiFi, and microcontroller units (MCUs) such as M5StickC Plus, Super Mini ESP32-C3, and Raspberry Pi Pico, the project aims to demonstrate real-time tracking capabilities.

2. Problem Statement

The Smart Warehouse Inventory Tracker project aims to rectify the inherent limitations of contemporary IoT sensors, particularly concerning their efficacy in detecting objects in a vertical orientation within the intricate dimensions of a 3D indoor space. This deficiency becomes particularly pronounced and operationally challenging in vertical tracking scenarios, notably when applied to the precision monitoring of tools within a workshop environment. Recognising the urgency to overcome these limitations, the project introduces an innovative solution characterised by an augmentation of the sensor network, strategically increasing the number of nodes. This augmentation aims not only to bolster tracking accuracy but also to hone in on the nuanced demands of vertical tracking within the specific context of workshop tools.

Key Points:

- Vertical Tracking Limitation: The prevailing generation of IoT sensors grapples with challenges in effectively detecting objects oriented vertically within the intricate spatial landscape of a 3D indoor environment. This limitation poses a substantial impediment to achieving precise and reliable tracking outcomes.

- Enhanced Accuracy: The proposed solution unfolds as a meticulous strategy involving a discerning increase in the number of nodes within the sensor network. This deliberate augmentation is envisaged as a cornerstone for achieving a paradigm shift in tracking accuracy, transcending the constraints imposed by current sensor limitations.

- Workshop Tool Tracking: A focal point of this initiative is the tailored attention given to the tracking of tools within the dynamic setting of a workshop environment. Recognising the unique challenges presented by workshop scenarios, the solution aims to elevate the accuracy and reliability of tracking specifically for tools, thereby addressing a critical operational need.

- Scalability Consideration: The design philosophy underpinning the proposed solution is inherently forward-looking, with scalability positioned as a paramount consideration. Beyond immediate requirements, the solution is meticulously crafted to seamlessly expand and adapt to the evolving demands of future expansions, ensuring sustained relevance and operational efficiency.

3. Literature Review

The literature by Yoo et al. (2018) explored the implementation of a real-time location system (RTLS) for asset tracking in a tertiary care hospital, with the aim of enhancing hospital productivity and nursing process. This could possibly be emulated in a warehouse setting for the group project.

BLE/WiFi Integration: Yoo et al. (2018) explained that the asset tracking system utilised the hospital's pre-existing WiFi infrastructure for general asset tracking across all hospital wards, and it also used independent BLE sensor beacons to enhance the tracking accuracy in specific areas. According to Yoo et al. (2018), the hospital information system, integrated with the asset management system, allow users to verify each asset's location and the tag battery's status. Yoo et al. (2018) stated that the combination of WiFi and BLE allow for a comprehensive tracking system, which considers the trade-offs between accuracy and energy consumption.

Target Asset Selection: Yoo et al. (2018) emphasised the importance of defining clear targets for asset tracking systems; by selecting only meaningful assets, it helped to streamline the inventory. Yoo et al. (2018) stated that the system allows users (e.g. nurses) to ascertain the assets' status, specifically if they were onsite, offsite, or loaned, and the location of the assets are also labelled clearly on the aerial floor plan of the hospital. Another group of users (administrators) could also determine other information such as the assets' current and previous locations, tag battery's status (Yoo et al., 2018).

Technical Limitations: However, Yoo et al. (2018) acknowledged technical challenges, such as inaccuracies in location tracking because of disruptions from other radio waves, with users reported occasional discrepancies in asset locations, indicating potential issues with the system's real-time accuracy.

Battery Life and Replacement: Yoo et al. (2018) highlighted that the reliance on battery-powered tags and beacons poses challenges, as real-time tracking caused battery draining, which requires periodic replacements. Yoo et al. (2018) noted the difficulty of replacing batteries for a large number of assets, suggesting the need for more sustainable power solutions to enhance operational efficiency.

Tag Size vs. Efficiency Trade Off: Yoo et al. (2018) mentioned that larger tags with extended battery life resulted in reduced adhesive power and occasional tag loss. Yoo et al. (2018) highlighted that balancing these factors requires careful consideration of site-specific needs and organizational policies.

The strengths and limitations highlighted in the literature offer valuable considerations for the group project, which involves implementing a similar system in a warehouse setting.

4. Reference

Yoo, S., Kim, S., Kim, E., Jung, E., Lee, K. H., & Hwang, H. (2018). Real-time location system-based asset tracking in the healthcare field: lessons learned from a feasibility study. *BMC medical informatics and decision making*, *18*(1), 80. https://doi.org/10.1186/s12911-018-0656-0