 

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

Literature Review (Individual)

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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) 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 tools within a workshop environment. Recognising the urgency to overcome these limitations, the project introduces an innovative solution that augments 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: Ultra-wideband Positioning Systems and Barometers

The study “Improved Height Estimation Using Extended Kalman Filter on UWB-Barometer 3D Indoor Positioning System” by Ji Li, Yepeng Wang, Zhuo Chen, Linlin Ma, and Suqing Yan covers the use of Ultra-Wideband (UWB) technology and barometers to calculate positioning within an indoor environment. This literature review aims to explore the advantages and disadvantages of Ultra-wideband (UWB) to calculate indoor positioning. We will also explore the use of barometers to provide an accurate vertical position.

UWB uses pulse radio to transmit a large bandwidth in short cycles while consuming little power, following the 802.15.4 standard to communicate with other peer devices. This can be used in indoor navigation and tracking.

(Weakness)

Since UWB positioning is derived from real-time calculations, requiring input data from signals such as Time-of-arrival (TOA), Angle-of-arrival (AOA) etc. It is also impacted by environmental factors such as Non-Line-of-sight or the lack of. (NLOS/LOS). This makes it very difficult to ensure the accuracy of the calculated positions. Especially in a warehouse scenario, where there are many metal objects or physical obstructions interfering with UWB accuracy. (Wang et al., 2018, pp. 3). Inaccuracies may be present even with the extended Kalman filter (EKF) used by Li et al. Adjustments to calculations must be made so that it may be mitigated for error processing. (Hao et al., 2018, pp. 1)

(Strength)

It should be noted that barometers can be subjected to environmental factors such as temperature and wind. Outdoors, air pressure decreases, the higher it gets. This does not necessarily hold true in man-made conditions such as air-conditioned buildings. (Binghao et al., 2013, pp. 2). This may lead to inaccuracies in air pressure measured by barometers. Accuracy of air pressure at the beginning and end of movement activity can greatly affect the location accuracy when only using barometers (Yu et al., 2019, pp. 10). However, Li et al.’s combined usage of UWB and barometer to determine vertical position provides relatively accurate vertical positions. Others have found similar accuracy by combining the use of barometers and other sensors and networks such as Wi-fi and iBeacons. (Fetzer et al., 2023, pp. 9).

## 4. References

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