BareTag Tool-Tracker*

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***Abstract*—Over the past 10 years, the majority of tools on a construction site have converted from wired to battery-powered. While this makes tools easy to move around, it also makes them easy to misplace and an easier target for theives. Data indicates that the construction idustry suffered nearly $1,000,000,000 in loses due to tool theft in 2023 alone [1], strongly indicating the need for a robust and effective theft mitigation system. We propose the BareTag Tool-Tracker, a novel approach to tool tracking that utilizes Ultra-Wideband(UWB) and Bluetooth Low-Energy(BLE) radio in order to real-time track tools, materials, or other valuable items on a construction site. The system utilizes a series of pre-placed Anchor posts, that send UWB pings to a Tag that is connected to a tool. Each Anchor can then calculate its distance to a Tag, relaying that information to a Base station over Long Range(LoRa) radio. The base station runs the aggregated distance data through a multilateration algorithm that can calculate the Tag's location with ± 10 cm accuracy. The calculated location is then output to a local terminal, as well as uploaded to a cloud database for future reference. Altogether, the BareTag Tool-Tracker is highly accurate (± 10 cm), low-power (1 year of battery life), and scalable (increase range by adding additional Anchors).**

***Index Terms*—component, formatting, style, styling, insert**

I. Introduction

On constructions sites tools are constantly being misplaced or passed around causing workers to spend extra time searching and waiting before returning to their assignments. Furthermore, in recent years research has shown that theft on constructions sites has built up costs for construction companies and slowing down projects, very detrimental for small companies. In recent years many different approaches have been taken to solve this growing issue.

A. Significance

In 2016 it was estimated that in the United States alone $1,000,000,000 worth of construction tools were stolen [1]. A survey by the Charted Institute of Building discovered that out of the 1000 construction mangers interviewed, a third responded that they had experienced theft weekly on their sites. It was estimated that each of these weekly incidents cost the business an average of $6,000, in some cases, in a single night the site had lost $100,000 worth of equipment [2]. What's worse is that this is a growing case. The FBI has reported that in 2021, theft on construction sites had outgrown theft in convenience stores [3]. Many managers have reported that these incidents have escalated to organized crime with evidence of sophisticated planning and coordinated executions. [2]. Theft on the site is not only costly to the business owners but also even more inconvenient for the construction workers and their managers. Due to the lack of proper tools construction workers may not continue with their assignments and managers have to keep pushing deadlines. The result of this costs the business not just in extra wages, but also extra insurance and the company's reputation [2].

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B. Context and Survey of Similar Solutions

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C. Societal Impacts

Define abbreviations and acronyms the first time they are used in the text, even after they have been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, ac, dc, and rms do not have to be defined. Do not use abbreviations in the title or heads unless they are unavoidable.

D. Goals Specifications and Testing Plan

- Use either SI (MKS) or CGS as primary units. (SI units are encouraged.) English units may be used as secondary units (in parentheses). An exception would be the use of English units as identifiers in trade, such as "3.5-inch disk drive".
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II. Design

A. Overview

At a high level, the BareTag Tool Tracker utilizes Ultra-Wideband (UWB), Bluetooth Low Energy (BLE), and LoRa radio in order to real-time track an item's location on a construction site. The technology at the core of our design is UWB radio. UWB radio is a form of radio communication that utilizes pulses of radio energy at specifically timed intervals in order to transmit information. This protocol is not ideal for data communication, but is very accurate in performing distance ranging. With two UWB transceivers, one configured as the controller (Anchor) and the other configured as the responder (Tag), the controller can send a UWB ping to the responder. The responder will almost immediately send back a response ping, the controller can then use the time between when it sent its ping to when it received the response ping, in order to calculate the distance between the two transceivers.

$$d = \frac{\frac{ToF}{2}}{c}$$

Where d is distance, ToF is time of flight, and c is the speed of light.

B. Tag

C. Block 2

D. Block 3

E. Block 4

Acknowledgment

The preferred spelling of the word "acknowledgment" in America is without an "e" after the "g". Avoid the stilted expression "one of us (R. B. G.) thanks ...". Instead, try "R. B. G. thanks...". Put sponsor acknowledgments in the unnumbered footnote on the first page.

References

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