



Performance evaluation of ultra wideband technology for construction resource location tracking in harsh environments

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ARTICLE INFO

Article history:

Accepted 2 May 2011

Available online 31 May 2011

Keywords:

3D
Accuracy
Error analysis
Laser scanning
Location tracking
Ultra wideband
Robotic Total Station
RFID
Safety
Visualization

ABSTRACT

Emerging wireless remote sensing technologies offer significant potential to advance the management of construction processes by providing real-time access to the locations of workers, materials, and equipment. Unfortunately, little is known regarding the accuracy, reliability, and practical benefits of an emerging technology, effectively impeding widespread adoption. This paper evaluates a commercially-available Ultra Wideband (UWB) system for real-time, mobile resource location tracking in harsh construction environments. A focus of this paper is to measure the performance of the UWB technology for tracking mobile resources in real-world construction settings. To assess tracking accuracy, location error rates for select UWB track signals are obtained by automatically tracking a single entity using a Robotic Total Station (RTS) for ground truth. Furthermore, to demonstrate the benefits of UWB technology, the paper provides case studies of resource tracking for analysis of worksite operations. The work demonstrates the applicability of UWB for the design of construction management support tools.

Published by Elsevier B.V.

1. Introduction

The dynamic nature of construction activities, in comparison to the manufacturing industry and its mostly stationary fabrication plants and assembly environments, presents a significant challenge towards realizing the goal of understanding construction site activities. Hindering this understanding is the fact that production control protocols in the construction industry are labor intensive, manual, and error prone [1]. Recent developments in remote sensing and automated data acquisition technology promise to improve upon existing material management strategies [2–7]. Similar benefits are anticipated for process management strategies.

To date, many barriers exist that prevent owners and contractors from deploying data acquisition technology in construction. These include the risk of failure during the initial implementation phase and the high cost of implementation. An additional barrier is the lack of demonstrated benefits associated with emerging technology, e.g. the inability of the owner and/or contractor organization to exploit the information collected. When faced with known costs but unknown returns on investment, adoption of emerging technology can be non-existent. Utilization of the technology is then limited to scattered implementations in various engineering subfields until more precise

cost-benefit valuations are determined [8]. It is, therefore, important to investigate how promising real-time location tracking technology may advance construction practices and enhance production control procedures in the construction industry. Two key areas closely tied to the economics of construction projects are productivity and safety [9]; lapses in both are responsible for significant losses in the construction industry.

With regards to productivity, one key area identified as a critical need is the localization and tracking of assets that are linked to work tasks, including workforce, equipment, and materials [10,11]. For example, material handling and transport has been identified as a critical work task in construction [11,12]. Recent studies report significant amounts of time spent on materials searches in lay down yards [13]. The material flow for a steel erection process at industrial job sites may involve the delivery of the material component from the fabrication plant to a temporary lay down yard. A lay down yard is an important temporal space in the assembly process of material components, as it allows for storing and sorting the components in the correct order, and provides a healthy temporal buffer to ensure parts availability when needed. Prior research has shown that the current process of material handling on large industrial job sites is inefficient [14].

Within the context of safety, significant time and economic resources are lost when workers are injured or killed by loads during work tasks [15,16]. Current construction best practices in material handling prescribe the foremen to blow a whistle or the equipment

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