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Fast Wireless Two Dimensional Object Tracking

This article presents a system for wireless, fast, and two dimensional object tracking in indoor environments. The system is based on the narrowband ultra-high frequency (UHF) radio frequency identification (RFID) technology and the use of low-cost transponders (tags) with low maintenance requirements. These tags have a unique identification number and are attached to the objects to be tracked. Ultimately, the position of a uniquely identified object can be determined in a room, which reduces search and dwell times and thus associated costs.

Introduction

In narrowband passive ultra-high frequency (UHF) radio frequency identification (RFID) systems, a reader wirelessly communicates with batteryless transponders (tags) which have unique identification numbers (IDs). By attaching these tags to objects, also the objects can be uniquely identified. The tag signal, e.g., the tag ID, is transmitted to the reader by a modulation of the signal that is reflected at the tag. The detected tag signal at the reader can be split up in a tag signal amplitude and a tag signal phase. The tracking system exploits the knowledge of the tag signal phase to track the tagged objects within a room.

The presented object tracking system provides various advantages compared to related work [M. Scherhäufl et al., 2015; T. Liu et al., 2016; R. Miesen et al., 2013; A. Buffi et al., 2015; A. Parr et al., 2013]. Firstly, only one communication cycle between the reader and the tag is necessary to determine the current object position. Secondly, based on the detection of the tag signal phase, the current tag position is calculated analytically, which is much faster compared to numerical calculations presented by others. These two advantages allow the tracking of fast moving tags and associated objects. The third advantage is that the system does not rely on the knowledge of possible tracks as other solutions do, but provides two dimensional (2D) position updates in arbitrary directions.

Object Tracking System

The tracking system is based on a multiple reader antenna setup as shown in Fig. 1. One transmit antenna (TX) and two receive antennas (RX1/2) are arranged at the same height and are horizontally distributed. The origin of the 2D coordinate system (x vs. y) is located in the middle of RX1 and RX2.

To demonstrate the system, the tag to be tracked is mounted on a pole at the same height as the reader antennas. As a requirement, the first tag position has to be known by the system.

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The tag signal is then detected at both receive antennas simultaneously as well as the corresponding tag signal phases. When the position of the tag changes, also the detected tag signal phases at RX1 and RX2 change. These changes and the specific reader antenna setup allow the calculation of the new tag positon.

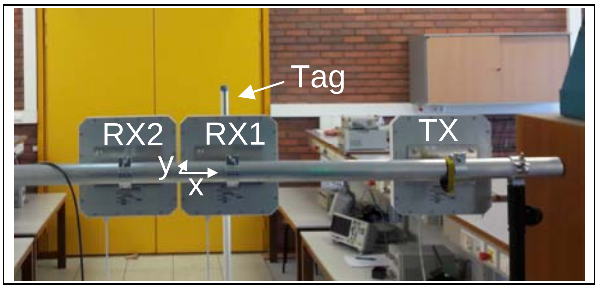

Fig. 1: The antenna setup of the object tracking system consists of one transmit antenna (TX) and two receive antennas (RX1/2). The tag position is determined by means of the tag signal phase and the specific antenna setup. This figure also shows the laboratory environment in which the verification measurements have been conducted [Görtschacher et al., 2017].

Figure 2 shows the recorded track of the tag (estimated positions) compared to the actual positions of the tag in a laboratory environment (see Fig. 1). By relying on the narrowband and low-cost UHF RFID technology in such environments, the received tag signal is distorted by reflections caused of objects in the vicinity. These system prerequisites make it impossible to determine tag positions in the single-digit centimeter range. However, the experiment shows that the maximum error of the estimated track is lower than 30 cm. An exceptional good result in comparison to existing systems based on the UHF RFID technology. In addition, the known starting position and the last position of the track are almost equal, which means that errors do not accumulate.

Impact and effects

With the presented tracking system, objects that are equipped with UHF RFID tags can be uniquely identified and tracked within a room. Furthermore, the UHF RFID reader that detects a specific object can be assigned to a certain room. With this, the room and the position within the room is known, which makes logistic of objects much more efficient.

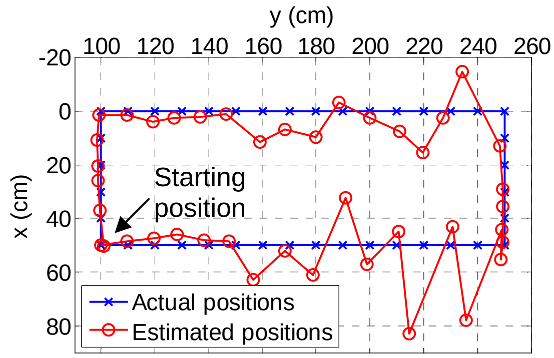

Fig. 2: Actual positions versus estimated positions of the tracked tag in the laboratory depicted in Fig. 1. Starting from a known starting position, the positions are recorded in 10 cm steps around a rectangular track. The maximum positon error is lower than 30 cm [Görtschacher et al., 2017].

A possible application of the system is the tracking of measurement devices in an automotive test factory. Such a test factory consists of several automotive test beds in which different measurement devices have to be shared. By exploiting the tracking systems, these devices can be located quickly. The time wasted for searching the measurement devices can thus be decreased by wirelessly tracking the measurement devices within the test factory. These time savings obviously lead to cost reductions.

Contact and information

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