A Wireless Ad Hoc Localization System

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***Abstract*—We present a solution for a wireless ad hoc localization network using RTLS Flares. The system does not rely on a central gateway nor on a complex infrastructure for estimating the position of mobile tags.**

I. Introduction

The benefits of an indoor localization solution are widely accepted e.g. for the navigation of robots, the coordination of rescue teams or the retrieval of certain objects.

With the help of ultra-wideband signals (UWB), the position of a mobile device can be determined quite easily due to the measurement of propagation delays of an emitted signal to different fixed devices. While other approaches like the measurement of signal strengths of Wifi signals or Bluetooth beacons have a limited accuracy or range, UWB promises to measure the distance accurately up to some centimeters. However, it is therefore necessary to know the exact position of fixed-points in the room to derive the relative position of the mobile nodes. As this might be impossible or too complex, a process has been developed in which the fixed-points are calibrated automatically and the mobile nodes do not require that information in advance.

II. System Overview

The system consists of so-called RTLS Flares of which one is shown in Fig. 1. The RTLS Flares are small embedded systems with a UWB transceiver, a micro-controller, an inertial-measurement unit and a USB interface. The hard- and firmware is equal for the anchors and mobile tags. The only difference is their role depending on the configuration and the quality of their individual position estimation.

The distribution of these Flares allows the set-up of a wireless ad hoc network. The first four Flares are configured to establish a three dimensional coordinate system and provide the network's first fixed-points for other modules' distance measurement. A new network participant estimates its own position using already available fixed-points. As the quality of this estimation improves, the Flare changes its role from mobile node operation to anchor mode and advertises its position as an additional reference for other mobile tags. In consequence the network coverage enhances and the position estimations improve for additional network participants.

Fig. 1. RTLS Flare module

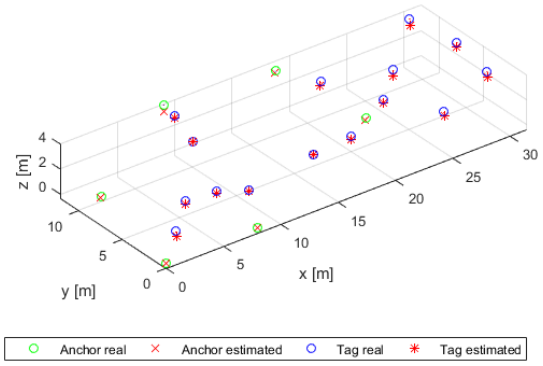

Fig. 2. Simulation results

The integrated localization engine enables the position estimation without additional, external devices such as computers or smartphones. The USB interface provides the energy for the operation of the RTLS Flares and enables the information exchange with higher-level software solutions like ERP systems.

III. Simulation Results

The ground truth data from the IPSN 2016 Microsoft indoor localization competition has been used for evaluating the system via simulation under line-of-sight condition between all network nodes. Six Flares are deployed and serve as anchors. Five of them measure their position with respect to the first module at the origin. The seventh RTLS Flare is used as a mobile tag to acquire the location of each point. The results are shown in Fig. 2. The mean error is 0.32 m assuming a standard deviation of 0.3 m for the range measurement between two nodes.