IntraNav – Low-Cost Indoor Localization & Navigation System

For industry and consumer markets

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ABSTRACT

In this paper, we briefly describe IntraNav, our low-cost and highly accurate indoor localization and navigation system, designed for consumer- and especially industrial-markets. The system is comprised of one (or more) tag and multiple anchor nodes. The anchors do not have to interact or be connected with each other; this makes the system very infrastructure and deployment friendly. There is no server, gateway or connections required.

The positions are calculated with the help of TDOA – Time Difference of Arrival, based on UWB (Ultra Wide Band) signals (3,4GHz to 4,8GHz). The 3D orientation is determined with the help of a highly integrated low-power MEMS IMU located on the tag-device. [1]

Keywords

Indoor localization; low-cost; industrial and consumer tracking; sensor data fusion

1. INTRODUCTION

Many years of academic research in the field of tightly coupled sensor data fusion (INS+X), development and feasibility studies with customers, lead Quantitec to create a low-cost indoor-tracking-system [2] with industrial-grade precision. The goal of these case studies was to *make things traceable with low-cost technologies,* which helped us make a marketable and affordable system able to track objects indoors with high accuracy. The centerpiece of our technology is the *FusionENGINE,* a library of algorithms conceived for error-correction, and fusion & calibration of sensor data. The *FusionENGINE* is based on adaptive modelling, estimation and sensor data fusion. [3]

Using the low-interference frequency band 3,4GHz to 4,8GHz allows us to stay away from the usual frequencies which can become a problem when deploying the system in highly regulated industrial areas.

2. HARDWARE

The deployed hardware consists of two components, the small, light weighted anchor nodes and one tag; both devices were conceived by Quantitec. There are two different Tags, a smart tag which does all the processing by itself and delivers a position; or a simple tag which passes the data on to a device of your choosing for further processing. Both tags have advantages, depending on the customer's wishes; either the smart tag for decentralized and autonomous systems or the simpler tag for mostly nonindustrial applications.

Figure 1. IntraNav anchor node and tag

The radio-localization's update frequency can be drastically reduced thanks to the integrated IMU, which is able to interpolate and bridge the position. This way a lot of energy gets saved, radio traffic is minimized and in case of extreme shadowing the system still works properly. The update rate can be dynamically defined and variable zones can be created.

Three to four anchor nodes are sufficient to determine the 2D/3D position. The tag is designed to communicate with as less as possible anchors in order to keep radio traffic and energy consumption at its lowest.

2.1. Deployment

The presented version of the system at the ISPN 2015 will require the installation of 10 anchor nodes. These nodes will be powered by USB power supplies or USB-Power-Packs. No other connections or infrastructure will be required. In this case we will be using a smart tag for the calculation of the position.

3. POSITION DETERMINATION

The position measurement is performed by calculating the time difference between the anchor nodes and our smart tag as well as through the one way ranging method and company-internal algorithms.

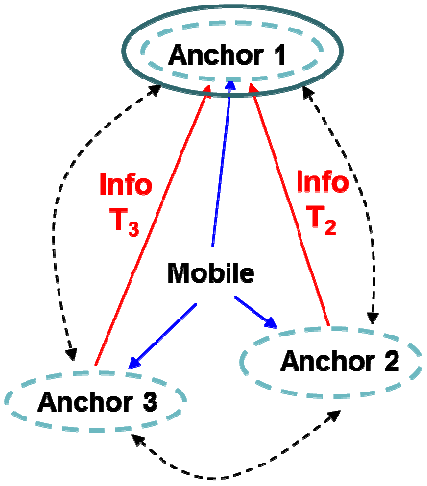

Figure 2. TDOA estimation [4]

$$\tilde{T}_{21} = T_1 - T_2 \Rightarrow \tilde{d}_{21} = \tilde{T}_{21}.c$$
$$\tilde{T}_{23} = T_3 - T_2 \Rightarrow \tilde{d}_{23} = \tilde{T}_{23}.c$$

Equation 1. TDOA - Basic estimation function [4]

4. PILOT PROJECTS AND FEEDBACK

The high precision of the system has been proved several times. In our offices in Germany we have a demo-system installed which has an accuracy of ±3cm to ±5cm depending on the calibration. We are currently involved with five entities from the automotive, media, machinery and logistics industry. Quantitec is developing in conjunction with these customers/companies a tailored tracking & navigation system for each of their applications.

5. FUTURE DEVELOPMENT

Goal is to miniaturize the system to a chip level format in order to integrate it into Wi-Fi access points, Smart-Phones, wearables or for example even LED bulbs (IntraNav enabled devices). Another goal is to reduce the costs of our technology even further to make it suitable for mass-production and -markets such as daily consumer applications.

1. REFERENCES

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