IntraNav – Low-Cost Indoor Localization System & IoT Platform

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 (at least) one 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 large/complex infrastructure required and it is effortless to install.

The positions are calculated with the help of TDOA – Time Difference of Arrival, based on UWB (Ultra Wide Band) signals (3,9 GHz / 6,4 GHz). The 3D orientation is determined with the help of a highly integrated low-power MEMS IMU located on the tag-device. [1] This unique hybrid solution or fusion of signals allows the system to run smoother and stabler as well as offer more than just positioning information. (e.g. sleep-mode when not moved or shock detection)

Keywords

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

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 bands 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 (at least) one tag; both devices were conceived by Quantitec. There are different type of Tags such as smart tags which do all the processing by themselves and deliver a position, or a simple tag which passes the data on to a device of your choosing for further processing as well as different sizes, interfaces and enclosures. The use of the different tags depends on the customer's wishes; either the smart tag for decentralized and autonomous systems or the simpler tag for mostly nonindustrial applications.

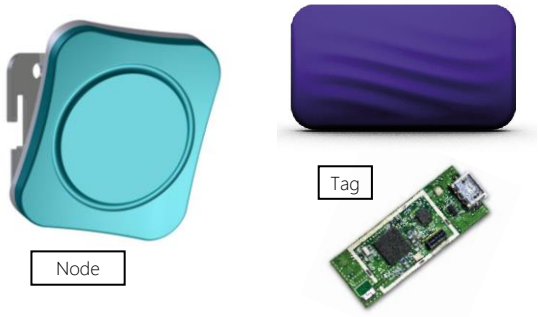

Figure 1. IntraNav nodes and tag

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 energy consumption and radio traffic is minimized, and in case of heavy shadowing the system is still able to work stable. 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

A cell is comprised of e.g. 4 Anchors and 1 Tag. One would deploy the 4 anchors in a rectangular or similar form. Distance between the anchors would be between 15m to 50m depending on the obstacles in the tracking space. The nodes can be USB powered, per battery or any other available power supply. No further connections or infrastructure is required.

3. Distance Measurement

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 internal company algorithms.

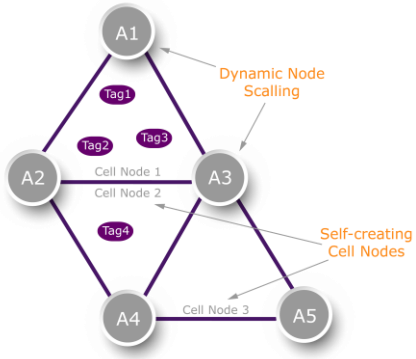

Figure 2. Cell & Tag arrangement

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

Equation 1. TDOA - Basic estimation function [4]

4. Pilot Projects and Results

The high precision of the system has been proved several times. We have had a number of pilot projects as well as first orders from large industrial customers where we have achieved an accuracy of ±5cm to ±10cm depending on the calibration. We are currently involved with many customers from the manufacturing, intra-logistics and automotive industry. Quantitec is working closely with these customers in order to even further adapt the system to industrial environments.

5. IoT & Industry 4.0 Platform

The platform is one of the heart-pieces of our system. It does not only provide the customer with a hardware but with an added-value. Our platform collects the data from all our sensors as well as other sensors and offers a clear overview of the tracked areas. Furthermore, the platform offers analytics, visualization, historical data analysis, statistics and many more. Functions such as heat maps, zones, trails and others are part of the platform as well.

Our platform is being created in collaboration with AWS and is designed for the future IoT, BigData and Analytics segment.

6. Future Development

Keep it the most scalable indoor localization system available. Develop and push our platform so that it becomes a standard.

Possibly 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). Further 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

[1] Ronald Christensen, Advanced Linear Modeling, Second Edition, Springer Texts in Statistics 2000

[2] Markus Haid, Jan Breitenbach, Low cost inertial orientation tracking with Kalman filter, Applied Mathematics and Computation, Volume 153, Issue 2, 4 June 2004

[3] Chris Harris, Xia Hong, Qiang Gan, Adaptive Modelling, Estimation and Fusion from Data, A neurofuzzy approach, Springer

[4] Rick Roberts, Harris Corporation, TDOA Localization Techniques, IEEE 802.15-04a/572r0, 4 October 2004

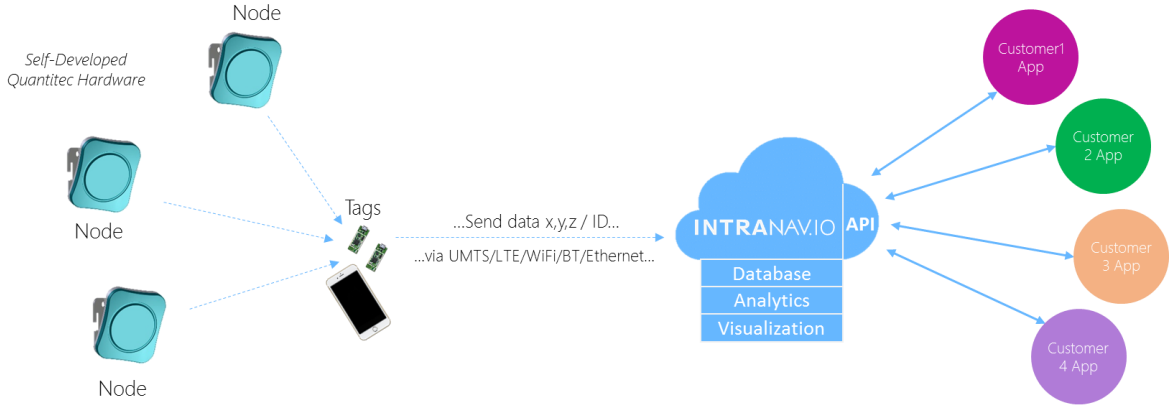

Figure 3. IntraNav System & Platform Overview