Indoor localization based on low-power chirp transceivers

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1. INTRODUCTION

In recent years number of approaches to measure distance between wireless devices and determine their absolute location emerged. We got used to ubiquitous presence of GPS/GLONASS devices and abundance of location-aware applications and services. Unfortunately, satellite based localization systems cannot be used (or at least experience difficulties) in indoor environments and underground. Consequently, number of alternatives were investigated and proposed.

Recently lots of attention is focused on WiFi (IEEE 802.11.x) and low-power radio networks (IEEE 802.15.4) in quest to enable them precise distance measurement and absolute localization within predefined area. As a result a number of radio technologies and techniques were (and still are) developed and tested – ultra wide band (UWB), chirp modulation, radio interferometric localization (RIL) and precise time measurements, just to name a few.

2. Related work

Number of 802.15.4 transceivers manufactures enable their modules with proprietary ranging capabilities. ATMEL provides a Ranging Toolbox [1], that use proprietary approach that is likely to be a variant of RIL. NXP [2] is using dedicated time-of-flight engine to enable distance measurements in Jennic nodes. Nanotron [3] incorporates a TN 100 [4] modules that use chirp modulation and precise time measurements to increase accuracy of measurements. Recently UWB attracts more and more attention since it allows for very accurate distance measurements (below 20 cm) [5] and UWB transceivers become more compact, less power hungry and robust.

Apart from technology different ranging and localization solutions use similar approach for determining localization based on distance measurements. The most often used approach is time difference of arrival (TDoA) in which allows for large number of mobile nodes in the area of interest but require precise time synchronization of anchor nodes. This approach has another drawback – when infrastructure fails (e.g. anchors brake down, synchronization is lost) then beacons are useless, as in TDoA two mobile nodes cannot range distance between each other without infrastructure.

3. Approach

Our localization setup is based on pair-wise distance measurements. This trades off system capacity (number of mobile nodes that can be localized in a specified period of time) with lack of synchronization requirement, ability to measure the distance between any pair of nodes, even when some of the anchors fail. The absolute localization is determined based on multilateration.

In our setup we use DiZiC wireless nodes, equipped with TN 100 [4] transceiver that use chirp modulation and precise time measurements to get packet time of flight (ToF) and find a distance. Preliminary range measurements in university corridors and rooms showed that accuracy can be as low as 1 meter. Based on distance measurement between nodes the location is found with respect to anchor that have known position

4. Deployment requirements

Nodes are battery powered, deployed on tripods but can be easily attached to walls. Nodes are equipped with dipole antennas. Single node weights approximately 300g dimensions 10x10x5 cm. No need for special deployment is needed.

5. REFERENCES

[1] Atmel AVR2152: RTB Evaluation Application Software, User's Guide, 2013

[2] Jennic Wireless Microcontrolers, JN5148-001, Data Sheet, 2013

[3] Real Time Location Systems (RTLS), Nanotron Technologies GmbH, 2006

[4] TN 100: High performance CSS transceiver enabling location awareness, ST Micro, 2008

[5] DW1000, Wireless Transceiver using Ultra Wideband radio technology, Decawave, 2013