InPhase: No-Cost Phase-Based Ranging and Localization

Extended Abstract

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ABSTRACT

The InPhase system provides ranging and localization based on phase-shift measurements of RF signals over multiple radio frequencies in the 2.4 GHz ISM band. Our system consists of anchors and tags equipped with standard IEEE 802.15.4 radio transceivers. We are testing a novel approach to calculate the distance from phase measurements between anchors and tags. Our localization algorithm is able to mitigate effects of measurement errors due to multipath propagation and Non-Line-of-Sight conditions.

1 INTRODUCTION

Commercially available radio transceivers are able to measure and report the phase of an incoming RF signal allowing distance estimation between wireless sensor nodes. By deploying a special firmware to the micro controllers of the nodes, existing wireless sensor networks can be retrofitted with ranging capabilities at no extra cost for specialized hardware. The InPhase firmware is able to perform distance estimation between radio transceivers by measuring the phase of a signal over multiple frequencies. [5]

After participation in the 2015 Microsoft Indoor Localization Competition with an overall error of 1.63 meters [4], we plan to evaluate our recent improvements of the system.

2 SYSTEM DESIGN

Our system consists of anchors and tags that are deployed in the evaluation area. Anchor nodes are fixed nodes mounted to the wall or ceiling with known ground truth location. Tags are movable nodes that should be located by the system.

We designed a modular wireless sensor node based on our previously used INGA sensor node [2]. The new design allows to evaluate different radio chips by interchanging the transceiver module. Currently, we use an AT86RF233-based [1] transceiver module featuring an RP-SMA connector. This allows us to study the impact of different antenna designs on the localization performance.

The ranging itself is based on the Active-Reflector-Principle [3]. Tags are initiators in our setup, while anchors act as reflectors and are passively waiting for localization requests. The initiator starts a range measurement by sending a message via the IEEE 802.15.4 radio to any reflector. When both nodes agreed on the measurement parameters, phase measurements are conducted over multiple frequencies. Afterwards, the reflector sends its results to the initiator which can then calculate a distance.

Figure 1: Modular sensor node with AT86RF233 radio module mounted to a wall.

For localization, the measured values are sent to a computer running the localization algorithm. Localization results can be used afterwards for any service that requires location information.

3 DEPLOYMENT

We will deploy battery-powered anchor nodes in the evaluation area. Anchor nodes will be mounted to walls and ceilings (if possible). One additional sensor node is used as tag and will be located by the system.

The tag is connected via USB to a standard laptop computer running the localization algorithm. Results are displayed in real-time and recorded to disk for later evaluation.

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