3D Indoor Localization with Commercial-off-the-shelf Ultra-Wide Band Radios

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ABSTRACT

In this work, we develop a 3D indoor localization system based on commercial-off-the-shelf ultra-wide band (UWB) devices. A prototype board was developed the features decaWave DW1000 module, microprocessor and inertial navigation units (IMUs). Preliminary experiments show that the system is able to achieve average errors around 20cm in a 16.5m by 13.5m area.

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1 INTRODUCTION

Location-based services (LBS) have experienced substantial growth in the last decade with the proliferation of smart devices. To provide LBS, location awareness is an essential step. To date, indoor positioning systems (IPSs) only have commercial limited success due to low accuracy and/or high costs of infrastructure supports. Various signal sources have been exploited in IPS solutions including radio frequency (RF), acoustic, geo-magnetic, etc. Most prominently, time-of-arrival (ToA) or time-difference-of-arrival (TDoA) estimates from radio-frequency transmitters (e.g., access points, ultra-wide band (UWB) beacon nodes) have been utilized to determine the ranges or pseudo-ranges from anchor nodes to target devices and to infer locations of the latter [Leng et al. 2012; Mariakakis et al. 2014; Xiong et al. 2014].

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In this work, we develop a prototype system using decaWave DW1000 module [decaWave 2017] and demonstrate its feasibility in achieving decimeter level accuracy. UWB-based localization is known to suffer from the problem of non-line-of-sight (NLOS) paths. Absence of LOS paths will result in large localization errors. To mitigate its negative impacts, we explore a multi-pronged approach, namely, i) signal level, ii) algorithmic level, and iii) node placement. Preliminary experiments show that the system is able to achieve average errors around 20cm in a 16.5m by 13.5m area.

2 SYSTEM OVERVIEW

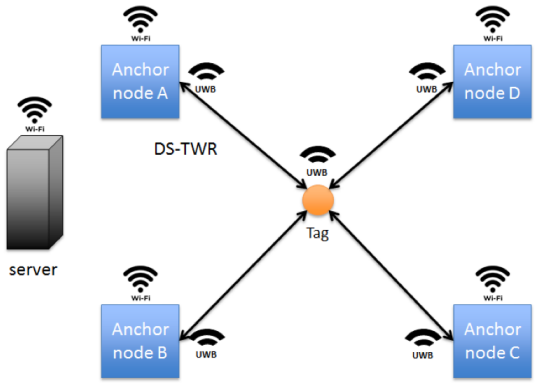

Figure 1: System Architecture

The system consists of a location server, anchor nodes and tags (Figure 1). Positioning starts from tags. Tags performs double-side Two-Way Ranging (DS-TWR) with each anchor nodes via UWB. The anchor nodes transmit the time-stamps measured during DS-TWR to the localization server via WiFi. Upon reception of the timestamps, trialeration is performed to determine the tag's location.

Our hardware platform is based on decaWave DW1000, a COTS UWB module (Figure 2). Additionally, it features an ESP8266 WiFi SOC, an STMicroelectronics STM32F105RCT6 microcontroller, and a 9-axis IMU.

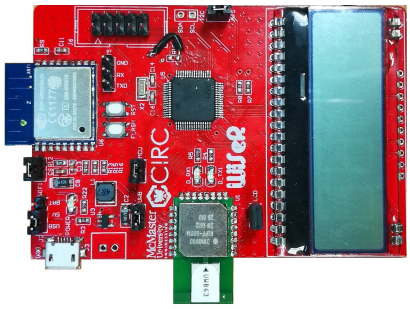

Figure 2: UWB Anchor Node

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