Drone Indoor Positioning System

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Introduction

Indoor positioning systems play a vital role in navigation within enclosed spaces. This project focuses on the development of an indoor positioning system for the RoboMaster Tello Talent drone, with an emphasis on Received Signal Strength Indicator (RSSI) technology.

Objectives

1. **Evaluate the feasibility** of using RSSI-based positioning given hardware limitations.
2. **Implement** an indoor positioning system for the RoboMaster Tello Talent drone.

Methods

Three common indoor positioning techniques (RSSI, AoA, ToF/ToA) were explored. RSSI-based positioning, compatible with the hardware, was selected. The drone comes equipped with an ESP32 module which supports BLE. This module made RSSI-based positioning possible without adding any additional third-party hardware.

Multiple ESP32 microcontrollers were programmed to send BLE advertisements which the drone received using the module.

Software Application Project

ECTS credits: 20

Date of publication: 2023, autumn

Instructors: Olli Himanka

The drone communicates with the main Python program using DJI's Tello SDK 3.0 (1), through Wi-Fi UDP protocol.

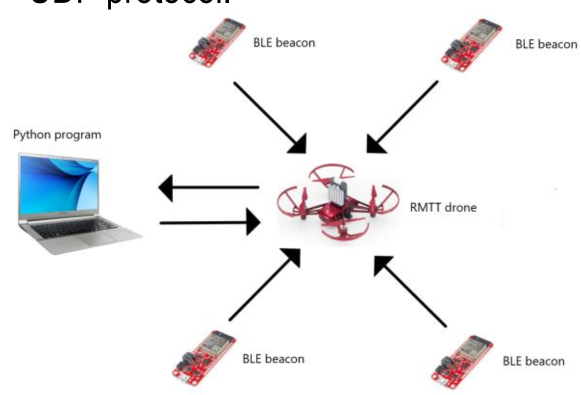

FIGURE 1. Overview of the system

The system has two different methods for estimating the drone's position: trilateration and fingerprinting.

Trilateration method takes in the RSSI values from all BLE beacons and converts them into real distances. These distances are then used to calculate the drone's position using trilateration. The position is then post-processed to increase accuracy in some situations.

Fingerprinting method requires initial database setup. The database consists of RSSI measurements (fingerprints) taken in known locations. After database is initialized the current RSSI values and compared to the fingerprints using K-nearest neighbor algorithm (2), giving you the estimated location.

Results

Among multiple measurements where the drone was flying at a steady speed, the average error between estimated and real location was ~3.3m. When the drone was hovering in place, the error was lower, around 2.8m. These measurements were taken using the trilateration method.

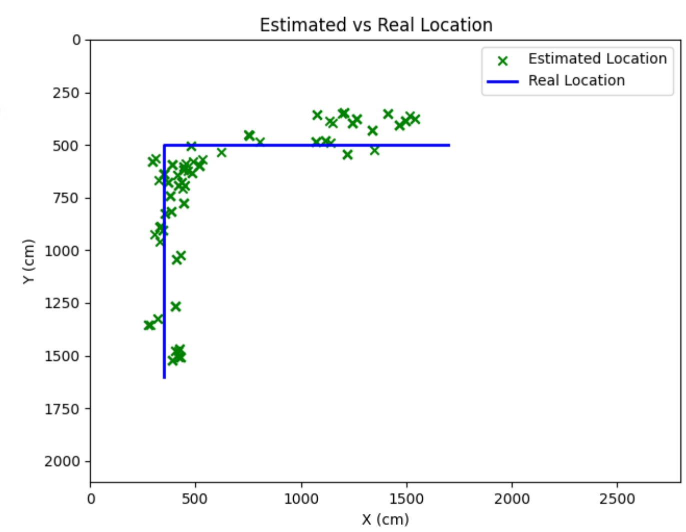

FIGURE 2. Example measurement.

Fingerprinting method was left unfinished due to time constraints.

Conclusions

The positioning accuracy is surprisingly good for hardware that is not designed for indoor positioning. To achieve sub-meter accuracy AoA or ToF/ToA is necessary (3), but this approach would require adding additional hardware to the drone.

References

1. Tello SDK 3.0

2. scikit-learn-knn

3. Survey on WiFi-based indoor positioning techniques