A Complete Indoor Positioning System Implementing Six-Port Interferometers

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***Abstract*— This work presents a complete in-door microwave localization system based on six-port interferometry. Using two planar fan beam antennas and an interferometer with power detectors, the angle of arrival (AOA) from a 2.4 GHz ISM-Band transmitter is determined. With two receivers the position of the transmitter is computed from the direction angles and displayed on a PC. The manufactured prototype detects and localizes a transmitter inside a room with an accuracy of about 10 to 20 cm. It is proposed to use the system for the telemetry control of small unmanned aerial vehicles inside closed buildings where GPS systems are not available.**

I. Introduction

The global positioning system (GPS) is one of the most exiting technologies today [1]–[3]. The applications of the system are almost endless: navigation of ships, cars and aircrafts, tracking goods and Search-and-Rescue systems to name just a few examples. The main drawback of GPS—and its European counterpart GALILEO—is the requirement of a line of sight to the satellites. An indoor localization is not possible.

For estimating the position of an object within a room other techniques have been developed. Mainly, three different measurement principles are in use today: angle-of-arrival (AOA), received-signal strength (RSS), and propagation-time based systems that can further be divided into three different sub- classes: time-of-arrival (TOA), roundtrip-time-of-flight (RTOF) and time-difference-of-arrival (TDOA). A detailed description of the techniques can be found in [4]–[7].

In this work we propose the AOA method for the localization of an unmanned aerial vehicle (UAV) inside a room. The UAV, a quadcopter, is shown in Figure 1. Deatils about the quadcopter are given in [8]. Outdoors the vehicle can fly triangles autonomously using differential GPS [2]. Indoors GPS is not available and a different localisation method must be found.

The here proposed system provides a reliable indoor localization method. The UAV hoovers inside the room and transmits a 2.4 GHz signal used as a beacon. The system localizes this beacon by the AOA technique and forwards the detected position via a telemetry link to the UAV. The UAV adjusts its position autonomously based on this information.

II. The System

The system localizes the transmitter by the direction (or Angle) of arrival method (DOA or AOA, respectively) by detecting the phase difference of two slightly separated antennas with interferometers. This AOA detection method has been first proposed by Tatu et. al. in [9]. In this paper we extend the technique into a complete localization system.

When placing two receivers in the corners of a room, the angles of the arrival α_1 and α_2 can be determined as seen in Figure 2. Each of the two receivers is equipped with two sector antennas separated by the distance d. The angle α of

Fig. 1. UAV Quadcopter in Flight

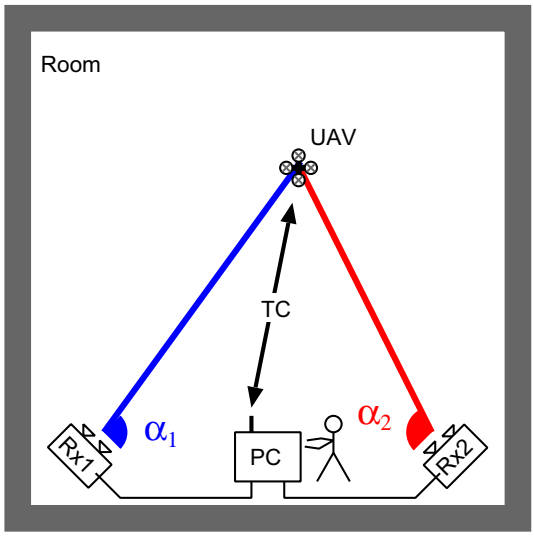

Fig. 2. Setup for DOA System