Configurable Software Defined Radio System for Two Way Time of Flight Ranging

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Many applications rely on precise positioning. For outdoor positioning, GPS, or more generally, Global Navigation Satellite Systems (GNSS) have became a standard. On the other hand, there is no standard solution for indoor positioning. Two favored methods are mainly used. So called "WiFi fingerprinting" is based on the measurement of the received power from WiFi access points. It is interesting, because it can be easily implemented on hand-held devices, like smart phones. Due to the need of an extensive training process for building the fingerprint database and limited precision, this method has limited usability. The other group of indoor localization methods are based on Time of Flight (ToF) measurements. They have better precision, but also higher complexity. No training databases are needed. The deployment of ToF systems is usually very simple.

In principle, simulation of Time of Flight based methods is quite straight forward. However, there are problems, due to the channel models available. They are mainly developed for communication system testing and simulation. These channel models do not carry the information of the distance between the nodes. They allow only qualitative testing of the system, but no quantitative estimation of distances. In this paper, we propose and develop a system which is used for real life ranging experiments. The system is built using a Software Defined Radio platform. The time critical tasks are implemented on the FPGA, available in the Software Defined Radio. The non time critical tasks are done in MATLAB. A special library, for transferring measurement data into MATLAB, for further processing, was developed.

The developed system was tested in a Two Way Ranging scenario. A pseudo random (PR) sequence was generated in MATLAB. It was uploaded on the software defined radio platform. After issuing a special command for ranging, the Two Way Ranging procedure is performed. The received data is downloaded into MATLAB. Correlation and interpolation is performed in MATLAB. The first arriving correlation peak is used for distance estimation. The system was tested with 2.4 and 5.8 GHz analog front-ends and the precision achieved is approximately 0.5 meters. The Two way Ranging procedure takes less than 10 ms, with data transfers, to and from MATLAB, included. The short measurement time allows performing a lot of measurements, in order to obtain statistics. Unfortunately, the processing in MATLAB slows down the complete ranging procedure to 100 ms per measurement. Implementing the processing in C/C++ should overcome this issue. Anyway, with this system, the MATLAB code used for simulation, can be directly tested, using hardware-in-the-loop, and evaluated in real life system.