The extensive utilization of Global Positioning System technology has made our daily lives much easier. Compared to outdoor localization which requires an accuracy of just several meters, the complex indoor scenarios with dense multipath components need a better positioning performance. Ultra-wideband technology (UWB) improves the precision significantly to centimeter level. The large bandwidth of UWB impulse radio (>500MHz) guarantees high time-of-arrival (TOA) resolution. However, even with such accuracy, the estimated indoor coordinate still deviates from the real location. The study of the range error dependency on distance helps refine the position estimation algorithm more effectively, hence enhance the reliability of UWB technology.

**Objective**

To find a suitable model to relate range error changes with distances between two sensors using UWB RFID indoor positioning technology.

**Hardware**

- Battery-powered transmitter (driven by Texas Instrument MSP430 low power microcontroller)
- Two signal sensors
- UTP cables (10m, 30m)
- Locator box (USB2.0 interface)
- Computer

**Methodology**

**Data Collection**

Two sensors are separated by distances from 1~35m, with the tag placed at one sensor first. 500 sample data of TOA at both sensors is collected. Then the tag is moved to the other sensor and another 500 sample data is saved.

**Time-Difference-of-Arrival (TDOA)**

TOA consists of the signal generation time ($T_t$), the time of flight in the air ($T_f$) and the cable transmitting time ($T_c$).

When the tag is placed at $S_1$, $T_f^1=0$

$$T_{DOA}^{21}=TOA_2-TOA_1=(T_f^2-T_f^1)+(T_c^2-T_c^1)=T_f^2+(T_c^2-T_c^1)$$

When the tag is placed at $S_2$, $T_f^2'=0$

$$T_{DOA}^{21}'=(T_f^2'-T_f^1')+(T_c^2'-T_c^1')=T_f^1'-(T_f^2'-T_c^1')$$

Ideally, $T_c^1=T_c^1'$, $T_c^2=T_c^2'$. Hence the time for the signal to travel between two sensors is $T_{21}=T_{21}'=T_{DOA}^{21}+T_{DOA}^{21}'/2$.

**Distance**

To convert the sampling time points to real time distance: $d_{21}=T_{21} \times tsamp \times c$, where $tsamp$ is the inverse of the frequency of the time points ($3.25MHz \pm 10ppm$), $c$ is the speed of light in the air.

**Range Error Modelling**

Mean and Root Mean Square Error with respect to distance are modeled.

*Indoor measurements were conducted @ INFINITUS lab (S2-B4b-05), NTU.*

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