Equivalent Time Sampling Techniques Performance in a High Accuracy Localization System

Essam Elkhouly[(1)], Aly E. Fathy[(1)], Mohamed Mahfouz[(2)]
(1) EECS Department, University of Tennessee, Knoxville, TN 37996, USA,
elkhouly@utk.edu
(2) MABE Department, University of Tennessee, Knoxville, TN 37996, USA

The limited GPS coverage to outdoors and the need for more accurate and precise tracking system propelled the research for indoor localization systems. Research is focused on developing efficient systems to work in the challenging indoor environment. Hospitals and manufacturing facilities backgrounds are full of tremendous amount of multipath interference which made the use of UWB technology more appealing. Precise localization has numerous applications: surgical navigation, machine inspection, gait analysis, etc.

At the University of Tennessee, we built an UWB system that achieves a 3D dynamic accuracy of 5-6 mm (C. Zhang, M. Kuhn, B. Merkl, A. Fathy, M. Mahfouz, "Real-time non-coherent UWB positioning radar with millimeter range accuracy: theory and experiment," in IEEE Trans. Microwave Theory Tech., 58(1), 2010, pp. 9-20).The developed system is comprised of a 300ps smooth pulse generator with a 3 GHz bandwidth, and a sub-sampler of a 100 GSPS equivalent time sampling rate. Equivalent time sampling can be implemented using either an external sampling clock with slightly different frequency than the pulse repetition rate of the received signal; so the samples are slightly shifted from one period to another; or, we use an onboard delay line chip to shift the sampling clock once at each period.

The delay line chip approach is simpler to implement, but it significantly affects the performance. Experiments showed that the delay line chips are not accurate enough for our mm-accuracy goal. The delay line chip has delays that are not linear which imposes numerous challenges as we run tag localization. The first method has demonstrated much higher accuracy.

The implementation of the first method and a new scheme to speed up sub-sampling by a factor of 10 will be presented. The system was used in multiple localizations experiments and it doesn't show the nonlinearities presented in delay line chip system. However the first system requires more complicated circuitry to synthesis the correct frequency shift.