Ultra Wideband Transmit-Only Based Digital Communication for Tag ID Transmission in a Millimeter Accuracy Localization System

Nathan C. Rowe[1], Aly E. Fathy[1], Michael J. Kuhn[2], and Mohamed R. Mahfouz[2]

[1] EECS Department, University of Tennessee, Knoxville, TN 37996, USA

[2] MABE Department, University of Tennessee, Knoxville, TN 37996, USA

Ultra Wideband (UWB) wireless positioning systems have many advantages for tracking and locating items in indoor environments. Surgical navigation and industrial process control are potential applications for high accuracy UWB localization systems with millimeter or better accuracy. Several commercial systems exist that support multiple-tags using robust system architectures. To-date these systems have been limited to localization accuracies of about 7-30 cm. Experimental systems have pushed the localization accuracy much lower, even sub-millimeter, but have generally neglected the need for a robust system that can support multiple-tags in near simultaneous operation.

An experimental UWB localization system at the University of Tennessee (UT) has successfully achieved accuracies of only a few millimeters using a sub-sampling technique. Prior work in multi-tag support for this system has utilized a 2.4GHz transceiver for tag control and a simple round-robin multiplexing scheme. This paper outlines a multi-tag scheme developed for the UT system that utilizes the UWB radio for multi-tag operation and eliminates the need for a 2.4GHz transceiver. This approach offers advantages in reduced tag complexity, power, and cost. The scheme also provides many options for further improving multi-tag performance that take advantage of the characteristics of the UWB radio.

The proposed scheme addresses both multi-tag performance and localization accuracy using UWB transmit-only digital communication and time difference of arrival (TDOA). The scheme takes advantage of a digital sampling circuit that can be used for both sub-sampling and data acquisition. The developed system addresses the challenge of collisions inherent in an asynchronous transmit-only system while maintaining high accuracy and significant update rates. Preliminary experimental results using this system show successful data transmission and reception of tag identifiers along with time difference of arrival (TDOA) measurements between 2 base stations. Experimental results for this 1-D localization system resulted in a total system update rate of 889 Hz and localization accuracy of 3.25mm. These results are encouraging for further development of a robust millimeter accuracy 3D tracking system with a large number of tags based on this scheme.