

Development of low power asset tracking system with precise location

Global Positioning System (GPS) and Global Navigation Satellite System (GNSS) are currently widely used for measurement of real time location of assets in tracking applications. However, in indoor dense cluttered environments, the direct line of sight signal from the satellite is weak and the received signal is dominated by reflected signals (multi-path signal). This causes the receiver to track the multi-path signal resulting in degraded position information or the signal may be so heavily attenuated that it goes below the noise floor of the receiver and makes it difficult for the receiver to detect the signal. There is also strong demand for indoor positioning applications driving the need for indoor localization. The goal for this thesis is to develop the low power asset tracking system for the indoor applications.

The thesis is commenced with the design of the energy efficient tags that will be carried by the people or objects to be tracked in the indoor environment. The design of tags includes the hardware and firmware code development with the aim of achieving energy efficiency as the tags are powered by coin size battery. The tags transmit the Ultra-Wideband (UWB) signal for the purpose of localization and are commanded through a sub-1 GHz wireless data link. The tags designed to be used in this system are UWB transmit only. This is done to achieve the low power design parameter for the system as the UWB receivers are likely to consume higher power and the tags are powered by a coin size battery leading to the less operational hours. For the purpose of commands and control along with the consideration of the low power design parameter, an ultra-low power sub-1 GHz wireless data link is used in comparison to the 2.4 GHz band, which is used in many applications resulting into the difficulty of achieving the reliable data link. The firmware code is developed for the tags to perform sub-1 GHz wireless communication. The three design strategies are presented and implemented in the design of the tags which aid in achieving the longer battery life. The current measurement results are presented along with the battery life computation.

The development of indoor localization system is accomplished with the design of the reader/sensor system which include the hardware and firmware code development. The reader systems are distributed in the indoor environment to receive the UWB signal for the purpose of the localization. The localization technique used in the system is based on time difference of arrival (TDOA). The sub-1 GHz wireless data link is used by the reader systems for the intent of commands & control. The firmware code is developed for the reader systems to achieve the control over the whole process of indoor localization using the sub-1 GHz wireless data link. The reader cape hardware is designed to mount along with the BeagleBoneBlack (BBB) board. The equivalent time sampling is performed in the reader system with the help of low cost ADC to sample the UWB signals transmitted by the tags. The sampled UWB signals are processed in BBB board to find time of arrival (TOA). The TOA data from all readers is transmitted to central server where TDOA is computed and localization is performed using difference of TDOA's.

In the last, the energy efficient Medium Access Control (MAC) Scheme is designed and implemented for the multi tag indoor localization environment with the centralized architecture controlled by the master reader system by using sub-1 GHz wireless data link. To perform 1D ranging between the readers, the range equation using TDOA is derived in consideration with the clock skew and the clock offset at each of the devices. The measurement set up is developed including 2 reader systems and 2 reference tags (co-located at readers) for performing 1D range measurement between the two reader systems along with the implementation of MAC scheme.