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High Resolution Indoor Localization System Using Ultra Wide Band Impulse Radio

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Abstract: Internet of things (IoT) is an emerging technology which enables integration of billions of objects and complex systems over internet with the help of many technologies such as Wi-Fi, ZigBee, Bluetooth, UWB etc. Position estimation has become an essential and crucial factor in various monitoring applications of IoT. Precision localization and positioning has become an attractive area of interest for many new applications and business solutions. Although, the global navigation satellite systems (GNSS) can provide good performance and positioning in outdoor systems, they are not very accurate when it comes to indoor locations or in GNSS denied environments. With the ease of availability of commercial transceivers and the demand for accurate positioning systems by various industries, the research interest towards indoor positioning and navigation systems based on ultra-wideband technology (UWB) has been immense.

Good localization accuracy can be achieved by using UWB pulses due to their high temporal resolution and multi-path immunity. Apart from achieving high accuracy, UWB can also provide larger coverage and ranging capability. We present an ultra-wideband impulse radio (UWB-IR) based positioning system for indoor applications. The UWB systems can be operated in an unlicensed band in the frequency range of 3.1 - 10.6 GHz. The operation in an unlicensed band makes it even more exciting and accessible for different commercial applications. However, several GHz of Nyquist sampling rate is required to sample such a large bandwidth signal. A sampling rate of few tens of GHz is suggested for resolving large number of multi-paths in UWB based systems. Sampling at such a rate is an expensive solution and thus practically limited by cost and complexity of the required hardware, and thus, it is a bottleneck in designing low-cost sensor nodes employing UWB systems. To overcome the high sampling requirements, we proposed an equivalent time of arrival (E-TOA) based mechanism using equivalent time sampling technique. The proposed system achieved the resolution in the order of sub nanoseconds, with much reduced ADC sampling rate, in the order of few MHz, to be specific between 2-3 MHz.

We have designed and developed high-resolution low-cost sensor nodes. It is thus demonstrated, using in house designed sensor nodes, that high ranging accuracy, in the order of few cm, can be achieved by utilizing the proposed analytical E-TOA technique, even with low sampling rate.

Bio: Dr. A. Vashistha received his PhD in electrical and electronics engineering from Nanyang Technological University (NTU), Singapore. Currently, he is working as an Assistant Professor at Indian Institute of Information Technology, Kota. His research interest includes Channel characterization and modelling, Indoor wireless positioning and navigation system and embedded systems for IoT. During his doctoral studies he has designed and developed low-cost wireless indoor positioning systems using ultra-wide band impulse radio technology. He was associated with Delta-NTU Corporate Laboratory for Cyber-Physical Systems for 5 years during his stay in Singapore. He was awarded a best poster award for his work on cognitive radio in IEEE ANTS. He is actively involved in conducting many IoT hardware workshops for undergraduate students. He is an active member of IEEE Singapore section and had served as a vice-chair of IEEE Young professional Singapore section.

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