2012 International Conference on Indoor Positioning and Indoor Navigation, 13-15th November 2012

Time-Reversal UWB positioning beacon for railway application

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ABSTRACT

Guided urban automated transportation systems are progressing significantly nowadays, highlighting many benefits. User's security and accessibility to these guided transport systems constitute a major issue dealt with many teams. In order to obtain an efficient and safe control and command system of the trains, it is essential to determine accurately the absolute localisation of the trains.

In this work, we study a new guided transport localisation beacon, installed at ground, close to the track. The beacon works as a kilometre marker. It must deliver absolute localisation information whenever a train passes exactly at the same location along the track. In the vicinity of the beacon, it also enables high data rate ground to train communication. This beacon uses Ultra Wide Band radio and Time Reversal (TR) techniques (TR-UWB). UWB radio has the potential to offer a good level of performance in terms of localisation accuracy. Time Reversal channel pre-filtering facilitates signal detection and also helps increasing the received energy in the targeted area.

In this paper, we study the characteristics of TR technique in terms of temporal and spatial focusing by determining the equivalent channel model, Power delay Profile ($PDP_{TR\text{-}UWB}$) and Focusing Gain (FG) of TR-UWB. We analyse the contribution of time reversal associated with UWB in terms of localisation error. To perform this study, a deterministic channel model, consisting of several reflected paths combined with the direct path is modelled based on the geometrical optical approach.

In terms of localisation error, the simulation results show that TR-UWB technique delivers improved performance over the UWB alone localisation approach.

KEYWORDS: Localisation beacon; UWB; Time Reversal (TR); geometrical optical model; TDOA.