

Angular Dependence of Transducers for Indoor Positioning System Using SS Ultrasonic Waves

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ABSTRACT

For robot self-localization and navigation, indoor positioning systems with SS (Spread Spectrum) ultrasonic waves using all-purpose transducers have been investigated as a low cost and high accuracy system with noise tolerance and CDMA. In the situation of indoor positioning, it is rare case that a transmitter and a receiver are arranged face to face in collinear, each other. However, it is difficult to find research on measurable area or error depending on angles given by a geometrical arrangement of transmitter / receiver relation using SS ultrasonic signals. This study presents the angular dependence from two viewpoints of correlation values on SS signals and errors of distances. The correlation values can be calculated with received SS signals and replica SS signals generated in a receiver unit. From a peak of the correlation values, we can detect TOF between a transmitter and a receiver. To discuss the angular dependence, an experiment of measurement distance was conducted using angled transmitter and receiver from 0 degrees to 90 degrees, respectively. In this experiment, we utilized a transducer with closed aperture type for a transmitter and with open aperture type for a receiver, respectively, and a distance between the receiver and the transmitter are set to 3 metres. This transducer with closed aperture type has weaker directional characteristic, and requires more electrical power than with open aperture type. From the experiment using an angled transmitter, a peak of correlation values can be detected within 10 centimetres error, even if a transmitter was oriented at right-angles to a receiver. The experimental result was also compared with a measurement using normal ultrasonic signal with on-off-keying. The result with SS modulations presents almost same trend as with on-off-keying, however, measurement accuracy and measurable range were improved. From this comparison, effectiveness of SS modulations for indoor positioning was shown.

KEYWORDS: Spread Spectrum Ultrasonic Waves, Angular Dependence, All-purpose Transducer, Measurable Range, Distance Accuracy