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Department of Electrical and Electronic information Engineering		ID	M101831
Name	Takumi Shinohara		

Supervisor	Shuichi Ichikawa Naoki Fujieda

Abstract

Title	Investigation of correction method based on circuit characteristics of ultrasonic positioning system

（800 words）

A positioning accuracy is important in various positioning systems. GNSS (Global Navigation Satellite System) is a navigation system using radio waves. GNSS detects receiver's position using radio waves transmitted from satellites at the same time. Positioning systems using radio waves require accurate measurement of time because radio wave propagates at light speed. A method using ultrasonic waves enables highly accurate positioning more easily. A positioning system using multiple frequencies of ultrasonic waves has been proposed by Matsuoka et al. as a low-cost system.

Matsuoka's system has two problems. The first problem is narrow positioning range due to interference of ultrasonic waves. The second problem is low positioning accuracy caused by systematic ranging error. Sakaguchi et al. proposed an improved receiving circuit to reduce interference and a correction of measured range for ranging error. However, the positioning accuracy with the correction has not been enough, because it used a simple linear approximate expression. The ranging error is due to the dullness of the waveform in receiving circuit of the system that is not linear. To increase the positioning accuracy, correction should be made based on the circuit characteristics of the system.

This paper examines a correction method based on the circuit characteristics. The method corrects propagation time using a correction formula. The correction formula reflects a propagation model and a delay model. The propagation model defines a measured propagation time including error with a true propagation time excluding error and error time. The delay model defines delay time in receiving circuit as the transient phenomenon in a filter. The correction formula's constant value is set with parameter fitting.

The correction was applied to a positioning calculation program and evaluated for positioning accuracy and processing time. The micro controllers used for the evaluation were Arduino and PSoC (Programmable System-on-Chip). The average positioning error reduced by 17% from 3.0 cm. The processing time increased by 285% from 444 ms on an Arduino micro controller. However, it became 274 us by using a PSoC micro controller of the same price range. Therefore, it became clear that the proposed correction method is effective for increasing positioning accuracy on the system.