Position Measurement Using Enclosed Signal Field with Pulse-Width-Modulated Function

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Abstract

A novel pulse-width-modulated(PWM) function is introduced for precise position measurement in an enclosed signal field. An amplitude modulation was used to light the LEDs for the conventional study. However, the transform properties from the driving signal to the lighting intensities of the LEDs are non-linear, and accurate control of the lighting power was necessary. Therefore, a lighting function independent of these properties is desired. Well-known PWM functions are used to construct the enclosed signal field by simulation, and the precision of the phase detecting system is analyzed. A novel "axial symmetry PWM" function is found to be effective for orthogonal phase detection.

1 Introduction

Position and attitude measurement systems, which can be shared by multiple robots are described. The system is supposed to be applied to multiple automated vehicles working together in factories, to robots working in wide open spaces, or to flight systems, etc. We solved this problem by using the idea of "the optical signal field", and in practice, have described some examples[1, 2, 3]. In this report, we introduced a novel signal modulating method for precise position measurement. An amplitude modulation was used to light the LEDs for the conventional study. However, the transform properties from the driving signal to the lighting intensities of the LEDs are non-linear, and accurate control of the lighting power was necessary. Therefore, a lighting function independent of these properties is desired. A well-known PWM function of lighting LEDs was applied to solve this problem. The features of this technique are (1) Independent of transform properties, (2) On-off lighting function, (3) Only time resolution is required. First, several PWM functions were used to construct the enclosed signal field by simulation, and the ability of the phase detecting precision was analyzed. A novel "axial symmetry PWM" function was found to be effective for the orthogonal phase detection. Next, this function was used to construct the experimental system. The experimental results show the effectiveness of this method especially for flexible measurement using this technique.

2 Construction of enclosed signal field[1]

Consider the arrangement of the four LED-arrays as shown in **Fig. 1**. LEDs-A, B, C and D are linear LED arrays, and they are located on each lattice of a square. The length of the lattice is 2a. Each face of the LED is directed toward the origin (O) of the coordinates. Points P_1, P_2 and P_3 are the positions of the photo detectors. The purpose of this measurement is to determine the coordinates of each detector. Each detector is capable of moving on a plane, which is called the *sensing plane*. The size of each detector is small enough to be regarded as a pinpoint, and their directional sensitivity is isotropically uniform in all directions. The distance between the LED plane and the sensing plane is h.

Every LED lights according to a sine wave with a specific amplitude and initial phase shift, that is, their lighting functions are as follows.

$$A : A(t) = \kappa_A \cos\omega_1 t \quad (1)$$

$$B : B(t) = \kappa_B \sin(\omega_1 t + \Theta_1) \quad (2)$$

$$C : C(t) = \kappa_C \cos\omega_2 t \quad (3)$$

$$D : D(t) = \kappa_D \sin(\omega_2 t + \Theta_2) \quad (4)$$

A special signal field is generated by the superposition of four kinds of signals in the inner space between the LED and the sensing planes. This is the *enclosed signal*

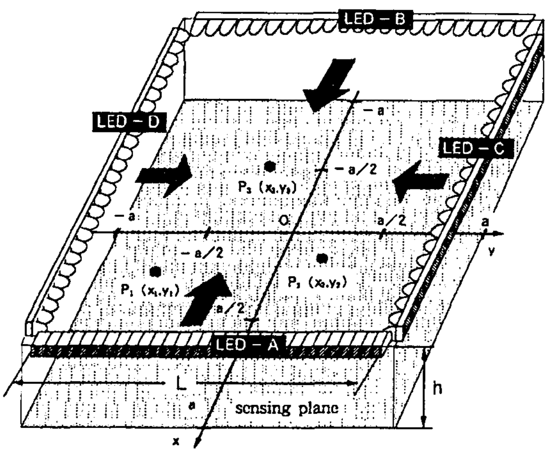

Fig. 1: Configuration of enclosed signal field.