Indoor positioning using visible light communication and high-speed camera equipped with fish-eye lens

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ABSTRACT

This study proposes a method for detecting the position of an object indoors using visible light communication and a high-speed camera equipped w/ a fish-eye lens. An experimental apparatus consisting of LED (Light Emitting Diode) lights and a handheld optical sensor. The light can transmit a unique positional signal (Signature) using an additional controller. The fundamental reception method is divided into three steps. Step1: Under an LED light, the signature is received by an optical receiver with 9 photo sensors. Step2: To obtain a more precise position, a camera equipped w/ fish-eye lens is used to capture a 180 degree view of the ceiling, and the light's location. According to the location of lights and signatures, the receiver position is triangulated. Data regarding location of each light is stored in the receiver's database.

Step3: By replacing the camera's old image-sensor with a specially-developed high speed CMOS sensor, both ceiling image and signature can be captured in the camera. The image sensor's resolution is 256 by 240 pixels; acquisition time for 256 pixels by 30 lines is 250 μsec. Therefore, the maximum sampling rate is 2.5 kHz for each pixel to measure brightness.

In the experiment using a prototype circuit board with camera and FPGA (Field Programmable Gate Array), we confirmed that image acquisition time equals 5 msec for one image (256 by 240). The maximum signature decoding rate was 1 kHz. Our next task will involve adding absolute positional information for each light. It will allow us to determine one's exact position in a building.

KEYWORDS: Visible Light Communication; Indoor Positioning; Fish-eye lens; Image sensor; Camera