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Visible light indoor positioning system

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Abstract

Visible light indoor positioning technology is an indoor positioning technology based on visible light communication. Compared with traditional indoor positioning technology, this technology has the advantages of high positioning accuracy, few additional modules, good confidentiality, taking into account communication and lighting. In some occasions without wireless signal coverage, using visible light to achieve positioning is an effective scheme. This system is composed of transmitter, receiver and display terminal. Because in visible light positioning, the position information transmitted by multiple positioning beacons is needed to realize the positioning function. Therefore, the receiving end can simultaneously collect the illumination intensity signals of multiple beacon points and provide them to the positioning algorithm for positioning. The formula of light intensity distribution is derived from the geometric relationship between LED and the node to be measured. The distance measurement formula based on the intensity of illumination is derived through the photometric formula, and the position coordinates of the nodes to be measured are calculated by using the triangulation algorithm, which is finally realized.

Keywords

Visible light indoor positioning; time division multiplexing; triangulation.

1. System design objectives

Visible light indoor positioning technology is an indoor positioning technology based on visible light communication. Compared with traditional indoor positioning technology, this technology has the advantages of high positioning accuracy, few additional modules, good confidentiality, taking into account communication and lighting. In some occasions without wireless signal coverage, using visible light to achieve positioning is an effective scheme. Visible light positioning system is an important application field of visible light communication. However, there are relatively few indoor intelligent systems based on visible light positioning, so this system starts with visible light positioning technology, analyzes the working mode of visible light emitting end and several common positioning algorithm principles, and designs a visible light indoor positioning system based on non imaging positioning technology.

The system takes STM32 as the control core, and is equipped with upper computer at the sending end, visible light signal sending end, visible light signal receiving end, positioning server and gy-39 sensor module. In this system, the upper computer at the sending end and the visible light signal sending end jointly undertake the signal transmission and sending of LED, and convert the voltage signal into electrical signal output. It can be seen that the signal receiving end and the positioning server jointly undertake the signal reception, analyze the signal to obtain the information data, and display the position coordinates on the upper computer. Using C language to regulate the state of the transmitter, the main controller based on STM32 is programmed to control the driving circuit, which converts the level signal into optical signal. The receiving end decodes and uploads the parsed information data. The location server parses the data and outputs and displays the location results,

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2. Design of visible light positioning system

2.1. Overview of visible light positioning system

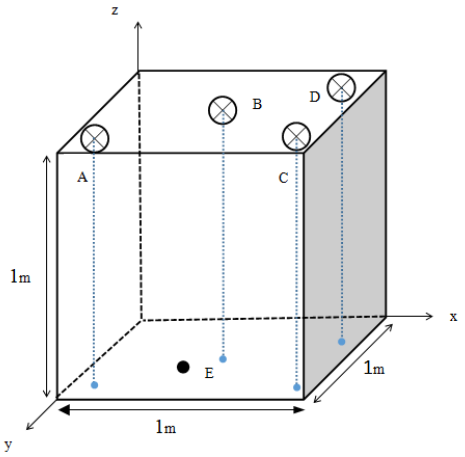

Fig. 1 Visible light positioning model diagram

When positioning, select three light groups for positioning. As shown by lights a, b and c in the above figure, during the experiment, first turn on light a and turn off light b and c, then record the illuminance value of light a measured in the illuminance meter, then turn off light a and c and turn on light b, then record the illuminance value of light b measured in the illuminance meter, repeat this operation, and measure the illuminance value of light c. Bring the obtained illuminance values of a, b and c lamps into the corresponding formula for calculation to obtain the position of the illuminance meter, that is, complete the positioning.

2.2. Visible light location system algorithm

The visible light location algorithm mainly adopts triangulation. By controlling the transmitter and using the sensor to collect and process the illumination value, three different illumination intensities from three LED lights can be obtained in one cycle. Using the mathematical relationship between illumination intensity and distance (in this algorithm, the luminous flux is set to a fixed value of 2200lm), calculate the three distance values r1, r2, r3 from the three LED lights to the node to be measured. Since the positions of the three LEDs are fixed on three points (0, 0, 1), (0., 1, 1), (1, 0, 1), the three coordinates are projected onto the xoy plane to obtain three coordinates (0, 0), (1, 0), (0, 1). At the same time, a right triangle relationship is established, and the three distances in space calculated previously are also projected onto the plane to obtain the distances d1, d2, d3 from the three known coordinates on the plane to the node to be measured. Through the distance formula between two points, three abscissa x and ordinate y equations about the node to be measured are established. Subtract the first equation from the second equation to obtain auxiliary equation 1, and subtract the first equation from the third equation to obtain auxiliary equation 2. Finally, two unknowns x and y can be solved through these two auxiliary equations, and finally the coordinate value of the node to be measured can be obtained, so as to realize the function of positioning.

3. Sensor selection and communication realization

Gy-39 sensor module is selected in this system. Gy-39 is a low-cost, air pressure, temperature and humidity, light intensity sensor module. The working voltage is 3-5v, with low power consumption and convenient installation. Its working principle is that MCU collects various sensor data, processes them uniformly, and directly outputs the calculated results. This module has two ways to read data, namely serial UART (TTL level) or IIC (2-wire).

The baud rate of serial port is 9600bps and 115200bps, which can be configured, including continuous and inquiry output Mode, this module can save the settings after power failure. It can adapt to different working environments and connect with MCU and computer. In addition, the module can set the working mode of a separate sensor chip. As a simple sensor module, MCU does not participate in data processing.

This system only adopts the light intensity sensor module of gy-39 sensor module, whose light intensity measurement range is 0.045lux-188000lux, and the working voltage is configured as 5V. After MCU collects the signal from the transmitter led, it calculates and processes the data. The processed data is sent to STM32 MCU through serial port communication, and the baud rate is 96000bps.

4. Program division

The application is divided into three main levels:

Transmitter control: it mainly controls the three LED lights to turn on and off in an orderly manner. In the program, a timer is used for timing. 6 seconds is a timing cycle. LEDa is on in the first second, and the other lights are off; In the second second second, LEDb is on, and the other lights are off; In the third second, LEDc is on, and other lights are off; From the fourth to the sixth seconds, the three lights are off, and then the relevant data processing and display are carried out. sensor data reception: provide basic data for positioning algorithm. Gy-39 sensor module collects and processes the data transmitted from the transmitter in real time, and displays the processed data on the upper computer in real time through the serial port. The baud rate of the serial port is 9600.

Positioning algorithm: process the received data and judge the position of the point to be measured. Through the received information data, it is input into the positioning algorithm. The algorithm obtains the two-dimensional coordinates by plane projection of the theoretical model, carries out relevant calculation, and finally obtains the lower value and y value of the coordinates of the points to be measured, so as to realize the positioning function.

References

[1]Chong-You Hong,Yu-Chun Wu,Yang Liu,Ke-Ling Hsu,Wahyu Hendra Gunawan,Assaidah Adnan,Liang-Yu Wei,Chien-Hung Yeh,Chi-Wai Chow. Using silicon photovoltaic cells and machine learning and neural network algorithms for visible-light positioning systems[J]. Optical Engineering,2020,59(9)

[2]Mahmoud Abdulrahman A.,Ahmad Zahir Uddin,Haas Olivier C.L.,Rajbhandari Sujan. Precision indoor three-dimensional visible light positioning using receiver diversity and multi-layer perceptron neural network[J]. IET Optoelectronics,2020,14(6).

[3]Li Xianmin,Yan Zihong,Huang Linyi,Chen Shihuan,Liu Manxi,Mondal Samir K. High-Accuracy and Real-Time Indoor Positioning System Based on Visible Light Communication and Mobile Robot[J]. International Journal of Optics,2020,2020.

[4]Zhang Zhuo,Chen Huayang,Zeng Weikang,Cao Xinlong,Hong Xuezhi,Chen Jiajia. Demonstration of Three-Dimensional Indoor Visible Light Positioning with Multiple Photodiodes and Reinforcement Learning[J]. Sensors,2020,20(22).

[5]Mahmoud Abdulrahman A.,Ahmad Zahir Uddin,Haas Olivier C.L.,Rajbhandari Sujan. Precision indoor three-dimensional visible light positioning using receiver diversity and multi-layer perceptron neural network[J]. IET Optoelectronics,2020,14(6).