

Development of Road Light Gateway with Sensor Network

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Abstract— In this paper, we have developed the gateway for multi-information convergence system in ubiquitous sensor network. The gateway gathers the various sensor data from a road light device, and the data is transmitted into an energy management system. The sorts of data are the intensity of illumination, humidity and diagnostic results.

Keywords— Sensor, Monitoring, Gateway, Zigbee, UART

I. INTRODUCTION

In recent, a light source of road lamp equipment is replaced by LED type. In order to save the power consumption, the research of light source has progressed for various areas.

The growth of the digital technology and an internet made us to merge the LED, sensor and information technology. The advantage of LED can reduce the power consumption and an interface the LED with a sensor could have as well management as control of energy [1].

The convergence of such a LED and sensor based on an information technology provides more many opportunities to vendors and clients. The one is realized for home network or outdoor road light system [2].

The important study for this convergence system is an intelligent of the integrated devices. In order to implement the road lamp of LED type with sensor by network, we are interconnecting between lamp posts, which can integrate the platform of various LED device, sensor hardware specification and dimmer function [3].

In this paper, a sensor network for satisfying these have proposed the one of the node devices is the gateway. The gateway for the sensor network play role in gathering the data from around sensors and control a command. Then the gathered data is transmitted into an energy management system (EMS).

Figure 1 shows the sensor network. Most of sensor

network devices are built to have a high performance and has the minimized consumption power, connected to the CPU that include 8 or 16 bits microcontroller in 900 MHz or 2.4 GHz.

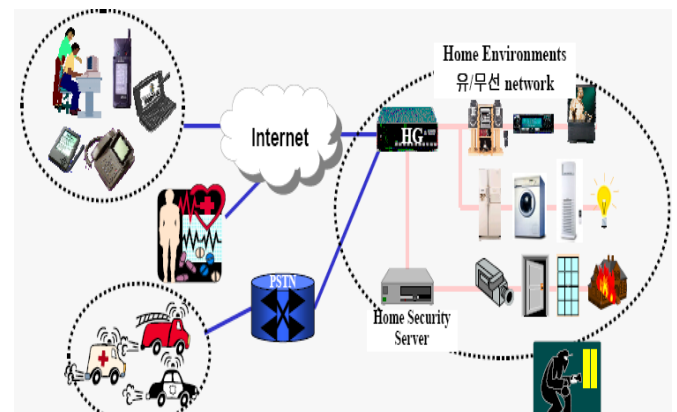


Figure 1. Block diagram of the sensor network

In this paper, we use the ad-hoc network technology to integrate the lamp posts. The gathered data by sensor networking is transmitted into EMS through the gateway. Also, we use wireless technology to transmit the gathered data among LED lamp posts. Finally, the data is transmitted into an EMS center, and then we use the CDMA technology. The EMS center can monitor variously the data obtained [4].

II. THE GATEWAY FOR LIGHT SENSOR

A sensor device has been used in road lamp system and the information of the sensors is transmitted into the control box through the gateway device. It controls the distributed box for control the lamp management system, reversely. Figure 2 shows the structure of sensor network for implementing the gateway [5].

The sorts of the sensors use CO2 sensor, intensity of illumination for measuring the light level and the humidity.

The gateway of the sensor network exists between sensor node devices and the monitoring system. The gateway handles various sensing information obtained from sensor node [6].

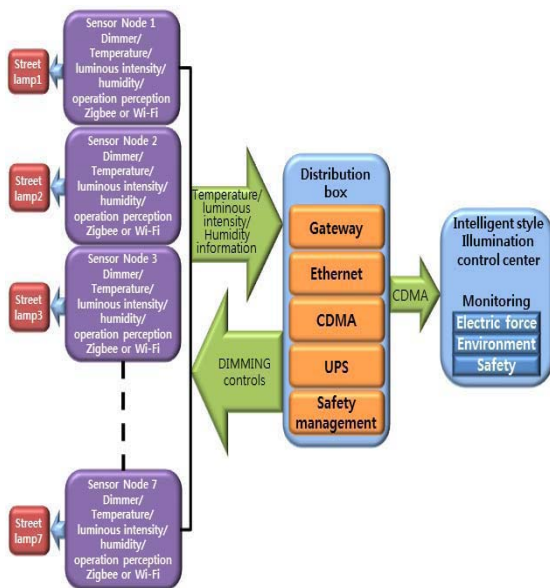


Figure 2. Diagram for sensor network

In order to supply a voltage source, we use electronic ballasts that are composed of drive circuit, multivibrator, protection circuit and output parts. An external ac, 220 V input signal for driving the ballasts is connected to the circuit, and then drive the oscillator and the switching circuit.

The variable resistor of an oscillator can control the pulse width of signal and the driving speed. By doing these operation, the electronic ballasts can control the output voltage and current of a transformer [7].

The period of pulse use $0.5\mu s$, the stabilized high voltage in the rectifier circuit drives the transformer. If we add output load (or neon tube) to electronic ballasts, the overvoltage protection circuit isn't operating. But if the electronic ballasts have no load, it stops the high voltage by holding the output signal of oscillator.

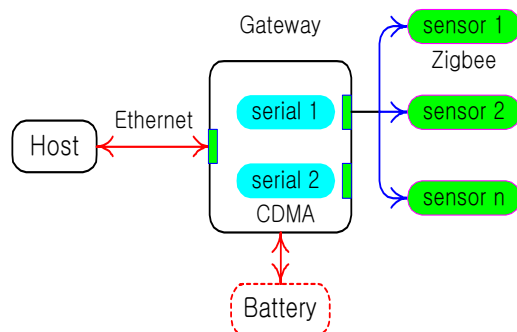


Figure 3. Block diagram of the gateway around

Figure 3 shows that the system structure of the gateway communicates with the host computer using the web or the monitoring system.

The gateway of implementing in this paper are composed of ARM7 core of RISC families, a processor compatible with communication hub or router, 4MB(x2) flash ROM, 16MB(x2) SDRAM, 10/100based Ethernet and two serial port with sensor nodes and CDMA module. Also, the one supports 4 UART serial interface and wireless Zigbee. The main processor operates in 50 MHz, the Ethernet transceiver operates in 25 MHz. Two systems are connected with DMA (data memory access), use DMA interrupts and detect physically 10 Mbps or 100 Mbps.

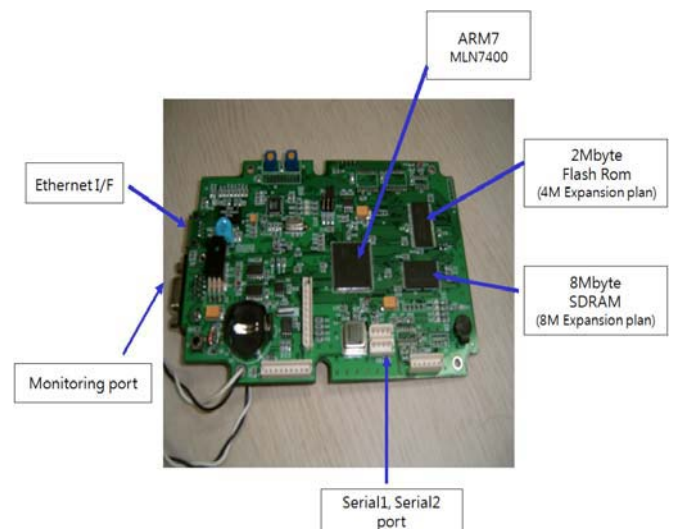


Figure 4. Diagram of the gateway

UART#1 is connected to the sensor network devices with 900 MHz and UART#2 is connected to the sensor network devices with 2.4 GHz. OS use an Embedded Linux. Figure 4 shows the diagram of the gateway. This gateway communicates with smart meter and CMDA module. The one transmits the control command into monitoring management system [8].

The output characteristics of the PECL VCXO have a complementary type, sustain the valence to the output impedance and transmission delay. Unless, the zero cross point both output signal is changed and leads an asymmetric characteristics of the signal waveform.

In general, if we use the FR-4 PCB in the frequency band, the harmonics loss and an impedance variation due to the transmission line of the PCB is bring. In order to protect the main circuit, we must test between LED node and SMPS [9].

The output impedance (z_o) of the circuit have a matched impedance relation to the transmission line. Both are explained in an input reflection coefficient (Γ_{in}). Also, both

Z_o and a measurement probe (Z_l) form an output reflection coefficient (Γ_o). Such as unmatched impedance leads to the loss and distortion of the waveform. Equation (1) presents the reflection coefficients.

$$\Gamma_{in} = \frac{Z_s - Z_o}{Z_s + Z_o}, \quad \Gamma_o = \frac{Z_l - Z_o}{Z_l + Z_o} \quad (1)$$

Such matched attenuators decide the stability of signal, the voltage standing wave ratio (VSWR) and the power. Their relation is written by

$$\Gamma = \frac{VSWR - 1}{VSWR + 1}, \quad VSWR = \frac{1 - \Gamma}{1 + \Gamma} \quad (2)$$

There are π -type, T-type and bridge-T type in the topology of a matched attenuator.

Figure 5 shows the structure of all management system. The zone 1 is the most lighted area and the zone 2 is the middle level and the zone 3 is the most darkness area with the arrest.

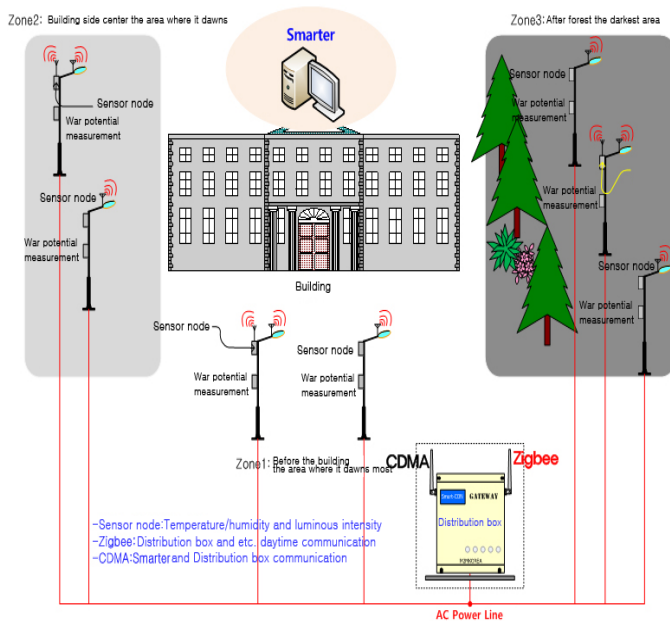


Figure 5. The scene of road light system

III. Experimental results

In order to protect the circuit from an over voltage source or the lighting, we must test the safety of the circuit through the test. Figure 6 shows the output signal of the circuit using the test Jig. The rising and falling time of the signal are 345 PS and 312 PS, respectively. The duty cycle is 49.88%.

Figure 7 shows the phase noise that the loop bandwidth is 96.2 Hz, tune slope is 50 Hz/V and reference extra level is

10.0 dB. We can observe the existence of a noise in the frequency duration.

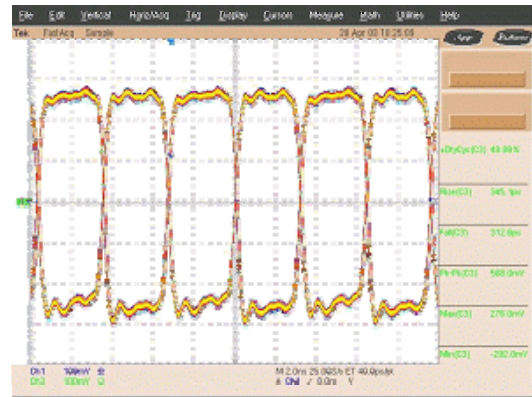


Figure 6. The output signal

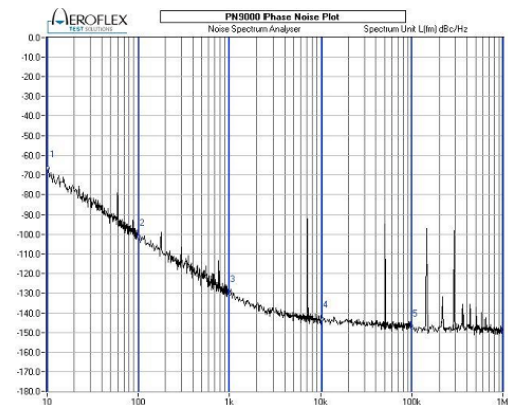


Figure 7. The phase noise

Figure 8 show the jitter signal that the maximum and minimum of an output voltage are 2.32 V and 1.2 V, respectively. The rising time and falling time are 330.9 PS and 326.0 PS, respectively. Then duty cycle is 48.32 % and the voltage of peak to peak is 1.2 V.



Figure 8. The jitter signal

IV. CONCLUSION

In this paper, we have developed the gateway that can interconnect between EMS center and the lamp post using the CDMA. The sensor node among road lamp posts can gather the various data like the intensity of illumination of LED, humidity and CO₂. The one is transmitted into an EMS center through the gateway.

It is necessary for studying the chip to minimize the power and size of gateway. In the future, we must research for the data communication method of Ad-hoc network among the LED lamp posts in order to growth up the real time process and an efficiency of the network.

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