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Design of Bidirectional Remote Control Module of LED Advertisement Streetlight by User Participation Control

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Abstract

It is time to collect the consumer's feedback to utilize the new variables of the system in any fields of processes or systems, yet the street sculptures using the streetlight as one of the offline advertisements are maintained and exposed in the form of unidirectional communication. The advertisement participation by the control for external advertisements or sculptures of the consumers can be a new paradigm of the street advertisement. This study aimed to design the system so as for multiple consumers of the advertisements to be able to control them, and to realize the remote sculptures exposed again by their participations. Additionally, LED advertisement streetlight which can be used efficiently in the street is feasible to self-charge by the sunlight, to control remotely, and to deliver the information of voltage and LED power consumption status. With this system, we anticipate to provide the users with the efficient illumination information and its control.

Keywords*: bidirectional control, advertisement, self charge, solar system*

1. Introduction

Upon expediting the industry development, the advertisement methods by external sculptures or advertisement sign boards became dynamic consisting of lots of messages [1]. The consumers translate the messages in view of their fixed passive positions experientially under the massive message flows, receive and accept them in the filtering process [2]. This filtering is relative and experiential so that more provocative advertisements make the information acceptance even dull, therefore, the stimuli of the advertisement become harder and harder resulting in the vicious cycle in terms of information learning [3]. Internet web-services eliminated the unidirectional factors and accepted the user feedback of Web 2.0 so that mutual communication platforms were developed, while the offline advertisements such as sign boards or external sculptures did not break away from uni-directional forms, yet. Generally, the street advertisements deliver the constant messages of the advertisers via one way and exclude the participations of the advertisement consumers relatively until the impact occurrence and linkage to the consumptions[4]. The studies on the network control of USN system under the practical road conditions are currently very active with the recent convergence of ubiquitous environments, suggesting the internet of things platform as the effective advertisement tool by allowing direct remote control of the users on the sign boards of the street advertisement or light of the sculptures [5-6]. On the other hand, self-powered streetlights by using solar cells and LED lamps, and the establishments of advertisement sculptures have been a new trend nationwide within a few years recently as the advertisement tools by local government or parts of the landscape architectures [7]. They are not operated by the remote controlling but by stand alone types as the independent

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self-powered advertisement streetlights by charging in the battery using electricity generation module, or the streetlights established in the remote areas such as islands or mountainous areas that have difficulty in the electricity supply [8]. In this study, we designed LED advertisement streetlight with remote controlling module, and produced their prototypes that could control remotely by smart devices using GPS sensor for the consumers to be able to participate in the advertisements on these advertisement sculptures.

2. Related Researches

System participations of the users have been rapidly expanded in the courses of web developments out of various developments. With the introduction of Web 2.0, contents syndication could bridge between suppliers and consumers to play a role to affect the contents regenerations by users. These technical protocols were performed by RSS and Atom in the web. The streetlights or advertisement lights are the representatives of street advertisement sculptures in the subjects of offline information consumers [9]. Currently, the light poles to be used in the self-powered streetlights are being replaced from traditional lights into LED due to the energy saving potential and its high efficiency. Dimming control systems are introduced to control the brightness of LED lights tracking the street illumination using the sensor [10]. In addition, the lighting devices are controlled by organizing distribution boxes via internet. Most of the lights or devices for the landscape architecture are controlled remotely by central processing control system so far. There is a realistic generation gap in the information delivery method like this, so it is required to close this gap in part in the offline information delivery system.

3. Designs of LED Advertisement Streetlight and Remote Controller

Self-powered LED advertisement streetlight using remote control and network, and design of remote controller system are divided by the following 4 development items.

- Network organization and development of control application for the control of user's positioning data and direct participation control
- Design and production of driving board in LED streetlight (including self-powered charging circuit)
- Production of control board
- Software development using micro-embedded computer

To do so, key generation of MAC address matching is required in the control board and LED driving power technology using solar energy is also required. Additionally, the technologies for wireless data transmission and telecommunication network organization should be applied in a way of convergence. Also, the light control technology should be applied based upon the participating consumer's positioning data together with illumination. The diagram of designed system is as seen in Figure 1.

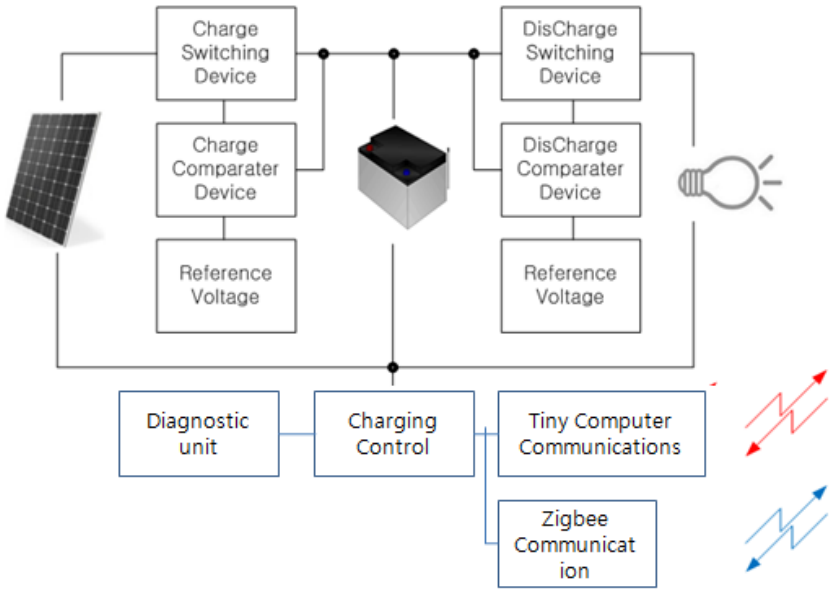

Figure 1. System Configuration

The control key would be provided to the advertisement consumers who are watching at the advertisement near the sculpture by application set up using smart devices so as to hand over the controllability of the advertisement sculpture, and the positioning data of the consumers would be matched, accordingly. The daily lighting time was 6 hours for the organized advertisement streetlight and 5 steps for the power of LED lights were applied at the maximum illumination based on the illumination. The stable heat control system was designed to realize the functions of temperature control and heat fold back. The period to prepare the cloudy and rainy days was 3 days based on 18 hours. The advertisement street sculptures can show the defined responses upon the positioning data of the consumers who have various controllability, and they can be adjusted by their participations(Figure 2).

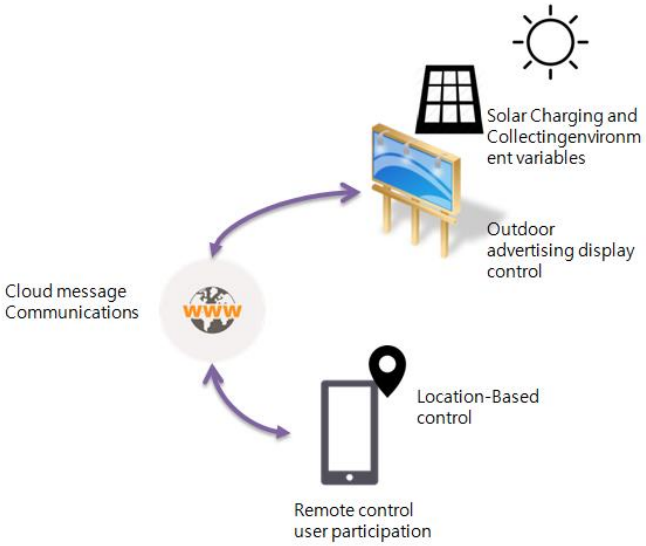

Figure 2. System Design

4. System Realization

The messages will be delivered using cloud messages so as to control them in the remote place well with the smart devices of the consumers. If the temperature of LED was increased over the safe degree, the durability and efficiency of LED would be lowered. In case of using 'LM3424,' the designer of the light can program the threshold of the temperature within the safe range for LED. If the condition occurred to exceed the defined temperature, the circuits of heat fold-back in 'LM3424' would lower the adjustable current to darken and maintain LED within the programmed range until the temperature was recovered. Applying booster method, we could double the driving voltage of LED streetlight at the battery voltage 12V(Figure 3).

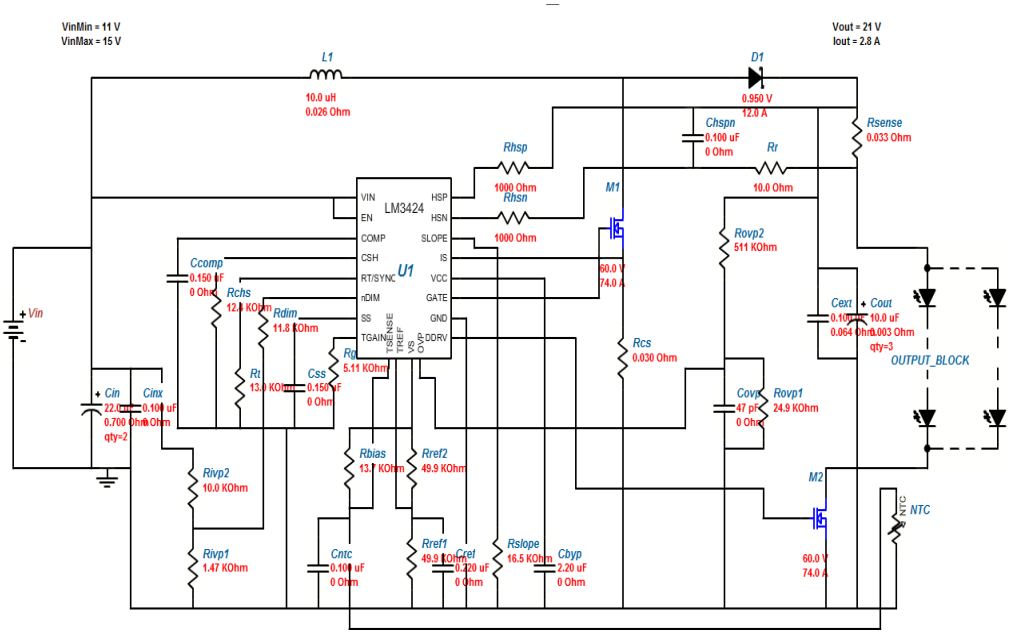

Figure 3. Simulation Circuit of the Driver

It is enabled to adjust the brightness with 5 levels using PWM dimming by surrounding illumination (Table 1).

Table 1. Adjust the Brightness of the Backlighting

Lux	Intensity of Light by Stage on Street Light
1 - 30	Stage 5
31 - 60	Stage 4
61 - 110	Stage 3
111 - 160	Stage 2
161 - 210	Stage 1
211 or above	Street lights Off

Also we organized them to enable to decide the trouble by detecting the supplied current and voltage to deliver their values to the remote Google Cloud Message(GCM); to investigate the supplied current whether the LED light turned on when dark, judging the illumination; and to use the solar cells as the generator and charging circuit.

For the developments of application and home server by single computer, we used with Arduino Ethernet Shield and Raspberry Pi to output the battery voltage, temperature, and the sensor value of illumination in the system into the application as a real-time basis. It is possible to control PWM of LED light and system selection on the activation or inactivation in the application. Also, it is possible to control MAC by Cloud Message and the illumination by any advertisement consumers. Since the efficiency was maximum at the angle of solar cell module with 90 degrees to the sunlight and the required electricity is 306Wh/day, we used the solar cells as the main generator and the wind power generator as the supplement for the charging control with the battery capacity 84.15Ah when used at 12V for 3 days. The power generated by the wind power generator was converted to 12V after rectification to lead in the next level of Buck Convertor for the solar cell of the charging controller. To prevent the charge loss due to the inconsistency of the maximum output voltage of the solar cell with the charging voltage of the battery, MPPT was controlled by Buck Chopper Converter as the below Figure 4.

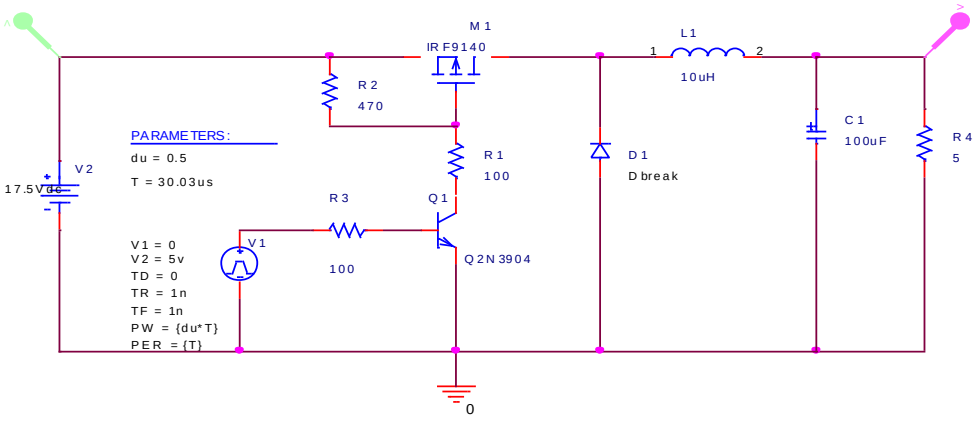

Figure 4. Charge Control Simulation

It shows the graph of charging control after the simulation(Figure 5).

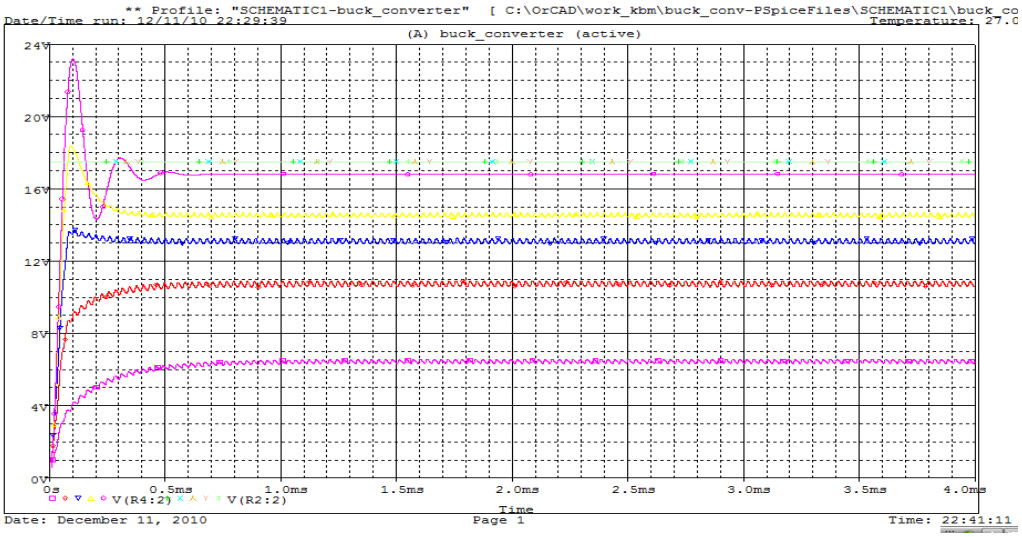

Figure 5. Graph of the Charge Control Operation Simulation

The circuit topology of Buck Converter is the same as the real one but not the microelectronic values. The Pspice simulation circuit of OR-cad and its results are as in the Table 2 to understand the trend of circuit operation.

Table 2. Pspice Circuit Simulation Results

Duty ratio	Output Voltage(V)	비고
0.1	6.372	Input Voltage 17.5V PWM fr=33KHz Period=30.03us
0.3	10.696	
0.5	13.134	
0.7	14.664	
0.9	16.817	

We applied the charging control system by using Buck Converter to control Maximum Power Point Track (MPPT) to show the maximum voltage and current with 17.5V/6.97A in the solar cell. We designed to charge the battery in the static current mode to prevent the battery damage in case of overcharging, and in the slow start in case of discharging(Figure 6-7).

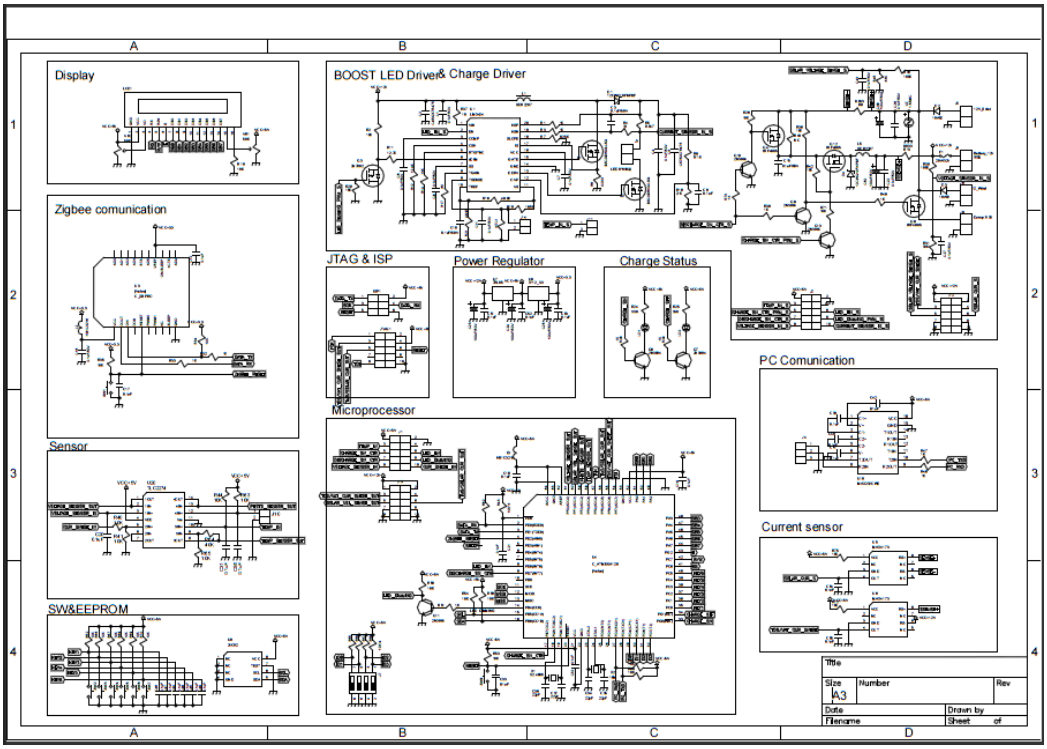

Figure 6. LED Driver and Charging Circuit

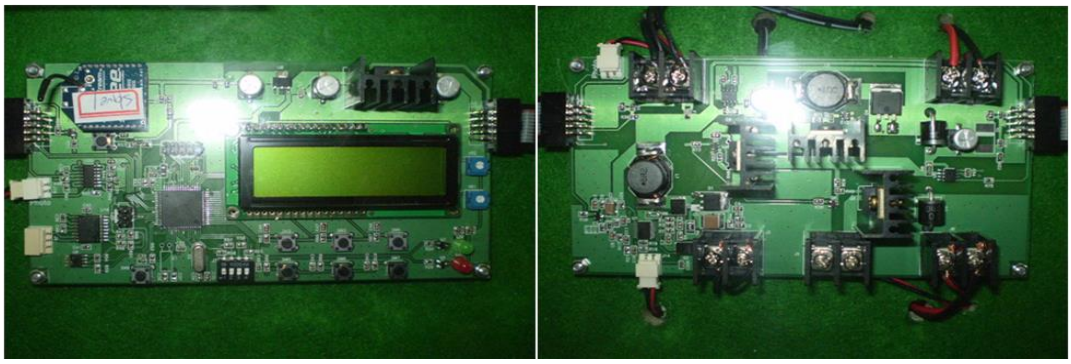

Figure 7. Prototype Model of Bidirectional Remote Control Module

In the control application of the smart devices, it was designed to accumulate the data of the illumination and charging statuses delivering them frequently (Figure 8). The small server was established by using related applications and single board computer for the communication with the smart devices by internet connection.

Figure 8. Images of Web-Site, Applications for the Smart Devices

5. Conclusion

Today, we collect the consumers' feedback in various fields to utilize them as the new variables in the system, however, the street sculptures using the street light are still maintained and exposed as the form of offline advertisement in a way of one-way communication. The impact of the advertisement by consumers' participations in the control of external advertisement or sculptures seems to be effective. In this study, we designed the system to be controlled by multiple consumers of the advertisement, and realize the remote control by their participations. We developed the system that it enabled the self-charge by solar energy, remote control, and deliveries of voltage and LED consumption status information of LED advertisement streetlight under the certain environment. With this system, the efficient deliveries of illumination information and control are expected for the remote users under the certain environment or situation. Self-powered LED light

can collect the data on the illumination environment so frequently by the remote control. In addition, the design of streetlight might be relatively economic and easy to organize the efficient space compared to the other facilities. Further studies will be focused on the data collection methods and systems to evaluate the effects of advertisements by consumers' participations.

Acknowledgments

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