Implementation of Autonomous Discharging Scheduling for Smart Streetlight System based on Supercapacitor

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Abstract

Smart streetlights have been developing owing to the internet-of-things (IoT). Despite the continuous improvements streetlight still suffers from overcharging and excessive power usage. In paper, an autonomous discharging scheduling for smart streetlights is implemented. The discharging schedule allows the user to personally be able to control and set the discharging scheduling of smart streetlights wirelessly. The implemented discharging scheduling is able to provide a real-time wireless monitoring of smart streetlights and the scheduling control is able to control the smart streetlights wirelessly.

Keywords— discharging, scheduling, smart streetlights

Ⅰ. INTRODUCTION

The world population residing in urban areas is forecasted to increase from 54% to 70% in 2050 [1]. To sustain the urban areas, cities has been transforming to smart cities. Smart cities are powered by the internet-of-things (IoT). One of the common uses of IoT is its integration in streetlights. Streetlight is generally used to illuminate dark areas and provide a safe environment for pedestrians and drivers [2]. In transitioning to smart cities, streetlights have been developed to smart streetlights as well. Smart streetlight uses technologies, such as sensors and actuators, to make traditional streetlights more intelligent. Researchers and developers will also include sensors and algorithms to provide fault detections. The mentioned features are the basic definition of intelligent lighting which solves the problem with high-power and maintenance cost. Most existing smart streetlights can wirelessly transmit and receive data. With this feature, wireless networks are embedded in the smart streetlights to make the streetlights communicate with the control or management center and introduced the wireless monitoring and control of smart streetlights which greatly reduces maintenance cost. Since smart streetlights are now able to communicate to users wirelessly, researchers started adding more features such as monitoring of environmental conditions, environmental noises, air pollution, and luminance monitoring in the smart streetlight by collecting data from the integrated sensors. Aside from monitoring of environmental parameters, monitoring the performance of supercapacitor used in smart streetlight is a must. This is to protect the supercapacitor cells from overcharge and deep discharge which often lead to a massive degradation of the supercapacitor life [3]. Acquired supercapacitor, solar panel and lamp parameters will be sent to a real-time database which can be retrieved for real-time monitoring. This paper is able to provide real-time monitoring by automatically syncing the collected data to the web-based monitoring system

Ⅱ. METHODOLOGY

The actual implementation of the autonomous discharging scheduling is shown in Fig. 1. The proposed web-based wireless control for smart streetlights system can accurately get the sunset and sunrise time based on MeeusJs API as discussed in the previous section. In this smart streetlight is discussed. The proposed smart streetlight is implemented and simulated in the board. As previously discussed, the streetlight is composed of a solar panel, a supercapacitor, a lamp, a controller, and a Wi-Fi module. Specifically, Texas Instruments C2000-F28379D and CC3220SF is used as the microcontroller and Wi-Fi module in this paper.

The simulation for the web-based control considers the time predicted by the MeeusJs API in order to control the smart streetlights based on sunrise and su nset time. The following will discuss the corresponding process based on modes and time chosen:

Mode 1 will turn the light "On" during sunrise and it will be "Off" during sunset. If the mode 1 connection is active, the MeeusJs API sunset time will be retrieved. If the user picks mode 1 and the current time value is currently sunset time, then the lamp will be "On". Otherwise, the lamp will be "Off" as long as the current acquired time of the MeeusJs API is sunrise time.

Unlike previous modes, mode 2 does not concern about the time if the connection for mode 2 has been engaged. The lamp will be dischargedMode 3.

Mode 3 and Mode 4 are quite complicated with scheduling In Mode 3, the lamp will be "On" for a hours after sunset and "Off" for the rest of the time. In this simulation, I chose mode 3 and assign the value of "2" for a variable, then, the lamp will be turned "On" for 2 hours after sunset and "Off" for the rest of the time. Since I input a value of "2" as the value of a variable, the result indicates that the smart streetlights will be turned on from the MeeusJs API anticipated sunset time of 19:46:43 to the additional 2 hours of 21:46:43 and the streetlight will be "Off" for the rest of the time.

In Mode 4, the lamp will be "On" for b hours after sunset and "On" for c hours after sunset. For instance, if the user chooses mode 4 and assign a value of "2" for b variable and value of "3" for c variable, then, the lamp will be turned "On" for 2 hours after sunset, 3 hours before sunrise. So, the result indicates that the smart streetlights will be turned on from the MeeusJs API anticipated sunset time of 19:44:49 to the additional 2 hours of 21:44:49 and will be turned "Off" after the time has been satisfied. The streetlights will turn "On" again for 3 hours before sunrise which is 02:09:01 until sunrise time of 05:09:01. Then, the streetlight will be "Off" for the rest of the time.

Simulation shows that the discharging and charging method are able to recognize sunset and sunrise without using timer or real-time clock. It can accurately and autonomously control the smart streetlight based on the acquired sunset and sunrise time from MeeusJs API. In results, it can control for smart streetlight on/off scheduling throughout the day without integrating sensors or components such as light sensors.

Ⅲ. CONCLUSION

In this paper, an autonomous discharging scheduling for smart streetlight system is implemented. The implement discharging scheduling allows the user to remotely access the webpage and control the operation of streetlights. Additionally, a high-level, low-cost, low-power management Wi-Fi module is used to minimize the delay in both monitoring and controlling the streetlights. Compared with onboard management

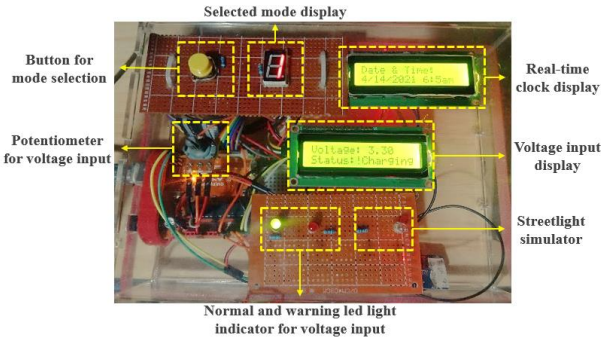

Figure 1. Actual implementation of Autonomous Discharging Scheduling for Smart Streetlights

systems, integration in cloud has higher computational power, enormous data storage capability, and higher system reliability which helps to ensure optimal streetlight performance.

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