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Standalone Smart Solar-powered Streetlamp Light control System

Wonchul Choi[1], Choongchae Woo[2]

[1] Hanseo University, Dept. of Electronic Engineering, Seosan, Korea
[2] Hanseo University, Dept. of Electronic Engineering, Seosan, Korea (corresponding author)
[1]comling2497@gmail.com, [2]woo9@hanseo.ac.kr

Abstract. This paper proposes a new solar-powered streetlamp light control system which improves the efficiency of energy consumption of conventional solar-power streetlamps. The proposed new solar-powered streetlamp light control system is efficiently recharged using the solar-power recharging controller having the maximum power point tracking function and controls the lamp using the vehicle detection system data applying the audio recognition technology. The test result confirmed that the streetlamps were lighted in accordance with the detected vehicle data and that the performance was 25% higher than the conventional solar-power recharging controller. The system is expected to help solving the problem of energy efficiency of conventional solar-powered streetlamp system, ensuring traffic safety, and preventing crime risk of nighttime walking.

Keywords: solar energy, smart light, light control, MPPT, streetlight

1 Introduction

Today's streetlamps are installed everywhere in the urban area to provide the needed view for the vehicles and pedestrians at nighttime. Such streetlamps light up the cities at night and prevent traffic accidents or crimes. However, the streetlamps installed in the rural or other areas where the pedestrian movement or vehicle traffic is light waste energy, increase the crime, and negatively affect the traffic safety [1].

To reduce the inefficient energy consumption of streetlamps, the solar-powered streetlamp using the photovoltaic power generation was developed, but it is having difficulties of establishing its presence in the market because of the problem not operating when the energy recharged in the storage battery is not sufficient due to the cloudy weather, rain, etc. To solve the above problem, the hybrid streetlamps combining both wind power and solar power or using both commercial power and photovoltaic power generation have appeared, but their applications have been limited due to the high price and maintenance cost.

This paper implemented a standalone smart solar-powered streetlamp light control system which efficiently consumes the energy to solve the problem of conventional streetlamps not operating when it is insufficiently recharged after wasting the energy.,

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The solar-powered streetlamp light control system proposed and implemented in this paper applies the solar-powered recharging system which tracks the maximum solar power point to generate the power efficiently. The advanced streetlamp light control system also utilizes the audio recognition technology with wireless network to sequentially light the streetlamps in the path of vehicle movement.

The main text of this paper is organized as follows: The organization and implementation of the developed system is described, and the theory and design method applied to the developed system are presented. The result of testing is described, and lastly the superiority of the designed system and conclusion are presented.

2 Main Text

The standalone smart solar-powered streetlamp light control system does not use the commercial power but is dependent upon only the new and renewable solar energy. It also applies the audio recognition technology which controls lighting by recognizing the moving objects to maximize the energy efficiency. The system can help solving the problem of streetlamps not being lighted because of shortage of recharged electric energy due to the prolonged shortage of sunlight which was the problem of the conventional standalone streetlamps.

Fig. 1 shows the operation diagram of a standalone smart solar-powered streetlamp lighting control system. It detects the power input from a solar cell to control the operation of the maximum power point tracking function, detects the power input from the solar cell and the power being recharged in the storage battery to monitor the power generation status, and supplies the electric energy stored in the storage battery as the power source to the smart lighting control system and LED streetlamp.

The smart lighting control system applies the audio recognition technology to detect the presence and path of a moving object and controls the LED streetlamp based on the detected data. It also sends the solar-powered recharging system status data and moving object detection data to the next streetlamp through wireless communication.

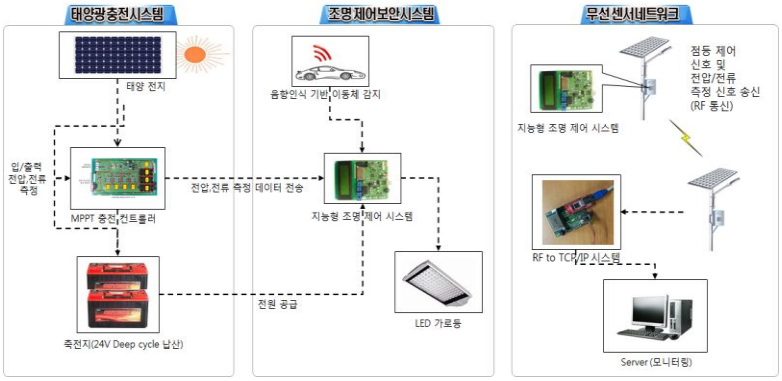

Fig. 1. Standalone Smart Solar-powered Streetlamp Light control System

The next streetlamp is lighted in accordance with the received data and performs the role of wireless communication relay station to send the data to the following streetlamp. The final streetlamp then sends the data through TCP/IP(Transmission Control Protocol/Internet Protocol) to the monitoring PC of the control room.

The solar-powered battery recharging controller consists of the voltage measurement system and current measurement system for maintenance of the solar-powered streetlamp, solar-powered MPPT recharging controller to optimize the output varying according to the ambient environment, and the recharging status monitoring system which allows the operators to check the electric energy output status of solar cell and battery recharging status in real-time.

A solar-powered recharging controller has a problem of having to be designed specific to the intended product performance. To solve the problem this study configured the voltage measurement system with scalable general purpose circuit as shown in Fig. 2.

The voltage measurement system is configured of the exclusive voltage monitoring IC while the recharging controller reads the voltage through the communication with the voltage monitoring IC. Since there is the phase difference between the battery and recharging controller, the circuit connected to the battery is configured as a module and the insulated communication is implemented.

The battery is basically discharged and recharged, and the direction of current is switched in that case. The circuit unit recognizing the current must recognize the direction of the current flow and be able to respond to even slight amount of current to cope with the change of current consumption.

To ensure that, the system is configured as shown in Fig. 3, and a heat sink structure is configured to prevent the error by heat generation from current change. Moreover, a separate A/D (analog to digital) converter is implemented in each direction to measure the current in both recharging and discharging direction.

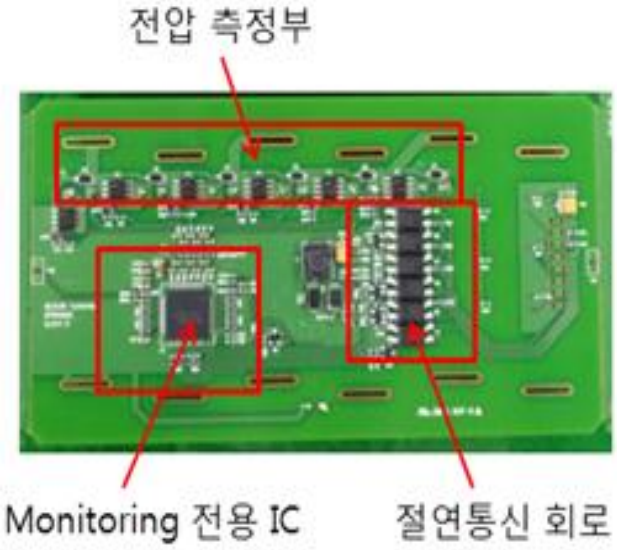

Fig. 2. Voltage Measurement System

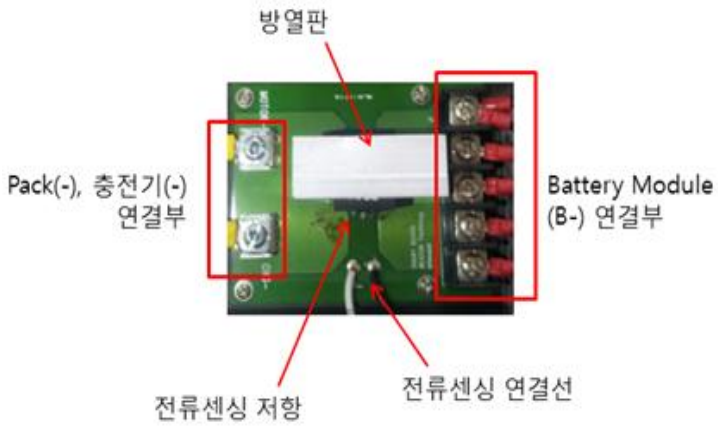

Fig. 3. Current Measurement System

3 Conclusion

Recent depletion of fossil energy and global warming have resulted in many ongoing studies of alternate energy such as the news and renewable energy. Moreover, studies of applying the solar power generation, which is one of alternate energies, are also actively ongoing to save energy. However, the solar-powered streetlamps is rarely applied because of the problems of low power generation efficiency and sunlight. As such, this paper studied and implemented the high efficiency solar-powered recharging system and means to solve the problem of wasted energy as the streetlamps are always lighted regardless of presence of vehicles.

The system proposed in this paper has following benefits: First, the audio recognition technology allows controlling of streetlamps for outstanding performance with low cost. Second, there is less risk of error by ambient environment such as the streetlamp condition and weather. Third, sharing of control data among the streetlamps enables efficiently manage many streetlamps at the same time as well as each individual streetlamp. Fourth, The initial installation cost can be lowered as it can be easily installed in the existing streetlamps. Fifth, the smart lighting control can reduce the energy consumption. Sixth, the solar-powered recharging controller applying the maximum power point tracking control technology enables effective recharging even when the recharging efficiency drops because of shadow, etc.

Because of these benefits, the system is expected to solve the energy efficiency problem of conventional solar-powered streetlamp system, ensure the traffic safety and prevent crime against nighttime walking.

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