Solar Powered Bicycle for WSN Control and Remote Power Management Applications

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Abstract

In this paper, a solar energy powered bicycle by a wireless sensor network (WSN) far-end network monitoring solar energy to transfer the electrical energy storage and the effectiveness analysis is proposed. In order to achieve this goal, an embarked ZigBee by a solar-powered bicycle the far-end wireless network supervisory system is setup. Experimental results prove that our prototype, the solar energy powered bicycle, can manage the solar energy for charging two Lead-Acid batteries pack. As a result, the user by the wireless network in parking period knows the data on the amount of immediate solar radiation, the degree of illumination, the ambient temperature, and electrical energy storage capacity information by the internet interface.

Keywords: solar, WSN, GPS

I.   INTRODUCTION

WITH the increasingly wide range of applications for renewable energy and wireless network technology, the conventional supervisory control and data acquisition (SCADA) system that employs power cable eployment for the remote terminal units and data line network between the monitoring end point and SCADA host center can being replaced. Take advantage of renewable energy resources in the transportation's environment, offers a power source limited by the transportation's physical survival rather than an adjunct energy source. This study examines "Solar Energy Powered bicycle for Wireless Supervisory Control and Data Acquisition Applications". The integration of renewable photovoltaic energy and wireless network technology enables a remote terminal units located in an open outdoor area to conduct on-site monitoring with photovoltaic power through a ZigBee wireless module, transmitting data back to SCADA host center without physical wiring. Considering the unreliability of photovoltaic power systems, this study also makes an in-depth understanding on the availability of photovoltaic energy Moreover, the unreliability of photovoltaic energy also makes user understanding residual electrical energy crucial

The ZigBee network element is one kind of the wireless network agreement which mainly made by the ZigBee Alliance [1]. Its first floor is the media access levels and the entity level by using the IEEE 802.15.4 standard. By using the Global System for Mobile Communications (GSM) the handset mobile phone can receive on the parking lot bicycle about the storage electrical energy to feed in the remote monitoring center and momentarily accepts the monitoring center the instruction. Valente et al. [2] made the wireless data transmission by using ZigBee under media access control (MAC) construction. Pegatoquet et al. [3] used a system-on-a- chip (SOC) chip, the digital signal processor (DSP), the micro control unit (MCU), the GSM, the Bluetooth, the global positioning system (GPS) to apply in the audio applications of the energy sources and environment. It is therefore essential to thoroughly understand and judiciously exploit these factors in order to maximize the energy efficiency of the solar cells module. Due to the unstable characteristic for solar energy, it ismore convenient to allow electric bicycles to run on stable sources of energy such as batteries

This study integrates solar energy renewable energy sources, the WSN and the wireless internet three units, and abbreviates power line's arrangement. Using lays aside on solar-powered bicycle's sensor element launcher, the user can know the data of the solar immediate degree of illumination, the solar generate electrical power rate, the ambient temperature, the storage electrical energy and so on

II.   SYSTEM STRUCTURE

This topic is carried on the solar energy powered bicycle as shown in Fig. 1 by the WSN far-end network monitoring solar energy to transfer the electrical energy storage and the effectiveness analysis. In order to achieve this goal, an embarked ZigBee by a solar-powered bicycle the far-end wireless network supervisory system is setup. As a result, the user by the wireless network in parking period knows the data on the amount of immediate solar degree of illumination, the ambient temperature, and electrical energy storage capacity information by the internet interface. Further simulation and experiment results will be shown in the final full version to verify the proposed WSN far-end network monitoring solar energy system

III.   WSN IN CAMPUS APPLICATIONS

There are several outdoor applications that seem feasible for WSNs. But to eliminate their dependence on batteries and use solar cells as an exclusive energy source would require the outdoor lights to be on continuously in the daytime. A simplified block diagram of a wireless router node operating on solar energy are shown with series and parallel connected in Fig. 2 and Fig. 3, respectively. Typically, a router node consists of an eight bit microprocessor with adequate resources to operate its kernel [7]. The microcontroller manages power to the sensors and data acquisition elements, as well as responds to commands from the base station. ZigBee ready radio frequency transceiver [1] integrated with an eight bit microcontroller and the system communicates inthe 2.4 GHZ frequency band.

In Fig. 2, one such wireless supervisory monitoring concept of a solar energy powered bicycle that can be used to monitor on the amount of immediate solar degree of illumination, the ambient temperature, and electrical energy storage capacity information. It is clear that solar energy is the most efficient natural energy source available for outdoor applications [6]. Exploiting solar energy resources in the outdoor environment, offers a power source limited by the devices physical survival rather than an adjunct energy source likes sockets or the battery charging station demand. However, the design of an efficient energy harvesting module involves complex tradeoffs due to the interaction of several factors such as the characteristics

Figure 1: Prototype of the Proposed Solar Energy Powered Bicycle

The maximum range of data transmission for such ZigBee is approximately one hundred meters [3]. Thus, additional nodes may be required to pass the data back to the central monitoring location There might be several such router nodes distributed in these WSNs, and number would depend on campus size and coverage required Typically, each router node in the network has a fixed location and its only function involves establishing itself in the network and enabling prompt data transfer to the nearest router node or base station. These router nodes obviously need to be continuously on so that data can be promptly transferred. Since the unstable solar power in the outdoor that harvests in the daytime, it is advantageous to get continuously data for scavenging solar energy. This would result in a cost saving overtime and eliminate the need to charge batteries.

Referring to Fig. 2 again, the base station in such networks consists of a router that receives data and is connected to a server. The data received by the base station is displayed to allow continuous monitoring and can be routed to the battery's characteristics for easy access in real time. Similarly, ZigBee sensors in the solar powered bicycle with the solar cells can scavenge energy through overhead sunlight rather than use battery charger. In fact, in such systems, ZigBee sensors might be mobile and therefore, it might be possible and advantageous to monitoring the electric power in the batteries through photovoltaic solar cells. There are two key issues that were addressed before embarking upon designing the solar powered bicycle for wireless supervisory monitoring applications. First, solar energy has to be harvested by an efficient energy scavenging system. Secondly, there has to be an efficient means of storing this harvested energy. The system must also effectively deliver the stored energy data to the remote user knows what the miles he or she can use to run the solar powered bicycle. This means there has to be an intelligent power management strategy in place. Obviously, this strategy must know how much the stored energy can use and where can be recharging the batteries. These details along with design considerations that impact efficiency and the associated tradeoffs are explained in the next few sections.

IV.   SOLAR CELLS CHARACTERISTICS

Solar cells have vastly differing characteristics from batteries. As listed in Table 1, a 835x540x35 mm 50W single crystalline solar panels from GE Inc. were chosen for the system due to ease of availability and low cost. Each panel was rated at 3.522A short circuit (Isc) and 22.38V open circuit voltage (Voc) under sun's irradiance (1000W/m2) conditions
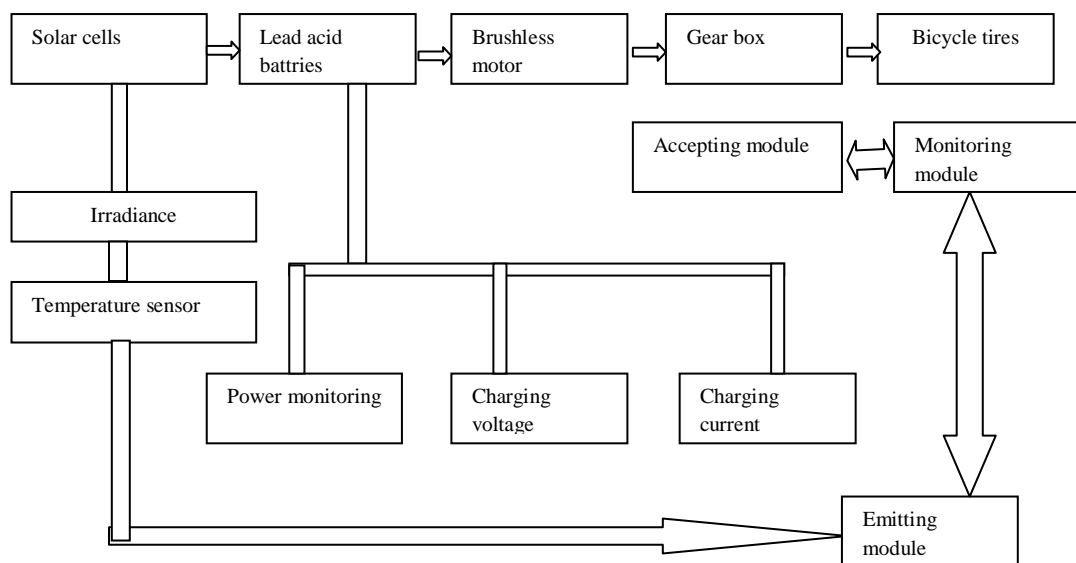

Figure 2: The Series Connected Monitoring Block Diagram

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In order to determine the number of panels required per solar powered bicycle, a simple load test was conducted. A single solar panel was connected across a varying load to determine its V-I profile. The V-I profile wherein it can be observed that at around 18 VDC the panel sourced out approximately 3 A. Therefore, 50W solar panel was enough to recharging lead acid batteries. Although the size of the panels was not a concern, a modularized approach was taken in order to reduce the panel size and weight further. It was assumed to use the solar power with 1/3 duty cycle in the daytime that the system is always power on to charging the batteries. In addition, two lead acid batteries 12VDC 36Ah were used in parallel with the solar panels to store the solar energy and to reduce the solar panel power rating requirement even further. These details are explained in the next few sections.

Table 1: Specifications of the Solar Powered Bicycle

Solar cells	
Type	GE 50W 12V
Test conditions	
Irradiance	1000W/m
Module temperature	25
Module size	835x540x35mm
Module weight	6.5kg
Maximum power	50w
Maximum power voltage	18V
Maximum power current	2.7778A
Open circuit voltage	22.38 V
Short circuit current	3.522A
Module efficiency	
Electric bicycle	
Weight	32kg
Tire	20 inch
Maximum speed	25km/h
Rated loading	<75kg
Lead acid battries	2x36Ahx2(12 v)
Noise	62 db
Rated voltage	24V
Over current protection	14AU1A
Motor type	Brushless motor
Dimension	1580x565x1075mm

To maximize energy efficiency, enhance device reliability, and lengthen the miles of electric bicycle. The power management circuit designed for this system provides regulated power in lead acid batteries.

V.   EXPERIMENTAL RESULTS

In order to determine the right number of solar cells for powering each electric bicycle a simple load experimental test was first conducted. The electric bicycle with two sets of 36Ah lead-acid batteries and the 50W solar cell in the back seat, which was conducted to test when the summer and sunny weather, only depends on the built-in batteries to run, the kilometres travelled distances away from probably is 66.5km, if the use solar cell charge, increases to 94.4km. In the winter, the experimental result respectively is 64.4km and 85.9km. For reference, as the ZigBee based wireless sensor node for real time monitor, the operation of the ZigBee sensors mote, ZigBee router based mote (red PC module) and the solar

Powered bicycle monitoring screen are shown in Fig. 3, Fig. 4 and Fig. 5 respectively. This result shown the proposed electric bicycle charging source by solar cells may lengthen the travel distance, reduces the manual charge the trouble. By ZigBee and GSM network, in monitors and the material picks up the system the solar electrical energy generation and the battery charge and the surplus electrical power system can obtain the immediate information rapidly on the surveillance bicycle by the network.

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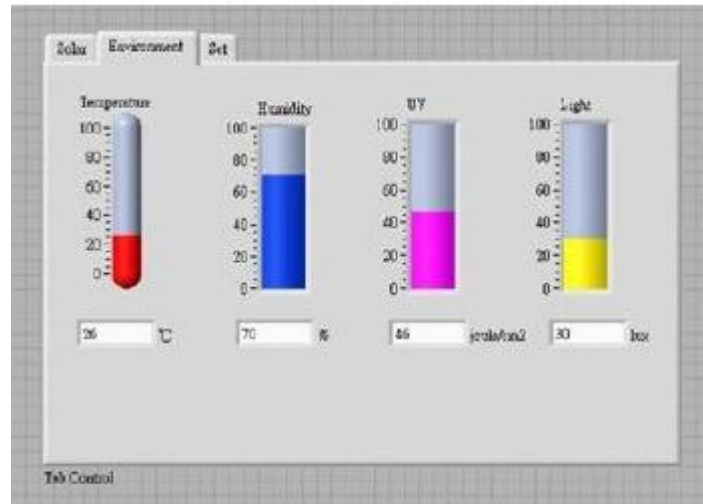
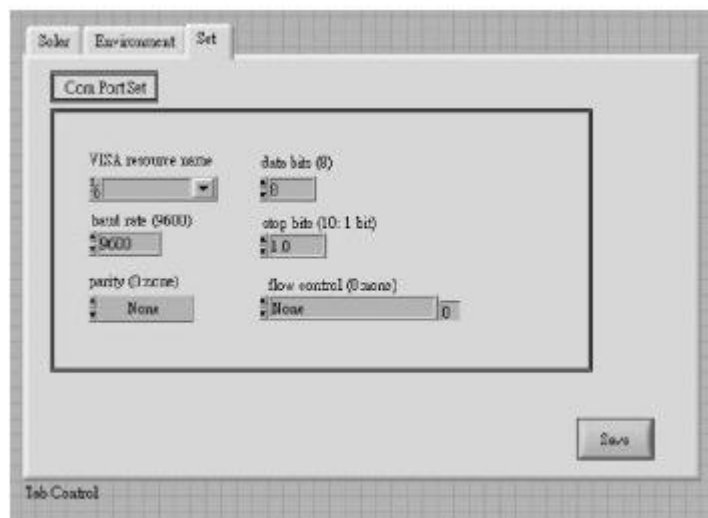**Figure 3: ZigBee Sensors Mote with Blue PC Module**

Figure 4: ZigBee Router based Mote with Red PC Module

5(a)

(b)

(c)

Figure 5

VI.   CONCLUSIONS

This topic is carried on the solar energy powered bicycle by the WSN far-end network monitoring solar energy to transfer the electrical energy storage and the effectiveness analysis. In order to achieve this goal, an embarked ZigBee by a solar powered bicycle the far-end wireless network Supervisory.

VII. REFERENCES

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