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Solar Powered Optimal Battery Charging Scheme For Moving Robotic Vehicle

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Abstract— This paper focuses on the design and development of an optimization charging system for Li–Po batteries with the help of solar tracking panels. Therefore, the implementation of a complete energy management system applied to a robotic vehicle. The proposed system is to design Moving robotic Vehicle. The design concept, based on a microcontroller. On this basis, our proposal makes a dual significant contribution. First upon, it presents the construction of a solar tracking mechanism aimed at increasing the robots power regardless of its mobility. Secondly, it proposes an alternative design of power system performance based on a pack of two batteries. The aim is completing the process of charging a battery independently while the other battery provides all the energy consumed by the robotic vehicle.

Keywords- *Li–Po battery, Arduino, photovoltaic (PV), robotic vehicle, solar tracker*

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I. INTRODUCTION

SOLAR power systems in autonomous robotic vehicles have been frequently used for some years. A real example is the Sojourner rover, in which most of the supplied energy is generated by a reduced-size photovoltaic (PV) panel [1]. However, in case of scarce to no solar light, the rover should minimize consumption, since its batteries in line could not be recharged when depleted [2]. The use of rechargeable batteries in a space mission was used for the first time in the Mars Exploration Rovers.

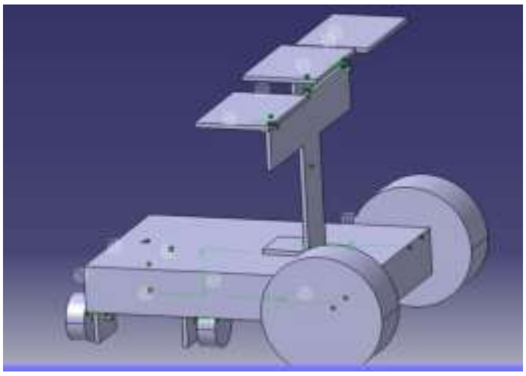

Figure 1. Solar Powered Robotic Vehicle

The robotic vehicle aims to improve various aspects of the-afore mentioned rovers with scientific and academic purposes. The paper presents the mobile robotic vehicle system. Its main features are described and its hardware and software architecture are presented. It introduces the concept of microcontroller for intelligent power management applied to an exploration vehicle. The following sections present the control of the battery-charging system by means of tracked solar panels, which is the main aim of this paper; the design of its mechanical structure, its electronic devices and the graphical user interface (GUI) are presented. The necessary parameters for the batteries sizing, charging, and discharging algorithm, and the PV system sizing are explained.

II. LITERATURE SURVEY

The literature survey carried out related to technology impact in the study of solar powered moving robotic vehicle with different techniques. Tom´as de et.al.[1] focuses on the design and construction of an optimization charging system for Li–Po batteries by means of tracked solar panels. Thus, the implementation of a complete energy management system applied to a robotic exploration vehicle is put forward.

Roger Gules et.al.[2] presents the analysis, design, and implementation of a parallel connected maximum power point tracking (MPPT) system for stand-alone photovoltaic power generation. The parallel connection of the MPPT system reduces the negative influence of power converter losses in the overall efficiency because only a part of the generated power is processed by the MPPT system.Maintaining the Integrity of the Specifications.

Moacyr Aureliano Gomes de Brito et.al [3] presents evaluations among the most usual maximum power point tracking (MPPT) techniques, doing meaningful comparisons with respect to the amount of energy extracted from the photovoltaic (PV) panel [tracking factor (TF)] in relation to the available power, PV voltage ripple, dynamic response, and use of sensors.

Vladimir V. R. Scarpa et.al.[4] proposes a method for tracking the maximum power point (MPP) of a photovoltaic (PV) module that exploits the relation existing between the values of module voltage and current at the MPP (MPP locus). Experimental evidence shows that this relation tends to be linear in conditions of high solar irradiation. The analysis of the PV module electrical model allows one to justify this result and to derive a linear approximation of the MPP locus. Based on that, an MPP tracking strategy is devised which presents high effectiveness, low complexity, and the inherent possibility to compensate for temperature variations by periodically sensing the module open circuit voltage. The proposed method is particularly suitable for low-cost PV systems and has been successfully tested in a solar-powered 55W battery charger circuit.

Francisco Paz et.al.[5] develops and discusses in detail an MPPT algorithm with zero oscillation and slope tracking to address those technical challenges. The strategy combines three techniques to improve steady-state behavior and transient operation: 1) idle operation on the maximum power point (MPP); 2) identification of the irradiance change through a natural perturbation; and 3) a simple multilevel adaptive tracking step. Two key elements, which form the foundation of the proposed solution, are investigated: 1) the suppression of the artificial perturb at the MPP; and 2) the indirect identification of irradiance change through a current-monitoring algorithm, which acts as a natural perturbation. The zero-oscillation adaptive step P&O strategy builds on these mechanisms to identify relevant information and to produce efficiency gains

Ling-Feng Shi et.al.[9] presents a mode-selectable synchronous buck DC–DC converter with high efficiency and low quiescent current is proposed, which is suitable particularly for use as an Li-ion battery charger. The high efficiency is obtained by applying dynamic power management technology under light load, which makes some modules of the chip enter into sleep state and the quiescent current of the whole chip down to 45 μA. At the same time, power metal–oxide semiconductor (MOS) devices are also shut down to decrease the dissipation of the system.

III. PROPOSED METHODOLOGY

A. *Hardware Design*

Robotic unit is consisting of four light sensors, tracking system, battery charger and battery selector circuits connected with solar panel which is movable around its axis in all directions. Arduino2560 processor is used for controlling complete circuitry.Arduino2560 controlled by master controller (PC) because of its user friendly nature it is used The SHM is based on a PIC16F886 microcontroller, which monitors VANTER consumption and decisions in a completely autonomous way [1]. In this work Arduino2560 is used because of its user friendly nature.

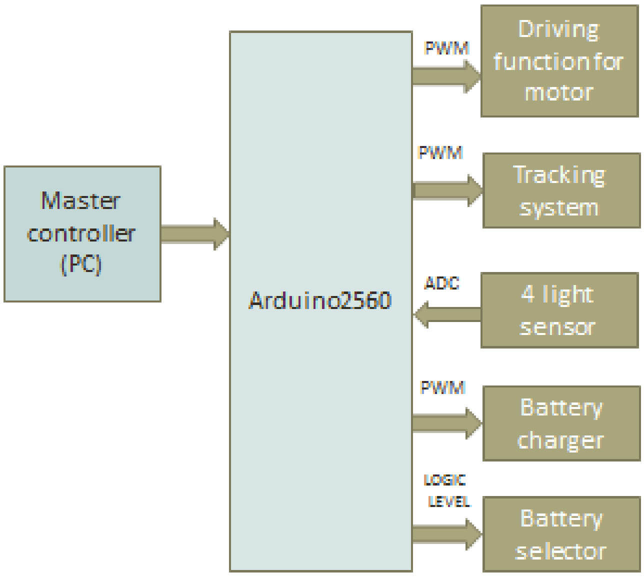

Figure 2. Functional block diagram for Robotic Vehicle

The implemented design in this paper proposes independent charging and discharging processes, thus dividing the problem into two batteries. A relatively good compromise between total weight, available capacity, and source-required power is reached. This strategy implies a smaller PV system to power a single smaller battery at a time and, therefore, solar panels are more economical. This goal was prioritized in this project.

TABLE I. TECHNICAL DATA OF ROBOT HARDWARE DESIGN

Component	Specification
Arduino	Microcontroller ATmega 2560
Li-Po Battery	2400mAh
Solar Panel	Rated power 11W,Voc=21.6, Isc=0.69A
CMOS Camera	Resolution Support for:640 x 480 & 1600 x 1200
DC Motors	3-5V DC ,100rpm
Relay	5V DS2Y 200mW
LDR	400-700nm
IR sensor	3-5V

B. Algorithm Of The Charging And Discharging Cycle.

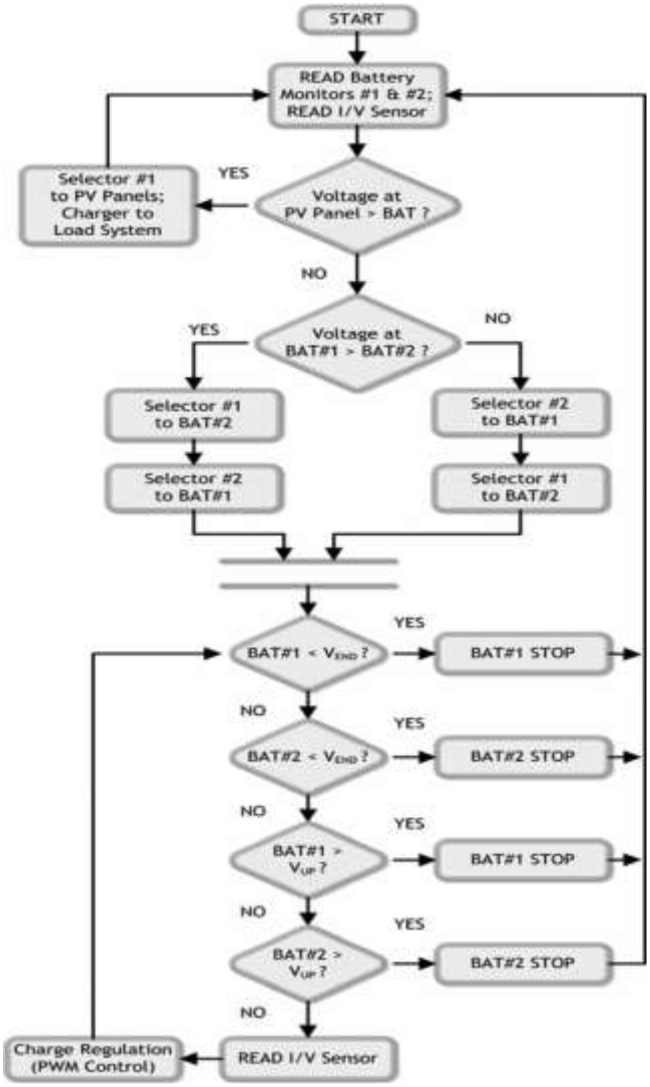

Figure 3. Algorithm of the charging and discharging cycle

The algorithm of the charging and discharging cycle can be elaborated as below:

The battery charging is started and read parameters of battery B#1 and B#2.If B#1 is more Charge than B#2 then select B#2 for charging. This process is takes place repeatedly. There are two conditions if charging of B#1 is less than Vend then charging of B#1 is start AND B#2 will be connected to the load. If charging of B#2 is less than Vend then charging of B#2 is start AND B#1 will be connected to the load. This is continuous process until B#1 and B#2 will be fully charged. Read I/V sensor for maximum power generation towards maximum intensity of light. Depending on maximum intensity of light perform the respective action.

IV. Implementation

Figure 4. Implemented Hardware

Here is the circuit diagram of solar tracker using AtMega2560(Arduino). 4LDRs are connected to the analog input AN0,AN1,AN2,AN3 of the of the arduino. These LDRs help the controller to track the movement of the sun throughout the day using 2 DC motors which are connected to the pins 9 and 10 respectively. With this we can collect maximum energy using solar panel. this energy is used to charge two 12V batteries(on pins A6,A7) alternately. These batteries are used to serve load alternately. When one of them is discharged then its corresponding relay gets on (on pin A5), and it gets charged from the charger circuit. The status of the battery is displayed on 16*2 LCD display. 4bit mode is used for displaying data on LCD. (Pins 5,6,7,8 on).

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