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Microcontroller Based Optimum Battery Charging Using Multi Directional Solar Plate

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Abstract— As technologies scale down from one node to other complications limiting the designing, costing and implementing issues. This paper focuses on the designing concept and construction of an optimization charge system for Lithium– iron rechargeable batteries by means of tracked solar panels for the robotic vehicles. Thus, the achievement of a complete power management system useful to a robotic vehicles experiments put onward. The proposed system was tested on the robotic platform an independent unmanned examination vehicle specialized in credit. The attention of this vehicles scheme lies in the design concept, based on microcontroller. On this basis, our proposal makes a double significant involvement. Secondary, it presents the creation of a solar tracking mechanism designed at increasing the vehicles power apart from of its mobility. The mean is completing the process of charging a battery separately while the other battery provides all the power consumed by the vehicles. On the other hand, it proposes an substitute design of power system presentation base on a pack of two batteries.

INTRODUCTION

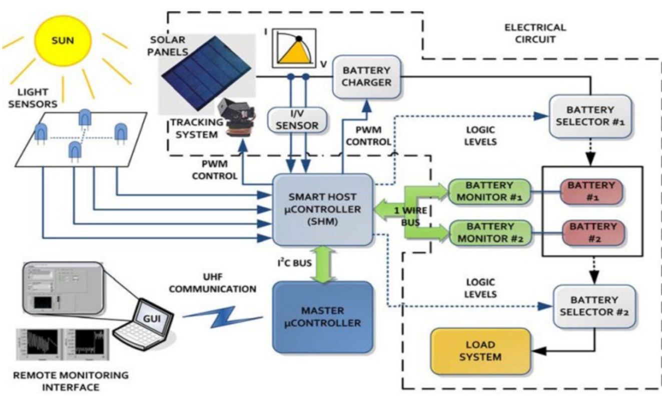
Solar power systems in autonomous robotic vehicles have been often used for some years. A real example is the Sojourner rover, in which most of the supplied energy is generated by a reduced-size photovoltaic (PV) panel. However, in case of scarce to no solar light, the rover should minimize consumption, since its batteries in line could not be recharged when depleted. The use of rechargeable batteries in a space mission was used for the first time in the Mars Exploration Rovers. This solution works as the basis for the design of solar panels for the future automatic robotic mission [1]. In this robot high-efficiency ultrathin-film silicon cells constructed on carbon-fiber reinforced plastic, is capable of providing higher power. However, in case of scarce to no solar light, the vehicles should minimize consumption, since its batteries in line could not be recharged when depleted [2]. The use of rechargeable batteries in space mission was used for the first time in the Mars Exploration Rovers. Nevertheless, the need for greater operation autonomy by Spirit and Opportunity was solved by means of larger deploy solar panels [3]. This solution works as the basis for the design of solar panels for the future in army fighter vehicles. This rover in army vehicles, thanks to its high-efficiency ultrathin-film silicon cells constructed on Carbon-fiber reinforced plastic is capable of providing higher power [4], [5]. NASA designs inspired different generations of exploration vehicles [6]. This is the example of K9, a rover for remote science exploration and autonomous operation [7]; field integrated design and operations, an advanced-technology prototype by Jet Propulsion Laboratory for long-range mobile planetary science [8]; and Micro5, a series of robotic vehicles devised for lunar exploration [9].As its main design advantage, this vehicles succession has a dual solar panel system attached to assisted deferral mechanism. This is the case of SOLERO, developed by the Ecole Polytechnique Federale de Lausanne, which reached optimal energy consumption by a combination of a smart power management and an efficient locomotion system [10], [11]. On the other hand, the Carnegie Mellon University developed Hyperion, a rover in which the major technological milestone was the implementation of solar-synchronous techniques to increase the amount of energy generated by solar panels [12].A vehicle capable of long-distance traverses under extreme environmental conditions devoted to science investigation at the Atacama desert [13]. With an educational approach, Carnegie Mellon University also developed a personal exploration vehicle called PER [14]. More recently, Lever and coworkers [15] and [16] have described the concepts of modeling, design, and fabrication of a robot-box prototype to be used in polar environments. There are some noteworthy projects which main achievement is the optimal selection of solar energy and different power sources according to the operation conditions of a robot [17]–[19].From the above references we got the limitation is that the tracking of solar panel is only in single direction, we can achieve further at any direction with respect to maximum intensity. The army fighter vehicles aims to improve various aspects of the above mentioned vehicles with technical and academic purposes. To introduce the developed robot the main features and properties are compared Subsequently, this paper is organized as follows. The next section presents the mobile robotic system. Its main features are described and its hardware and software architecture are presented. The next Section introduces the concept of smart host microcontroller (SHM) 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. Section IV aims at providing the necessary parameters for the batteries sizing, charging, and discharging algorithm, and the PV system sizing. Therefore, Section V puts into experiments of the developed methodology by testing the rover power systems. Finally, the results and findings from the developed work are presented

II. MOBILE ROBOTIC PLATFORM

The Spanish acronym for autonomous unmanned exploration vehicle specialized in recognition is a robotic exploration vehicle developed is it was urbanized to be guided and has a put of four wheels coupled to a flat surface chassis that can rotate separately. The four-wheel-drive (4WD) and the individual control of each wheel allow different types of movement; including Ackerman design, the crabbing maneuver or the rotation with inner inertial center. The four wheels the vehicle is continued by means of self-governing passive suspension of double aluminum fork to absorb terrain vibrations. Each controls consists of two motors, First one for rotation and one more for driving. secondary, forward movement is formed by means of dc motors. The vehicle system programming is separated into three main code level and its hardware was designed with a hierarchical control structure based on modular AVR microcontrollers. The top level program, carried out in Lab VIEW language, is execute in a remote PC & offer a GUI to monitor and control the whole robotic vehicle [21].

III. MECHATRONIC SYSTEM DESIGN

A typical power management design consists of smart batteries integrating both communication devices and electronics able to control the charge. However, when an economical system is required, the concept of intelligence should be applied to software design for simple batteries. One of the main objectives of this paper is the implementation of the SHM concept to develop a low-cost power management system aboard a robotic vehicle. The system consists of an electrical circuit interconnecting a PV system, a charger device, a selector system, a batteries monitor system, and a battery system . The SHM is based on a ARM microcontroller, which monitors vehicle utilization and decision in a completely independent way [22]. The SHM has two functions 1) detecting environmental light intensity and calculating the solar tracking system to obtain the highest power; & 2) interpret operation data from batteries and solar panels to manage the working mode of the charger consequently.



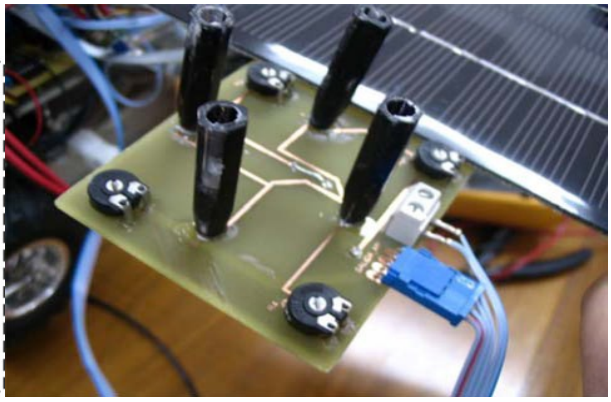


Figure 1. Block Diagram of Vehicle Mechatronics System ***Figure 2. Photovoltaic System Mechanism***.

When selecting the solar panels, vehicle physiognomy and consumption dictated its construction and electric requirements. The panel weight is a factor that limited its mechanical design; light-weight panels provide lower power consumption and require optimizing the robot's overall performance Photovoltaic System with Solar Tracking Mechanism.

Figure3.2. shows the mechanical solar tracking system. This comprises (a) a fixed solar panel mounted horizontally on vehicle and (b) two panels with symmetrical movements. The mechanical structure is mounted on (c) aluminum chassis on which the electronics were mounted. On top of this platform two side supports has been assembled. The solar panels are mounting on pan and roll unit formed by two DYS0213MGs metal gear servos. Each pair of digital servomotors allow soft rotations with an amplitude of180◦ in (g) azimuth and (h) elevation, so that the solar panels.

VI. BATTERY SWITCHING SYSTEM

We favor the switching scheme consists of two MAX1538EVKIT selector with break-before-make operation logic. Their function is between electrically the charge & discharge paths between the batteries, the charger module, and the load system That is, selector one(1) is inserted connecting the charger & the dual-battery pack. Its purpose is direction-finding the current from the PV panels to the input of the charger and, from there, to the battery selected in each moment. Selector two(2) is used to attach the selected battery to the load system. Therefore, the dynamic connections of the electric circuit are carried out according to the SHM-defined logical operation mode.(Ref. fig.4.1)

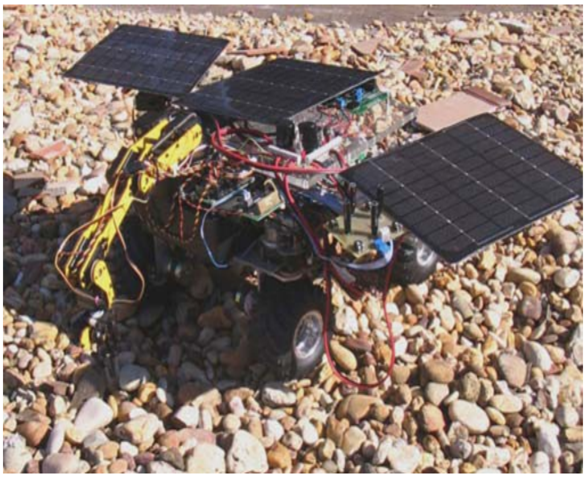


Figure 3. Mechanical solar tracking system.

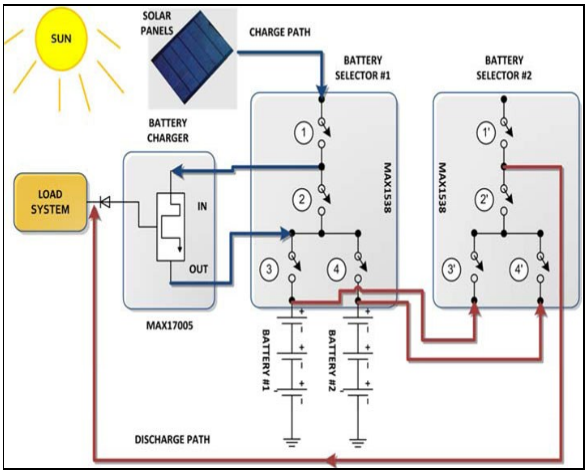


Figure 4. battery switching circuit

IV. CHARGING AND DISCHARGING SYSTEM

This device consists of a dc–dc synchronous-rectified converter with step-down topology. The charger system is controlled by the SHM using a PWM signal applied to one of its terminals and supplies each battery according to a programmed algorithm. Between the PV system and the charger system there are a voltage conditioning capacitor and an I/V sensor from Autopilot with 0–3.3 V output. The capacitorC1 prevents voltage at the charger input pin Vch from falling below the charge voltage of the battery cells Vcv when solar power is not capable of providing appropriate voltage level Vs. During that instant the capacitor is discharged with a current Ich through the dc–dc converter.

V. REMOTE MONITERING INTERFACE

In addition to the GUIs of the navigation system and the5-DOF manipulator arm aboard vehicle as described in[20] the power management system presented in this paper may also be monitored from a remote PC .The virtual instrument is divided into several functional areas that facilitate the composition of the communication packets between the remote PC and vehicle by means of setup menus(a) and displays (b) and (c). The graphical representation of the values allows real-time verification of solar panel-generated voltage and current, batteries' current, voltage, and capacity as well as SoC and discharge, operation temperature, servo position, and photo diodes light level. As an example of the monitoring interface operation, the switching states of the batteries current (d) and voltage (e) during the charging and discharging processes are shown in different tabs. Finally, tab (f) displays both photo sensor-generated voltage levels and the magnitude and angle of the resulting vector.

5.1 EXPERIMENT.

On the basis of operations we achieve some results from ground testing from different light sources.

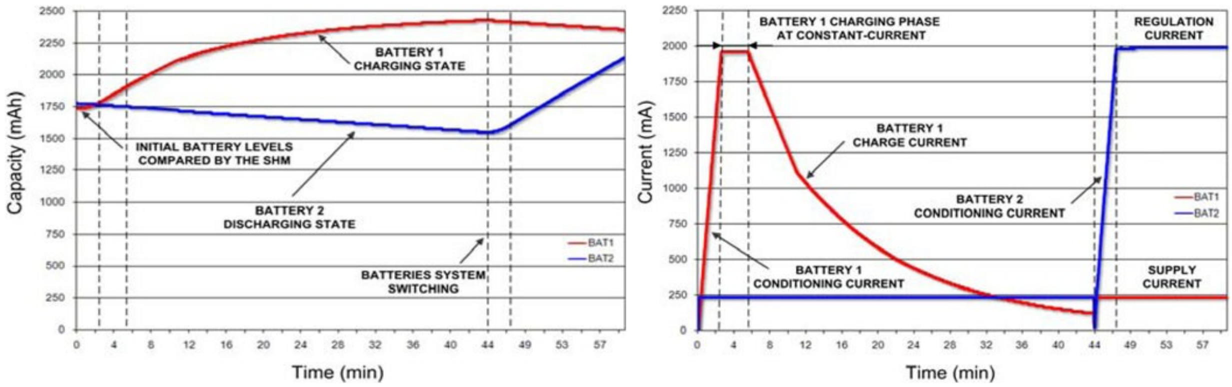


Fig. 4.1 Capacity curves in the batteries for a charging and discharging cycle

CONCLUSION

This paper presents the design and implementation of optimal battery charging in solar power robot. This also gives a smart energy management system applied to a robotic platform, an autonomous unmanned vehicle devoted to exploration tasks. The proposal includes the construction of a solar tracker mechanism based on mobile PV panels aimed at increasing system energy. Its main advantage is that the amount of generated power is independent from the vehicle mobility, since the proposed mechanism is capable of tracking maximum light intensity. Delivering the systems' energy requirements while recharging the backup battery was made possible by implementing a dual system of selectors, monitors, and batteries. This strategy implies small solar panels to power a single battery at a time. A relatively good compromise between total weight, capacity available, and source-required power is reached. This solution does not attempt to achieve high charging times or great operating times but to prove a sustainable and commercially feasible solution applied to a robotic vehicle.

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