Microcontroller Controlled Optimal Battery Charging for a Solar Powered rover With Efficient Wireless Camera

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Abstract: The energy released by sun is referred as solar as a solar energy which will not decay & is costless and this energy is utilized in many applications where power supplies are absent. So here smart microcontroller is used for optimal battery charging that is used in solar powered robotic vehicle. It includes design and construction of optimized charging system for Li-Po batteries by using tracked solar panels to get maximum power from sun regardless of rover's mobility. It also gives the alternative design of power system performance based on pack of two Li-Po batteries. The objective is completing the process of charging a battery independtely while other battery provides all energy consumed by the rover. In this thesis robotic vehicle is based on two PIC16F877A microcontrollers and the efficient wireless camera using two wheel differential drives.

Keywords: *Li-Po batteries, solar tracking mechanism, relays, microcontrollers.*

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I. Introduction

Photons of light with energy higher than the band-gap energy of PV material can make electrons in the material break free from that hold them and create hole-electron pairs such as shown in figure 1. These electrons, however, will soon fall back into holes causing change carriers to disappear. If nearby electric field is provided, those in the conduction band can be continuously swept away from holes toward a metallic contact where they will emerge as a electric current[3]. The electric field within the semiconductor itself at the junction between two regions of crystals of different type, called p-n junction.

Need of dual batteries: Though the use of rechargeable batteries were possible, but when the battery is fully discharged the , there will be no supply available for rover, so to increase the power system performance it is necessary to construct the dual batteries for robotic vehicle drive. Due to which it is possible to provide uninterrupted supply to rover that will increase the systems performance. As a result one of the battery will take power from sun and other will provide energy to robotic vehicle

Mechatronic system: It introduces the concept of smart host microcontroller for intelligent power management system applied to exploration 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.

Solar tracking mechanism: It gives selection of solar panels based upon the power, weight and cost. It gives information about solar tracking mechanism based on the concept of maximum power point regardless of rovers' mobility. Gives details about how servo motor works according to voltage generated from photovoltaic panels. The advantage over other systems based on solar mathematical equations is that this mechanism allows tracking as closely as possible to the solar position in any ambient light situation.

Optimized battery charging: Optimized battery charging for the rover is one of the main objectives that are possible by using dual PIC16F877A and two wheel differential drive [6]. That will tend to reduce the systems cost becomes economical system. Smart host microcontroller algorithm is used to describe the method of dual battery charging, selection of batteries on the basis of upper and lower limit for charging and discharging

Mppt scheme based upon DPPM: The output power produced by high concentration solar thermal and photovoltaic systems is directly related to the amount of solar energy acquired by the system, and it is therefore necessary to track the sun's position with a high degree of accuracy. This thesis provides a high level overview of the sun tracking system field and then describes some of the more significant proposals for closed –loop sun tracking scheme[4]. The principles of maximum power point tracking to realize a power electronic converter for transforming the output voltage of a solar panel to the required DC battery bus voltage. The maximum power point tracker is now prevalent in grid-tied PV power systems and is becoming more popular in standalone systems .A MPPT consists of two basic components a switch mode converter and tracking section. The goal of maximum power point tracking system is to provide system efficiency. MPPT control algorithm for determining the maximum power operation point of a photovoltaic power system subject to rapidly changing levels of solar radiation. The tracking system was designed to follow the position of the sun autonomously in the altitude and azimuth directions and was used to drive two 12V DC motors. The proposed system explained in this thesis contains the SHM algorithm that works on the maximum power point. The proposed system demonstrated a robust tracking performance in the presence of modeling uncertainties and parameter variations. MPPT should not be confused with sun trackers, mechanical devices that rotate and or tilt PV modules in the direction of sun [3]. The function of SHM to calculate maximum power point so readings has been taken at 30^{o} C to calculate maximum power point.

II. Related Work

Required hardware

I PIC16F877A:

PIC refers to peripheral interface controller. It belongs the family of modified Harvard architecture microcontroller which was made by microchip technology. It is more popular due to their low cost, wide availability, free development tools and reprogramming (serial programming) in flash memory. The original PIC was built with 16 bit CPU and the CP1600. The CPU was good, but CP1600 has poor I/O performance.

II MAX 232:

The MAX232 is a dual driver/receiver that includes a capacitive voltage generator to supply EIA-232 voltage levels from a single 5-V supply

III LM317:

The LM317 is an adjustable 3−terminal positive voltage regulator capable of supplying in excess of 1.5 A over an output voltage range of 1.2 V to 37 V. This voltage regulator is exceptionally easy to use and requires only two external resistors to set the output voltage.

Table I. Comparison of PIC & AVR

Parameter	PIC	AVR
Instruction set	Small instruction set	Nonorthogonal instruction set
Clocks	More accurate calibrated RC oscillators.	Less accurate calibrated RC oscillators.
Power consumption	Lower	Higher
Interrupts	Interrupts latency is constant	At least one cycle jitter
ADC	Faster conversion	Slower conversion
Availability	More	Less

IV L298:

The L298 is an integrated monolithic circuit in a 15- lead multiwatt and PowerSO20 packages. It is a high voltage, high current dual full-bridge driver designed to accept standard TTL logic levels and drive inductive loads such as relays, solenoids, DC and stepping motors.

V ULN203:

ULN 2003 it gives maximum 30V/500mA per pin. We have given 12V/60mA as relay current will flow through it.

VI Motors:

Servo motor are three each of which 5V, 700mA. DC motor are of 12V,Two DC motors of 12V,30 mA are used that gives 10 rpm.

II LDR & solar panels

Required software

MPLAB V8.36, Proteous, Visual studio 6.0+

III. Algorithm

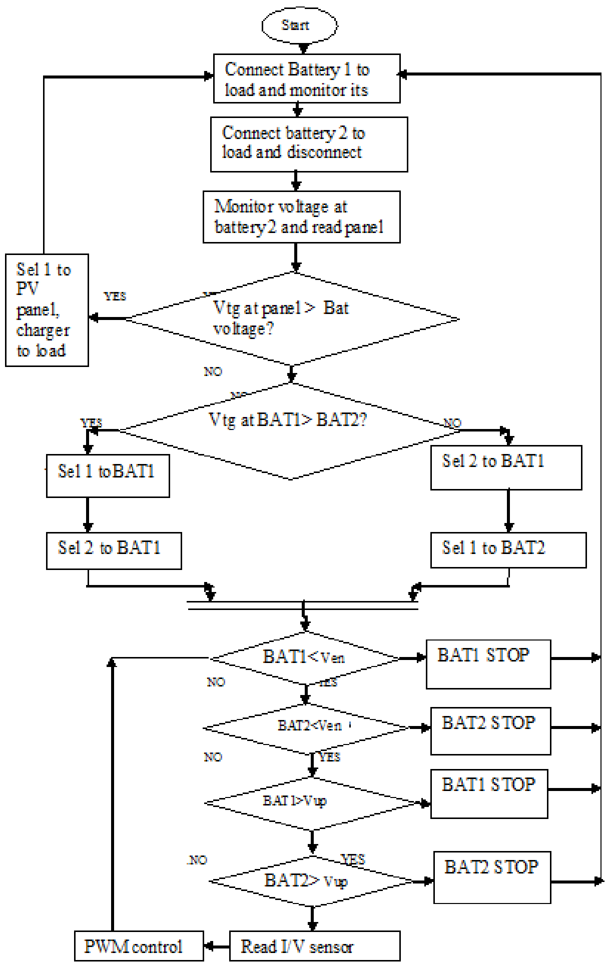

Figure 2. SHM algorithm

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It reads panel voltage and battery voltage. If panel voltage is greater than battery voltage then load gets current from PV panel. If panel voltage is less than battery voltage, then first it compares the voltages of both batteries, battery those having less voltage that will be connected to PV panel and another will be connected to load. When voltage of any one of the battery falls below 10.3 V, it starts to charge & voltage of any one of the battery goes up to 12.4V, it starts to discharge Open circuit voltage of PV panel is 11.9 V, so the PV panel voltage at the maximum power point must exceed this value.

IV. Block diagram

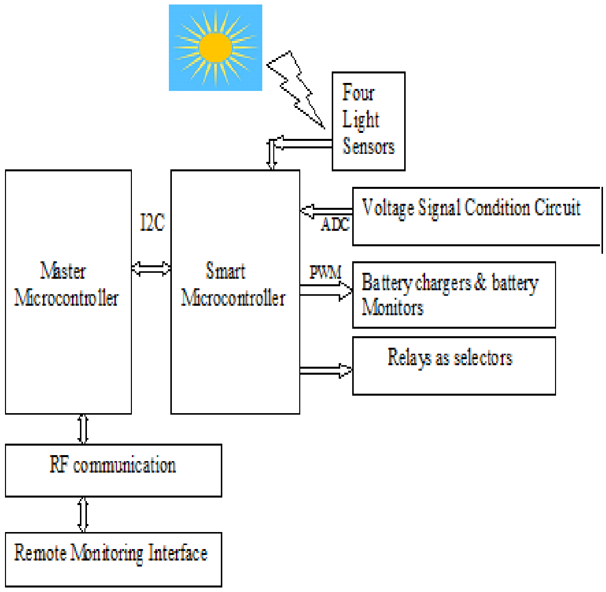

Figure 3. Block diagram

Block diagram consists of one smart host microcontroller and one master microcontroller. SHM is used for intelligent power management system applied to exploration vehicle. SHM is PIC 16f877A which monitors rovers consumption and autonomous way. The SHM has two main functions 1) detecting environmental light level and controlling the solar tracking system to obtain the highest power 2) interpreting operation data from batteries and solar panel to control the working mode of charger accordingly. Above figure shows the various connections inside the system. Light sensors senses light intensity and gives analog signal as output to MPP tracker. SHM to moves solar panels to achieve maximum power. Battery charger is controlled by MPP tracker using, PWM signal that is applied to one of the battery terminals and supplies each battery according to program written in MPPT. I/V sensor are used to detect the voltage and current level that is supplied to the charge and discharge paths between batteries, charger module and load system. Dual battery monitoring system is more reliable.

V. Implementation & Result

Implementation

Table I Power demand of project

Device Name	Average Current
3 X Servomotor	200mA X 3
2 X DC motor	150mA X 2
Active Electronics	100mA
Total	1000mA

VI. Result

I. Voltage Curves

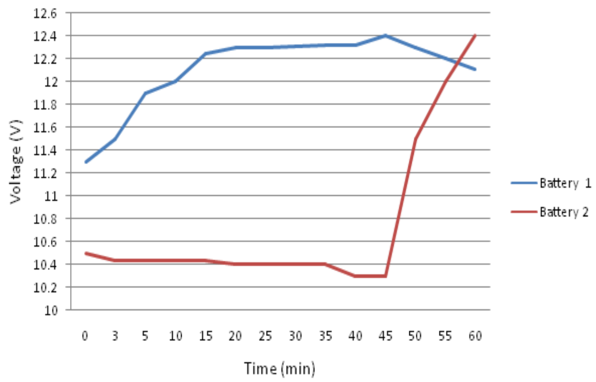

Figure 4. Voltage curves

Thus, the graph illustrates how battery 1 passes from constant-current charging phase to the constant-voltage charging phase when Vup reaches for this test. Then charge current of battery 1 begins to drop while stabilizing the voltage and battery 2 continuous to discharge until the end voltage is reached 10.3 V. In this point, at t= 45th min the switching of batteries system observed. In summary, the constant current charging phase in which the Li-Po battery is considered charged to a 75-80% takes up relatively short time, while the following phase 80 to 95% takes much longer time as shown in figure5.1.2.

II. Current curves

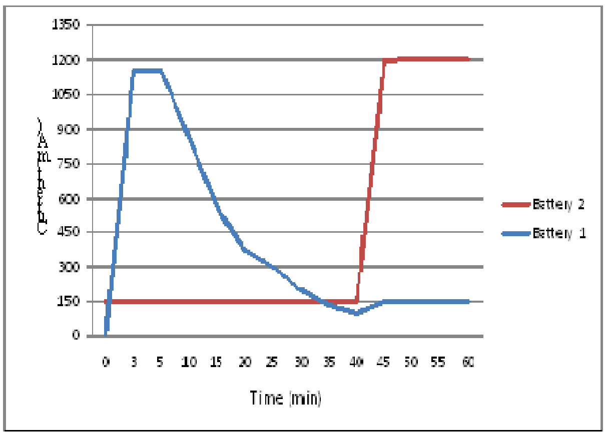

Figure 5. Current curves

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III. Graphical User Interface

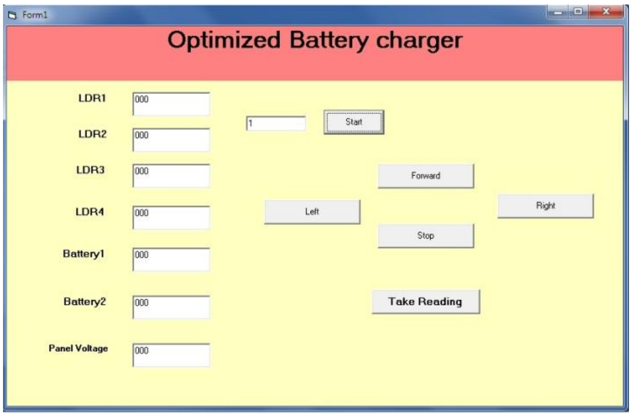

Figure 6. Graphical user interface

IV Performance evaluation

Table 2 Performance Comparison

Parameter	Implemented rover (Year- 2014)	Previous rover (Year- 2013)
CPU	2 X PIC 16F877A	6 X 8- bits Microcontrollers
Battery System	2 X Li-Po(0.15 Kg/u,1200mAh)	2 X Li-Po(0.15 Kg/u,2400mAh)
Weight	12Kg	6.3Kg
Wheels	6	2
Speed	0.6 m/s	0.6 m/s

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