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ARM 7 Based Energy Management and Direction Control in a Solar Powered Robotic Vehicle

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Abstract: ***Robotic vehicles were powered by batteries, fuels, rechargeable batteries etc. in earlier days. Shortage of nonrenewable fuel in the future is an upcoming global issue, therefore renewable energy resources have to replace non-renewable energy sources. Solar energy is an example for renewable energy resource. Solar tracking method is used to charge robotic vehicles now days. In this work, a robotic vehicle is designed which is powered by two rechargeable batteries that were charged by solar tracking mechanism. Robotic vehicles using only a single battery, can't perform its function when the battery gets depleted. In this work two rechargeable batteries are used one will be in the state of charging while the other will provide power to the robotic vehicle. The robotic vehicle is changing its direction for charging as it move towards the more radiated region, after charging completion it tracks back to its original path. The main components of these robotic vehicles are arm 7, rechargeable batteries, LDR, DC motor and the motor driver. The efficiency of the tracking system used in this work is more, as here fixed tracking method is not used. In fixed tracking method the panel can't move towards more radiated region, the LDR helps as to move the panel towards more radiated region with the help of dc motor.***

Keywords: ARM, DC motor, LDR, Solar panel, Solar tracking

1. Introduction

In earlier days, batteries were used to provide power to the robotic system. But, the batteries when depleted could not be recharged, thus affecting the performance of the autonomous robotic system. To overcome this, fuel cell based power supply system was introduced, which replaced the batteries in portable applications. The complexity increased because of large sized fuel cells.

Shortage of non-renewable fuel in the future is an upcoming global issue; therefore renewable energy such as solar energy has gradually replaced non-renewable energy sources. The solar powered robotic systems are often used for many years. However, when there is scarcity of sunlight the batteries in line could not be recharged when depleted. So, Rechargeable batteries came into account. Solar power is the conversion of sunlight into electricity. Photovoltaics are used for the conversion of sunlight into electricity either directly or indirectly with concentrated solar power (CSP), which normally concentrates the sun's energy to boil water which is then used to generate power [3]. Photovoltaics were initially used to power small and medium sized applications that are powered by a single solar cell to off-grid homes powered by a photovoltaic array. Solar cells are reliable and easy to maintain. The amount of power produced by a solar system depends upon the amount of sun light to which it is exposed. As the sun's position changes throughout the day, the solar system must be adjusted so that it is always aimed precisely at the sun and, as a result, produces the maximum possible power [6].

The purpose of this work is to design and the construction of an optimization charging system for batteries in a robotic vehicle by means of tracked solar panels and to control the tracking system of the vehicle. Thus, the implementation of a complete energy management system applied to a robotic exploration vehicle is put forward. For optimal battery charging solar tracking method is used. The LDR[5] will rotate the panel towards the more radiated part by making use of dc motor. As the robotic vehicle is changing its direction according to light intensity for charging, its position has to be tracked and controlled. In case of robotic vehicles using a single battery the vehicle will be in off state when charge is depleted in this work, we are using two rechargeable batteries that were powered by solar tracking.so when one battery fails the other will provide the charges required by the robotic vehicle[8]. Thus the proposal makes a twofold significant contribution. On the one hand, it presents the construction of a solar tracking mechanism aimed at increasing the efficiency of robotic vehicle. On the other hand, 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.

2. Literature Review

Previously, there are many works related to solar tracking systems. Solar Tracker Robot using Microcontroller was a work designed and developed an automatic Solar Tracker Robot (STR) which is capable to track maximum light intensity. The efficiency of the solar energy conversion can be optimized by receiving maximum light on the solar panel [5]. The main components of the robot consist of microcontroller namely PIC16F877A, sensors, servo motors and digital compass. STR is programmed to receive maximum sunlight by using 2two LDR's. Servo motor aligns the solar panel to receive maximum light. To position the robot digital compass is used. Two modified DC servomotors will move the robot back to the original position once the robot is out of position.

Solar Tracker Based Power Optimization in Performance of Robotic Vehicle is a work carried out to design a wireless based solar powered robotic system in order to optimize the power by improving the utilization of solar power The Master controller PIC16F877A senses the light intensity from two different directions using LDR. The panel's direction is adjusted according to the sunlight direction using a stepper motor. The exploration robot has two-fingered arm to pic and place the objects. The robot is controlled using Zigbee protocol. The Battery status will be continuously measured and sent back to the monitoring unit through Zigbee. The monitoring section consist a PC with Zigbee transceiver, VB based user interface used to control the unmanned exploration vehicle. Since we are using solar-based system, power consumption is reduced.

Sun Tracking Systems is a work that states that the output power produced by solar panel 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 paper has presented a review of the major algorithms for sun tracking systems. The sun tracking algorithms can be broadly classified as either closed-loop or open-loop types, depending on their mode of control.

Solar cells basic working principles, its input and output characteristics were plotted and studied in detail in Dynamic Power Path Management Simplifies Battery Charging from Solar Panels. The calculation of maximum power point(MPP) were explained. The dynamic power path management (DPPM) is used to implement MPP tracking.

The design and construction of an optimization charging system for Li–Po batteries by means of tracked solar panels were used in Smart Host Microcontroller for Optimal Battery Charging in a Solar-Powered Robotic Vehicle[1].Thus the implementation of a complete energy management system applied to a robotic exploration vehicle is put forward. The proposed system was tested on the VANTER robotic platform-an autonomous unmanned exploration vehicle specialized in recognition. Here two batteries were used that were powered by solar panel; one of the batteries will provide charges to the VANTER while the other will be in the charging state

3. Proposed System

In this work a robotic vehicle is designed which is powered by two rechargeable batteries. Robotic vehicles using only a single battery, can't perform its function when the battery gets depleted. In this work, two rechargeable batteries are used one will be in the state of charging while the other will provide power to the robotic vehicle[1].For solar tracking LDR are used, they track the maximum sunlight region and move the panel towards that region resulting in increasing efficiency. The robotic vehicle is designed such that it can move in all directions; Solar panel is placed above the vehicle for tracking. LDR's were placed in the panel in four directions and a dc motor is situated below the panel. LDR will move the panel towards the more radiated region with the help of dc motor. After fully charged the next battery that is providing the power is switched to charging state. The robotic vehicle is changing its direction for charging as it move towards the more radiated region, after charging completion it tracks back to its original path. The main components of these robotic vehicles are arm 7, rechargeable batteries, LDR, DC motor and the motor driver. The efficiency of the tracking system used in this work is more, as here fixed tracking method is not used. In fixed tracking method the panel can't move towards more radiated region. The LDR helps as to move the panel towards more illuminated region with the help of DC motor.

The block diagram consist of the ARM, LDR's, motor drivers, DC motor, LCD, solar panel and the rechargeable batteries. The solar panel will convert the solar power in to electrical energy and this energy is used to recharge the battery system. The battery charging system here consists of solar panel, optocoupler, an n-type mosfet and two rechargeable batteries. PWM signal from the arm processor is given to the optocoupler as input and the output of optocoupler is given to the mosfet, whenever this signal is high the electrical energy from solar panel is given to the battery. i.e., during on time of the PWM signal the battery charging occurs and during off time charging can't take place. Thus by using PWM signal the batteries were protected from overheating.

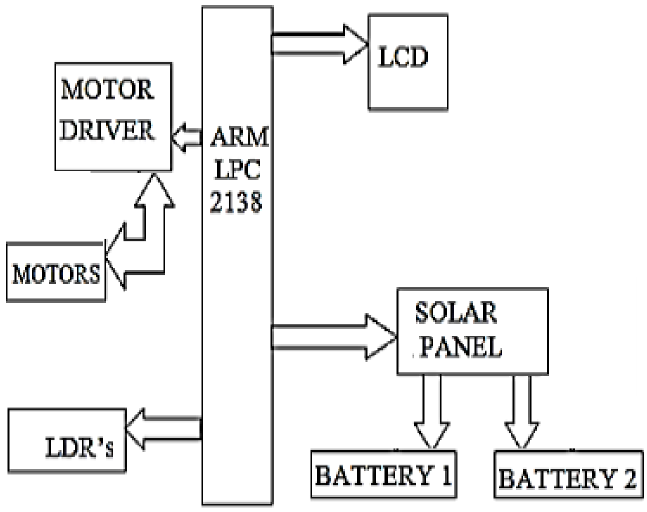

Figure 1: Block diagram of proposed system

For tracking of sunlight, LDR'S are used. Four LDR's are placed on the panel; at equal illumination both these LDR's have equal resistance. When any one of them falls in shadow region its resistance increases ,when it increase beyond a range the dc motor will rotate the panel towards the radiated region, thus increasing the system efficiency. Three dc motors are used here; one is used to control the panel movement while the other's help in the robotic wheel rotation. ARM 7 is used as the processor. The ADC of the processor helps as to calculate the charging states of batteries that have to be displayed in the lcd. ARM 7 processor mainly performs two functions, they include

1) Detecting the light level and controlling the solar tracking system for obtaining the highest power.
2) Interpreting the data from batteries and panels to control the charging mode of batteries.

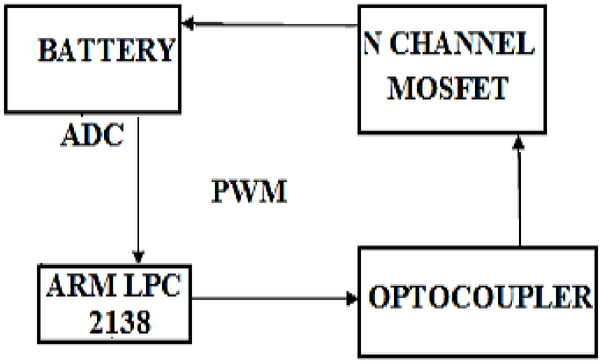

Figure2: Battery charging section block diagram

The battery charging section block diagram is shown in figure 2.The battery charging section consist of arm, optocoupler, n channel mosfet and the rechargeable batteries. The PWM signal from arm is given as input to optocoupler. The optocoupler is used to isolate the battery charging section from the arm. The output of optocoupler is given to an n channel mosfet such that it will be on only during the on state of the input PWM signal. The electrical signal from the panel is given to the battery only during the on state of mosfet, thus controlling the charging and discharging of rechargeable batteries. ADC in the processor calculate the charging states of two batteries .By using the charging values of the two batteries battery switching takes place

4. Results

PROTEUS and Keil are the software's used. The simulation results were as follows.

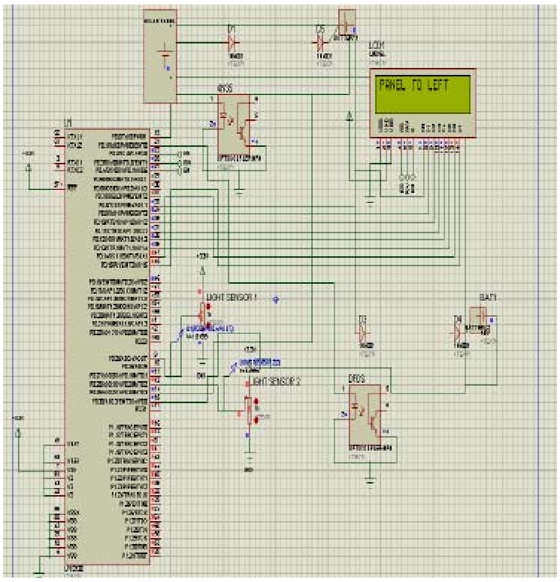

Figure 3: Simulation Result 1

In this simulation result the panel direction is displayed in the lcd. When the LDR on the right side falls in dark region the panel has to move towards the more illuminated region, thus the panel direction changes to left.

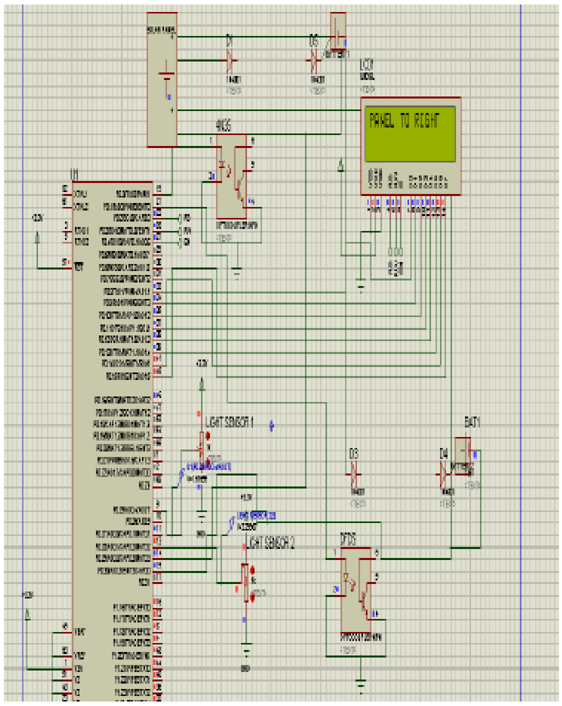

Figure 4:.Simulation Result 2

When the LDR on left side falls in dark region the panel will move towards the more illuminated right region.

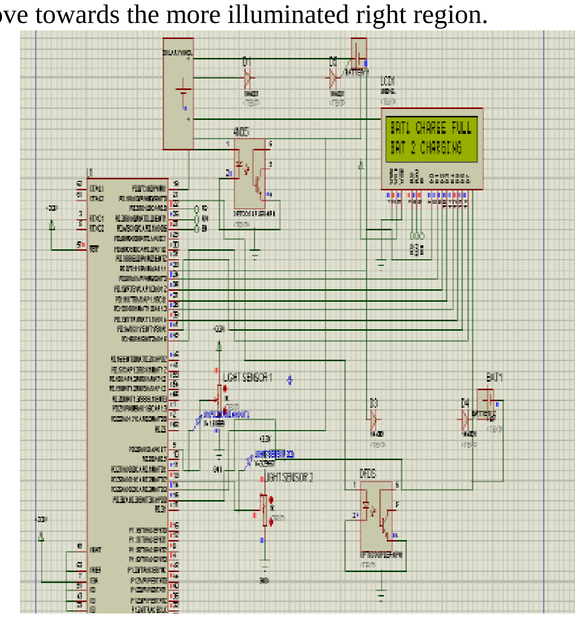

Figure 5: Simulation Result 3

The lcd also displays the charging states of the rechargeable batteries as we are using two rechargeable batteries, one of them will be in the charging state while the other one will provide the power required by the robotic vehicle.

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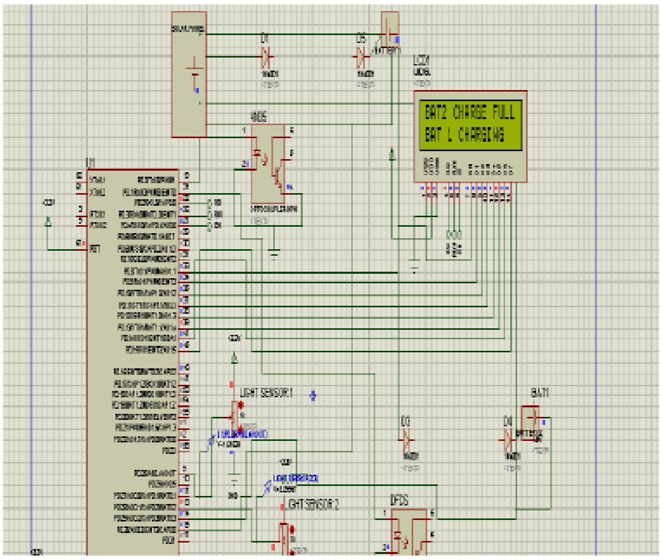

Figure 6: Simulation Result 4

When battery 1get fully charged, battery 2 will switch to the charging state which is shown in fig 5.When battery 2 get fully charged battery 1 will switch to charging state as shown in fig 6.

5. Conclusion and Recommendation

This paper has presented a smart energy management system applied to a robotic platform. Here the robotic vehicle is powered by two rechargeable batteries that are charged by solar tracking method. As we are using two rechargeable batteries one will be in the state of charging while the other provide all the power required by the vehicle, thus complete energy management is applied to the vehicle as compared to robotic vehicle powered by a single battery. Also the efficiency of the tracking system is increased here as compared to fixed tracking system.

Increase in use of LDR's in this work will be a future work that provides solar tracking more efficient and another work is to increase the number of batteries which leads more energy management.

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