Dual-Axis Solar Tracker in Robotic Vehicle for Optimal Battery Charging

V. Anitha  
RVS College of Engineering and Technology, EEE  
anithatvnathan@gmail.com

M. Iyappan  
RVS College of Engineering and Technology, EEE  
iyappannm.me@gmail.com

Abstract - This project focuses on the design and construction of an optimization charging system for 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 in this project “Dual-Axis Solar Tracker in Robotic Vehicle for Optimal Battery Charging”. The need for mobile robotic platforms is driven by the limitation of available power. It is commanded to collect, store, monitor, and control its attitudes and navigation; actively manages its power and its working. Its attitudes are referred to tilting of the solar panel and alternative use of batteries. So according to this concept, our proposal makes a twofold significant contribution. The first significant is, it presents the construction of a solar tracking mechanism aimed at increasing the robot’s power regardless of its mobility. The other significant is, it proposes an alternative design of power system performance based on a pack of two batteries. This robotic vehicle aims to improve various aspects of the aforementioned robot with scientific and academic purposes. The aim is to obtain the maximum energy from the solar panel by tilting the panel towards highest intensity where it gains the highest intensity of light and charging the two batteries. By completing the process of charging a battery independently while the other battery provides all the energy consumed by the robotic vehicle.

Index Terms - Optimization charging system, Solar Tracker, Highest intensity of light, Dual-Axis, Pack of two batteries.

1. Introduction

The Robotic Vehicle is developed with the victimisation of a host microcontroller (SHM). SHM for intelligent power management applied to a search vehicle. The construct of intelligence is applied to software system style for battery choice and for tilting the electrical device. one in all the most objectives of this paper is that the implementation of the SHM construct to develop an inexpensive power management system aboard a robotic vehicle. The SHM relies on a PIC16F877A microcontroller, that monitors the automaton consumption and choices in a very utterly autonomous means. The interest of this robotic system lies within the style concept, supported a wise host microcontroller. The SHM has 2 main functions: (i) police investigation environmental lightweight level and dominant the star chase system to get the best power. (ii) decoding operation information from batteries and star panels to regulate the operating mode of the charger consequently.

The PV system provides power, keeping in mind that voltages and currents generated should adapt to the most and minimum values of the hardware. However, since the environmental natural options cannot be expected at every instant, the quantitative energy from radiation can not be expected either. Thus, one in every of the most proposals of this project is that the implementation of a star pursuit mechanism geared toward increasing power levels within the PV panels. not like different robots that use navigation techniques to guide their panels toward the Sun, the Dual-axis star hunter golem quality doesn't represent an obstacle, since the projected hunter system appearance for the foremost powerful light. star hunter prototypes inbuilt mobile robots have tested that orientation of PV systems ends up in increased energy potency relative to systems with mounted star panels. this relies on many construction ways of the star hunter like the kind of panel movement (either single or dual) and LDR sensing element price.

The robotic exploration vehicle aims to boost numerous aspects of the same rovers with scientific and tutorial functions. the subsequent sections gift the management of the battery-charging system by means that of caterpillar-tracked star panels, that is that the main aim of this project; the planning of its mechanical
structure, its electronic devices and also the frequency (RF) communication area unit given. whereas dominant the mobile mechanism with RF communication we tend to even have regarding[to contemplate] that our application won't solely management the mechanism however additionally can do different tasks for gathering data about the surroundings. It ought to watch for these tasks to complete and sporadically send data to mobile robot’s negative feedback circuit. this era ought to be long enough to permit the opposite tasks to complete or ought to be variable and will run when finishing signal from the mandatory tasks. The mechanism was developed to be radio-controlled and incorporates a set of 4 wheels coupled to a plane chassis that may rotate severally. The four wheels of every combine derived by a relay and also the individual management of every combine of wheel can enable differing kinds of movement. It additionally aims at providing the mandatory vary for the batteries size, charging, and discharging, and also the PV system size. Therefore, this project puts into apply the developed methodology by testing the mechanism power systems.

The robotic system development is split into 3 main levels and its hardware was designed with a hierarchical management structure supported standard microcontrollers. the primary level, programmed in Embedded C language, runs autonomously on a PIC16F877A microcontroller. The second level, computer code simulation add Proteus eight skilled. The third level, Hardware development for the robotic vehicle.

The ASCII text file has been written for Rotation of solar array and LDR Sensing and Battery level. ASCII text file is developed victimization Embedded-C language. The code for solar array can permits the panel to rotate in Dual-axis with the motion of 2 motors below the panel. The code for LDR sensing can monitors the sunshine intensity price to tilt the panel on the most point and code for battery level is employed to watch the voltage level of batteries and to shift their mode of operations. whereas dominant the golem with frequency communication we have a tendency to even have to think {about|to contemplate} that our application won't solely management the golem however additionally can do different tasks for gathering data about the atmosphere, computing the mobile robot’s moving direction and so the RF affiliation mustn't block these tasks. It ought to watch for these tasks to complete and sporadically send data to mobile robot’s negative feedback circuit. this era ought to be long enough to permit the opposite tasks to complete or ought to be variable and will run once finishing signal from the mandatory tasks for the long run extended work.

2. Existing System

Solar power systems in autonomous robotic vehicles are typically used for a few years. a true example is that the occupant rover, within which most of the provided energy is generated by a reduced-size electrical phenomenon (PV) panel. It results to a development of compact mechanism. therefore the panel will provide power to the mechanism solely until their life time. just in case of scarce to no star lightweight, the rover ought to minimize consumption, since its batteries in line couldn't be charged once depleted. therefore the battery must be designed with internal power dissipation that is superimposed within the next generation. the utilization of reversible batteries during a house mission was used for the primary time within the Mars Exploration Rovers. all the same, the requirement for bigger operation autonomy by Spirit and chance was resolved by means that of larger deploy star panels. thus metal particle is employed as reversible batteries with internal dissipation to beat the defects long-faced by the previous section robots. This resolution works because the basis for the look of star panels for the long run ExoMars mission. This rover, because of its high-efficiency ultrathin-film atomic number 14 cells created on carbon-fiber bolstered plastic, is capable of providing higher power. Micro5, a series of robotic vehicles devised for satellite exploration. As its main style advantage, this rover series contains a twin solar array system coupled to Associate in Nursing assisted suspension mechanism. SOLERO, Delawareveloped by the Ecole Polytechnique F’ed’érale de city, that reached best energy consumption by a mix of a sensible power management Associate in Nursingd an economical locomotion system. The implementation of star-synchronous techniques to extend the quantity of energy generated by solar panels. The platform called Cool mechanism uses an impact algorithmic rule of most wall plug (MPP) aimed toward increasing system-supplied power for 5 PV modules designed as a cube. Finally, there area unit some noteworthy comes that main accomplishment is that the best choice of alternative energy and completely different power sources in line with the operation conditions of a mechanism.

I. Problem Definition
The on top of existing systems have some downside in it. Their drawbacks analysed and corrected in each future coming up with of golem. This project ‘Dual-Axis star huntsman in Robotic Vehicle for best Battery Charging’ overcomes the difficulties and downside and utilizes the suited technology from existing system area unit as follows to style the golem. Reduced-size electrical phenomenon (PV) panel, reversible batteries, Ultrathin-film chemical element cells made on carbon-fiber bolstered plastic, Locomotion system and Solar-synchronous techniques.

II. Objective

Dual-Axis star following golem is most advanced compared with the prevailing system as a result of its intrinsic technology. The advanced options as follows. solar battery are often atilt to the direction of high intensity of sunshine. LDR sensors live accustomed measure the sunshine intensity of setting wherever it’s placed in numerous direction. solar battery is titled all told four directions. 2 important factors: (i) Construction of a star following Mechanism, (ii) An different style of power grid performance supported a pack of 2 batteries and Introducing 2 batteries for different charging and discharging. the method of charging A battery severally whereas the opposite battery provides all the energy consumed by the robotic vehicle.

3. Dual-Axis Solar Tracker in Robotic Vehicle

This session provides the general theme of the system intimately with its clarification for the operating operate of the system and also the careful description of the diagram. The operating of system starts with the LDR device scenes the sunshine intensity from the atmosphere wherever it’s placed and passed to the microcontroller. Microcontroller examines the best candlepower worth in step with that the solar array is leaning to get the most power. solar array is leaning by 2 motors. One motor for front and back tilting and another motor for right and left movement. Power management is disbursed by exploitation 2 batteries. thus one battery is charged by solar array. wherever another one battery provides the ability to golem. Battery selector is employed to change the battery from discharging to charging once it goes to low voltage. that the charging battery is began to discharge. this may be an alternate action. candlepower worth and batteries voltage level are monitored and showed in LDC display. golem is controlled by remote operation on the premise of RF communication.

![Overall scheme of the System](image)

The description of the diagram is that the mechanism has four wheels (4 motors) wherever every pairs square measure connected to a relay and to microcontroller. LDR sensing element and show[LCD|digital display|alphanumeric display] display is connected to microcontroller. solar battery is revolved through two motors controlled by a relay and connected to microcontroller. From the panel, association passes to battery and to microcontroller through resistance. Battery selector gets the association from microcontroller then connected to power offer. mechanism is controlled by remote and that they square measure interfaced by RF communication.

4. System Description

The system consists of 3 main options that area unit as follows. initial feature is that the dual-axis star huntsman for following most wall socket with the assistance of LDR sensing element. Second feature is that the usage of 2 approachable batteries for power management wherever one battery can charged and alternative battery can discharged this undergoes electric battery change system. Third feature is that the PIC16F877A microcontroller is that the heart of the system known as sensible Host Microcontroller for its complete autonomous manner of operating within the...
system. thus a simulation add Proteus is developed for the system to look at some feature of functions.

The on top of space of Proteus is employed to develop the circuit for the simulation. exploitation the desired parts within the Proteus software system the desired circuits is intended. it's then saved and it ought to be compiled to rectify the error. If any error happens it ought to be removed. once removing the error, the simulation work are going to be processed by running the software system. The running work will be paused or stopped for the specified work. therefore the circuit description of the “Dual-axis star hunter in robotic vehicle for optimum power charging” is intended a proof as follows.

Description of circuit diagram is that the four LDR sensing element which will be adjusted manually. Four motor of wheel is connected to the C-port of PIC. 2 motors of panel is connected to the B-port of PIC. Battery selector circuit consists of 2 batteries, 2 relay switches and 2 transistors. solar array is interfaced with the battery selector circuit. solar array build with ultrathin-film atomic number 14 cells created on carbon-fiber bolstered plastic can offer high power and high potency. This can be wont to manufacture the high power by chase system and provides the facility to the system by storing it within the batteries. Chase the foremost powerful source of illumination is feasible as a result of analog signals are obtained by the photosensors since they already embody each electronic equipment and signal conditioner integrated circuits. during this manner, the tilting method try and place mobile star panels sheer to the foremost intense source of illumination on the market. Higher energy assortment is thus attainable. Proportional lightweight values are compared in pairs and, from their distinction, adjusting the management signal.

A. Solar Tracking System

In the precious robots or rover uses Single-Axis star chase that’s is that they will move solely in one axis either front or back nor right or left mistreatment single motor. During this system the operating of star chase are going to be Dual-Axis that’s the panel will move all told four direction. This can be created attainable by mistreatment 2 double-gear motor for the movement of panel in every axis. Solar array that manufacture 15W is employed here. It's created from electrical phenomenon cells. The solar array build with ultrathin-film atomic number 14 cells created on carbon-fiber bolstered plastic can offer high power and high potency. This can be wont to manufacture the high power by chase system and provides the facility to the system by storing it within the batteries. Chase the foremost powerful source of illumination is feasible as a result of analog signals are obtained by the photosensors since they already embody each electronic equipment and signal conditioner integrated circuits. during this manner, the tilting method try and place mobile star panels sheer to the foremost intense source of illumination on the market. Higher energy assortment is thus attainable. Proportional lightweight values are compared in pairs and, from their distinction, adjusting the management signal.
other positions. The Geared motor with 500 rpm is used for the tilting process which is controlled by the microcontroller. So coding has been developed for the rotation of the solar panel and for the detection of light intensity of LDR sensors. So a simulation work in Proteus is developed for the system to view some feature of functions.

B. Battery Switching System

The switching system consists of two MAX1538 selectors with break-before-make operation logic. Their function is connecting electrically the charge and discharge paths between the batteries, the charger module, and the load system. That is, one connection between the charger and the dual-battery pack. Its function is routing the current from the PV panels to the input of the charger and, from there, to the battery selected in each moment. Then the other connection is used to connect 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.

In the system, it was programmed to charge battery 1 while selector 2 is preset to discharge battery 2. Charge current obtained from the PV panels is routed to the charger through battery 1 and, from the charger, to the selected battery. Likewise, the discharge current of battery 2 is routed to the load system. The main advantage of the dual selector system is that it allows hot swapping of separated power supplies. In addition, in case both batteries were fully discharged, a working mode was programmed in battery 1 to supply the load system directly from the PV panels. Two batteries voltage level is monitored by the PIC and displayed in the LCD display. So to indicate the charging battery LED is used. Battery 1 is indicated by GREEN LED and Battery 2 is indicated by BLUE LED. When Battery 1 is getting charged so the GREEN LED is glowing and Battery 2 is getting discharged so the BLUE LED is not glowing and when Battery 2 is getting charged, the BLUE LED is glowing and Battery 1 is getting discharged so the BLUE LED is not glowing. Both the batteries corresponding voltage is shown in the LCD display. This alternative operation of the batteries is playing the role of Power management in the design of this robot and this operation is controlled by the PIC16F877A.

C. Smart Host Microcontroller

The SHM is based on a PIC16F877A microcontroller, which monitors the Robot consumption and decisions in a completely autonomous way. SHM for intelligent power management applied to an exploration vehicle. The implementation of the SHM concept to develop a low-cost power management system aboard a robotic vehicle. Detecting environmental light level and controlling the solar tracking system to obtain the highest power Interpreting operation data from batteries and solar panels to control the working mode of the charger accordingly. The SHM in this system is mostly interfaced with all the hardware. Explanation of hardware architecture is that the Microcontroller drives the Tracking system and Battery charger through Pulse width Modulation (PWM). LDR sensors are connected to the Analog to Digital Converter (ADC) of the microcontroller. Microcontroller operates the Battery Selector through Logic level. LCD display is connected to the I/O port of the microcontroller. RF Communication is interfaced with the microcontroller.
through Universal Asynchronous Receiver and Transmitter (UART). RF is selected as the medium of communication between the remote control and the robot. Since the PIC has inbuilt UART, the RF communication will be more efficient. Remote controller is used to command the robot for the required movement. The remote is the transmitter that transmits RF signals as medium for the robot motion. According to the Coding that has been created, the robot will move.

Fig: Block diagram of the hardware architecture with SMH

5. Conclusion

This project has presented a smart energy management system applied to a robotic platform of Dual-Axis Solar Tracker in Robotic Vehicle for Optimal Battery Charging, an autonomous unmanned vehicle devoted to perform different 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 robot’s 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 development is made with total weight, capacity available, and source-required power is reached. This result does not achieve high charging times or great operating times but to prove a sustainable and commercially feasible operation applied to a robotic vehicle.

The future enhancement will be developing the Hardware for Dual-Axis Solar Tracker in Robotic Vehicle for Optimal Battery Charging with an application oriented. Additional features like two way communication of the robot in the environment and monitoring the environment through external modules, will be added to the robot. The locomotion system of the robot will be carried out by the GPS system which is an advanced feature of the upcoming robot.

References


