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Solar Power Battery Management System

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Abstract - This essay describes an easy solar-powered battery monitoring system that employs numerous batteries as input from the sun. The state of a single battery is only minimally monitored by the suggested method. The battery voltage & power flows, which are the two parameters currently monitored, may be used to determine the depth of discharge (DOD), state of charging (SOC), and state of health (SOH) of the battery, among other features. using a straightforward design method that interfaces an Atmega 328 with readily accessible and reliable voltage and current sensors to read data. This system also shows the readings' outputs and maps the various features on a simple-to-use Graphical User Interface (GUI) built on the C platform. The suggested system includes a mechanism for power cut-off to prevent battery overcharging. Real-time data access from the battery being carried out, and all output parameters, even minute variations brought on by changing solar circumstances, are presented.

Index Terms—battery monitoring, solar, Atmega-328, C language

I. Introduction

Today, As one of the world's economies that also is rising the quickest, India has a huge need for energy. India is primarily focusing on adopting renewable energy in order to satisfy this need, apart from the traditional methods of energy supply. Most individuals base their calculations for obtaining their daily needs on the production of power from sources of conventional energy. Ensuring widespread energy availability throughout the nation is crucial for growth as demand increases. Increasing the use of renewable energy in the nation's architecture is one of the outcomes of achievingthis desired expansion.

The total renewable energy capacity in India, including big hydro, has expanded by 396 percent during the previous 8.5 years, reaching more than 174.53 Giga Watts, or nearly 42.5 percent of the nation's total capacity, based on the Ministry of New & Renewable Resources (MNRR) (as of February 2023). India saw the highest time-on-time increase (9.83 percent) on renewable energy additions in 2022.Several battery monitoring systems were operational right now.

Unfortunately, the practise of rigorous real-time mon- itoring is hindered by expensive maintenance and operation costs. As an example, a virtual PV panel has been created in PSIM (Physical Security Information Managing) and is also observed. Various monitoring methods have also been suggested. A three-mode battery-operated system has been proposed, however it lacks a user interface as well as a data record for end-user convenience. A lithium-ion battery monitoring system that employs a microcontroller and sensors to track and show battery data on an LCD screen has been suggested in. All of these findings are useful and beneficial, and they provide room for improvement and growth in future research on battery monitoring.The work that is being presented makes use of this areafor improvement and proposes a monitoring framework made up of a parametric modules. This module has a Mega 328 processor together with voltage and current sensor modules. Moreover, a Graphical Interface (GUI) utilising an esp8266- 01 has been created to show the battery data in real-time. The combination of all of these parts is discussed next. The essay is structured as follows: The suggested system is described in Part II. The system design is described in Part

III. The operation of the system is described in Section IV. The observations and findings are covered in Part V, and the conclusion is provided in Section VI.

Proposed System

A stepper motor is used in the suggested system to increase torque at low rpm and improve control for the tracking ofthe binary axis. PV is controlled by a micro-controller. Solar panels installed on a structure which moves during the day to monitor the sun are known as solar tracking systems. Active, passive, and chronological tracking are the three types of tracking. The single-axis and dual-axis solar system trackers may both use these designs.

During active tracking, detectors continually determine where the sun will be during the day. The mounting system is moved by an electric motor or drive that is started by detectors so that the solar panels contact the sun’s rays at all times during the day.

When there is an imbalance in pressure between two places, a passive tracker will move. Although this sun tracking device is not precise, imbalance results from solar heat producing a low gas pressure compressed fluid, that subsequently addition-ally shifts the structure.

A tracking system using timers is called Chronological Tracker. Throughout the day, the structure rotates at a constantspeed. The drive or motor is configured to revolve constantly

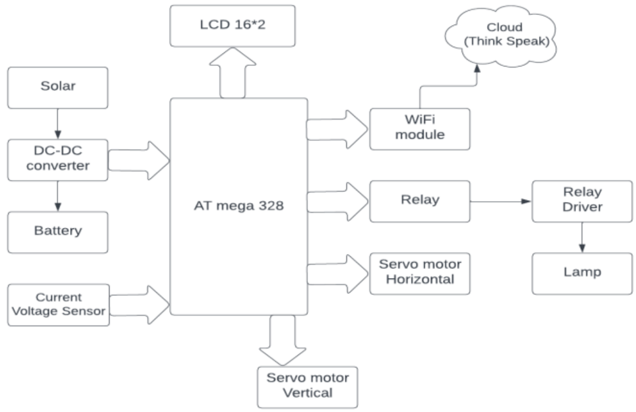

Fig. 1: Block Diagram

at a pace of 15 degrees per hour or a single revolution per day on average. This shading scheme is really precise. On the other hand, tracking sunlight on a day with heavy cloud cover is useless since the motor must rotate continuously, which increases power consumption.

The major goal of the proposed study is to demonstrate how the voltage and current values detected by the controller may be used to monitor system power. The systems solar energy metre shows use and performance. This system helps in making use of an intelligent grid for effective utilisation.

System Design

In this section we present the system design of the Solar Energy Monitoring System,

1) ATmega328

In the mega AVR family, the ATmega328 (ATmega328) is a single-chip micro-regulator developed by Atmel. It has an 8-bit RISC CPU core with a logical Harvard armature. The Atmel 8- bit A VR RISC-based micro-controller includes a 32 KB ISP flash memory with read-bit-write items, 1 KB EEPROM, 2 KB SRAM, 23 general-purpose I/O lines, 32 general-purpose working registers, 3 programmed timekeeper/counters with equivalent methods, external and new interrupts, magazine programmable USART, a byte-familiarized 2-line everyday interfaces, SPI journal haven, The price runs on 1.8 to 5.5 volts. The cost achieves increase ending in 1 MIPS/MHz.

2) DC-DC Converter

A buck Converters has been performed as an a DC- DC Converters for the charge regulator. It can be used to supply the most power by balancing the impedance of the battery and solar panel. To achieve the greatest amount of power transfer, the programme evaluates the voltage and current produced by the solar panel and adjusts the duty cycle of the gating signal accordingly.

3) Lithium-ion Battery

All around the world, lithium-ion batteries have become a more and more common alternative to solar power. The development of this type of batteries has a story to tell about how it works within the electric vehicle industry. The polychromatic structure of this substance provides benefits for solar systems and ventilation. Lithium-ion batteries respond to charging in two stages rather than the typical three since they have a specific voltage range. A voltage controlled charge regulator can be used to charge them. Even having a low characteristic discharge, lithium-ion batteries don't benefit from constant charging. This particular type of solar battery often has low conservation, strong special energy, and a long lifespan. Comparable to lead-acid batteries, lithium-ion batteries often bring. In addition, they may challenge a security circumference to restrain the current and voltage.

Lithium-ion batteries usually provide more cycles than lead- acid batteries, making them perfect for recovering additional cycles to the system. The attitude towards charging and dis- charging speed of lithium-ion is one energy-delivery element that makes it an accurate attachment for a solar system. These batteries also consume less space while not being in application, which is useful for solar power systems when energy is so frequently required.

4) MG995

Servo motors are widely used as well as has been used for a very long time. They create a small footprint and consume a lot of energy. These characteristics allow them to be used to drive radio-controlled or remote-controlled miniature motor cars and robots. Artificial intelligence, consistent production, and manufacturing methods can take applications for servo motors.

One of the things that makes servomotors so environmen- tally friendly is their relative simplicity. A small rapid current DC motor, which is similar to the type you might discover within an affordable toy, is at the centre of a servo. These motors run on battery power and rotate quickly, but they provide a surprisingly modest level of torque. A gearbox arrangement uses the motor's fast speed to accelerate the torque while slowing down the speed. The servo case's internal drive configuration changes the situation to a significantly slower rotational speed with increased torque. The amount of actual work is precisely the same but more usable. The servo case's gear arrangement transforms the incident into a big one.

5) LCD 16*2 display

With a 16*2 liquid-crystalline display, there are two match- ing files and 16 characters may be displayed per queue. Each character on this liquid crystal display is shown in a 5 by 7 pixel matrix, 224 unique letters and ensigns may be exposed using the 16*2 clever alphanumeric point matrix display. The videlicet, Command, and Data registers on the Liquid Crystal Display each have two entries.

Methodology

By providing PV panel rotation along two distinct axes, the proposed system for tracking more efficiently tracks the sun. Four LDR sensors, two stepper motors, and a micro-controller make up the tracker. The stepper motors all have been employed in this system, along with a couple of sensors and one motor to tilt the tracking device in the direction of the suns east-west rays and another pair of sensors and the motor mounted to the bottom of a tracker to angle it in the direction of the suns north-south rays.

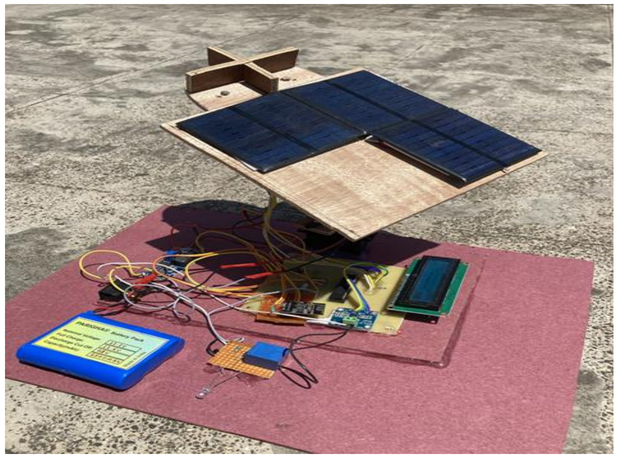

Fig. 2: Hardware Implementation

Stepper motors in the upper panel holder and the base follow the suns linear motion and parabolic descent, respectively. Using a micro-controller, the stepper motors and sensors work together. The motors at the base of the detectors input get the order from the micro-controller. LDR detectors get a signal from the light and transfer it to the micro-controller. A micro- controller compares the signals coming from LDR detectors and chooses the direction of the stepper motors revolution according on which signal is stronger. A micro-controller is an intelligent device that operates based on the input it gets from the detector and moves the motor driver circuit as a result. Driver circuits are turned on by the regulator, and stepper motors are moved to new locations where the light falling on sensor couples is the same. However, the motor continues to move the panel till the difference appears. The ray of light that hits the sensor is identical.

Data from the sensors are sent into the micro-controller. Analogue to digital converters (ADC) transform the analogue signals produced by sensors into digital signals. The micro- controller must already have this ADC module or it must be introduced externally. Micro-controllers are promoted from digitising signals. Once the digitised signal is acknowledged, the stepper motors step angle and direction of motion are

computed. According to the method, a micro-controller will only run stepper motors if the detectors light sensing results aren't equal to one another.

The photovoltaic (PV) panel is placed during this procedure at a position for maximum power that is typical to the sun. Data from the sensors are sent by the micro-controller to the dc-dc motor for step down voltage. The battery receives this voltage. A current-voltage detector will sense the voltage that is stored in the battery. The detected data will be display on an LCD and transmitted immediately to a wi-fi module by the current voltage detector. Readings of the charging battery and battery load will be displayed on a server. Voltage regulation is necessary for solar panels since it fluctuates. Solar generated energy is used to energise the Trackers circuitry. This also makes the design cost- and benefit-effective.

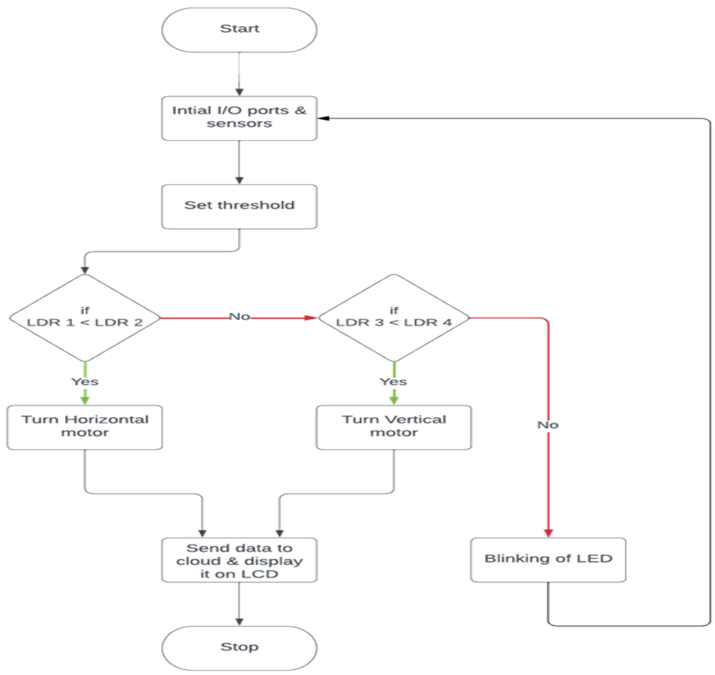

Fig. 3: Flowchart

Observations & Results

The system described here monitors the battery to learn more about the behaviour of the solar panels. demonstrates a GUI that displays voltage measurements, voltage load, and voltage-time graphs. These readings are obtained in Pune in March 2023, during the summertime.

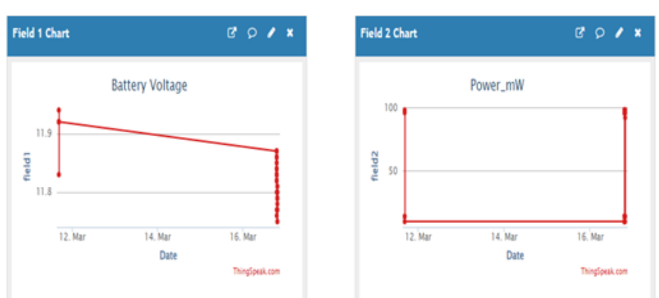

Fig. 4: Graph

The change in charging voltage as well as current that takes place when a load is placed to the battery is another realisation or demonstration of the idea experiment that was carried out during this session. The purpose of this test is to evaluate the proposed monitoring system's precision. In this instance, thereis a 20mA, 5mm LED bulb attached as the load.

The readings obtained under two load situations are dis- played in the tables below. Table I displays the battery's charg- ing voltage and current when the LED is not functioning. The same characteristics are shown in Table II when the LED is powered by a battery. The charging current as well as voltage levels are expressed in milliWatt and volts, respectively.

Readings with no Load Connected

Time(sec)	Voltage(V)	Power(mW)
13:04:34	11.73	10
13:08:21	11.74	06
13:12:59	11.79	14
13:17:38	11.87	10
13:21:51	12.01	10

Fig. 5: Table I

Readings with Load Connected

Time(sec)	Voltage(v)	Power(mW)
19:07:39	11.84	98
19:11:53	11.84	98
19:16:32	11.82	96
19:22:28	11.81	98
19:26:42	11.79	96

Fig. 6: Table II

Conclusion

The purpose of this system is to offer a simple digital solution for such growing need for battery management in photovoltaic infrastructures, solo rechargeable batteries, and for inverters without integrated monitoring software. The usage of an interactive Interface and its transparency on the battery fluctuations are two features that set it apart from othersystems. Also, it is simple to install and run in a range of environments where solar energy may be used, whether they household or industrial, without the need for expert personnel. This system may be used to detect and validate well-known facts and therefore can function as an experimental equipment since it has been used to test the behaviour of the battery under various load circumstances.

Future Scope

A Human-Machine Interaction (HMI) which shows the GUI on a touch interface is one improvement that might be made to the system as a result of this study. To broaden the scope even more, many more characteristics may be included, such as the battery and panel's temperatures. To increase the customer's supremacy and control on the batteries & solar infrastructure, a distinct product or service outside the purview of this paper can be created.

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