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Solar Based Battery Charging System Through IOT

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Abstract
Electrical Solar Power is a smooth and RE Strength aid that is on its way to a high level of penetration within the worldwide electricity basket. However, there are a number of challenges associated with solar energy, including intermittency, limited dispatch capacity, and non-storability. Non-storability in a standalone PV device can be reduced by installing energy storage devices such as batteries to store the electric power generated by the solar panel while the sun is shining and to provide energy when the sun isn't shining. As a result, batteries are an important part of a standalone PV system. And it's usually the weakest link in PV systems because it affects the system's maintenance costs and reliability. This work focuses on the design and development of a low-cost, completely solar-powered battery charging system using a microcontroller. I MPPT (ii) Arduino Uno interface for battery control capabilities are included in the designed system. (ii) LCD display for providing information to the user about the system, such as the structure's normal capacity to charge at any given time, (iv) data storage and GSM module for remote surveillance and uploading live records, which can also be used for studying the battery's fitness and assisting in battery maintenance. The produced solar-powered battery charging mechanism for DC hundreds was created with Solar Home Systems in view (SHS).
Keywords: *Battery, Charge controller, Arduino Uno, Solar PV Panel.*

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I. INTRODUCTION

Increasing power demand, diminishing fossil fuels, new load kinds, rural electrification, and electricity security are just a few of the incentives for power places to jump right into a sustainable energy adventure. On this process, renewable energies will play a significant role. Because it is abundant and simple, solar energy is likely to play a significant role in the power sector. Solar PV systems have no fuel value, operate silently, require little maintenance, and have a long lifespan.

The Solar Mission in India is aided by the use of MNRE and MoP. Through 2022, a total of 100 GW of solar electricity is expected. According to the report of JNNSM (Jawaharlal Nehru National Solar Mission) MNRE, India, 40 GW of rooftop PV and 60 GW of solar thermal might be generated. The Decentralized Distributed Generation (DDG) system envisions providing power to villages on a stand-alone basis using conventional or renewable resources [1]. In order to give access to energy to rural populations with low electricity consumption in off-grid and off-grid areas, a low-cost solution is required.

To A low-voltage DC distribution network, in which man or woman can connect Solar Home Systems (SHS), is an intriguing option [2]. However, such stand-alone renewable energy systems require high-capacity storage devices to ensure that the energy is available without interruption for several days. Lead-acid batteries are now the most cost-effective option to gain ratio among a variety of energy storage technologies [3]. A low-cost Arduino Uno-based solar-powered battery charging device for SHS has been devised and advanced in this study.

Solar PV panels, batteries, and electricity conditioning devices are the basic components of a standalone Solar PV tool. Solar PV panels provide DC electricity, which is then converted to AC with the help of converter devices. The application of power Electronic converters increase the complexity of the strength device while lowering its performance [4]. Nowadays, a growing number of devices that use DC, such as laptops, cell phones, and other high-power digital devices, are being introduced into our daily lives. These programs want to convert AC to DC once more. The losses and complexity of the power gadget will increase as a result of this conversion. This concept is particularly beneficial in rural and modestly populated areas, where a low voltage DC community may provide power supplied by solar PV to meet the load of LED lighting, DC fans, TVs, and mobile charging stations.

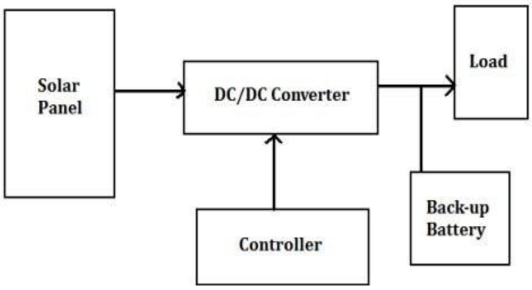

Figure 1: Block diagram of the solar energy storage system

II. PROPOSED SYSTEM

A deep depleted battery will be broken if a high modern is supplied to it. And if we leave a battery charging for an extended period of time (overcharging), hydrogen and oxygen gassing occurs at the electrode plates, clearing away the active material coated on the plates, resulting in battery failure. As a result, a practical battery charging system is required to address these issues. A low-cost solar-powered battery charger for DC hundreds (DC lighting fixtures such as LEDs, DC devices such as laptops, cellphones, satellite TV for computer TV controllers, and so on.) has been invented and advanced in this work.

The advanced equipment has the capability of logging and storing data for some distance off observation, with the primary goal of improving battery safety and therefore battery life. The suggested system is depicted in Figure 2 as a block diagram. The typical solar PV standalone device consists of a solar panel, an Arduino interfaced MPPT charge controller, a GSM module battery bank, and a load to provide useful power to the stop user.

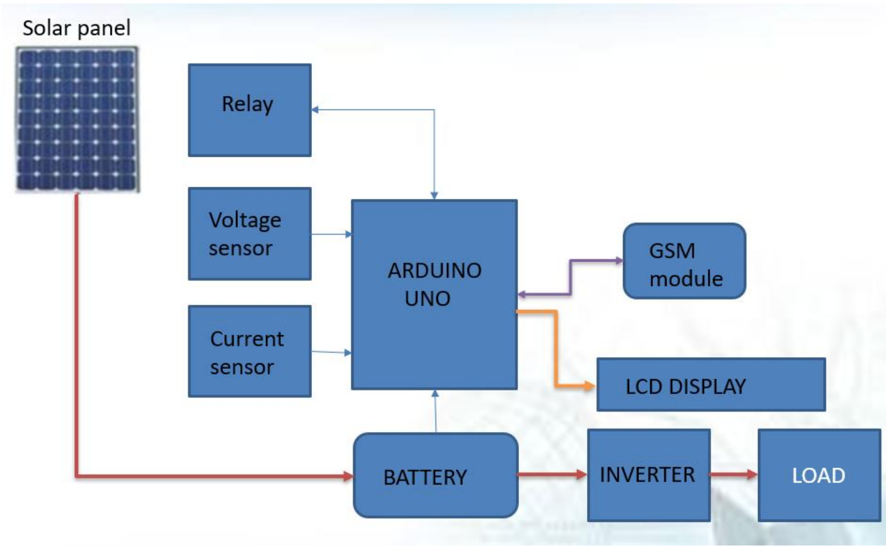

Figure 2: Block diagram of the proposed solar system

BASIC DESCRIPTION OF THE SYSTEM

Some Si-based PV cells are joined in collection and parallel in the solar panel, depending on the specified voltage and current. Polycrystalline Silicon, monocrystalline Silicon, copper-indium selenide, and amorphous silicon are currently the most widely utilized unique types of PV cells. The efficiency levels vary between 6% and 25%. A monocrystalline silicon PV cellular offers a higher total conversion performance (about 22%) as well as a lower price. Mono crystalline Silicon panel is used in this piece of art.

Electrical traits of the PV Panel (Values at STC (AM1.Five, 1000W/m², 25°C))

- Max Power Pmax: 50Wp +/-three%
- Panel Voltage: 12 V
- Nominal Current Imp: 2.77A
- Nominal Voltage Vamp: 17.20V
- Cell Efficiency: 17%

- Open–Circuit Voltage Voc: 21.6 V
- Module Efficiency: 14.6%
- Short-Circuit Current Isc: three.23 A

The I-V characteristic of solar cellular beneath numerous daylights is verified in Figure three. The knee factor where the dropping voltage line meets the vertical electricity line indicates the most high-quality energy available.

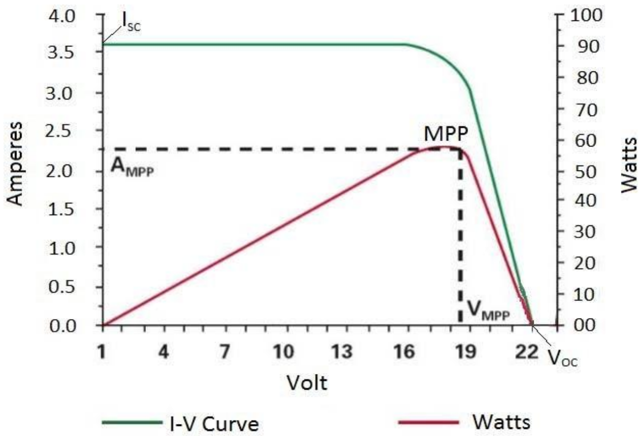

Figure 3: Standard I-V Characteristics of PV Cell

For 'power programmes' and 'electrical applications,' energy storage devices are necessary. In comparison to power programmes, the discharging of electricity in strength systems is slower and takes anything from ten minutes to hours. In the case of electricity packages, the stored energy is discharged at a very rapid rate, ranging from seconds to minutes [7]. Flywheels, batteries, hydrogen, and electrochemical capacitors are used as energy storage medium in power applications (ECs). The most commonly utilized energy storage generation is the lead-acid battery, which has a significant advantage over other rechargeable batteries in terms of energy ratio. Lead–acid batteries are divided into two types: flooded lead acid (FLA) batteries and valve regulated lead–acid batteries (VRLA). Absorbed Glass Mat (AGM) and Gel are two more terms for VRLA. Sealed batteries are another name for VRLA batteries. Sealed batteries have the advantage of less safety and a longer life duration, despite their high cost. AGM batteries are employed in the current work.

Without a rate, a battery charging tool isn't always complete. The distant shape of the regulator is primarily responsible for preventing overcharging of the batteries. The rate controller translates the incoming DC voltage from the solar panels into the precise voltage range needed to charge the batteries. The pricing controller unit should work for the stated voltage range and should reduce automatically if the SPV voltage falls below the preferred rate [13]. When the intensity of the light is reduced, the fee controller turns off and on mechanically until an appropriate amount of light is restored. The majority of the fee controllers on the market can be used under the optimum lighting conditions. The employment of such rate controllers is limited as a result of this flaw. The superior rate controller employs most electricity factor tracking (MPPT) to tune and adjust the voltage and cutting-edge in order to hunt for the most energy in the most advantageous scenarios. MPPT controllers, on the other hand, cost a lot of money [8]. Figure 4 shows the Maximum Power Point Tracker's Tracking Algorithm in action.

Pulse width rate controllers use high frequency pulses to control the current from the supply based on the battery's state of charge. To prevent battery overcharging, a pulse width fee controller examines the significance and duration of each pulse. A signal is obtained with the aid of utilizing the PWM charger during peak while the batteries are depleted, and all cutting-edge pulses continue to be non-forestall as it is charged, and this degree is referred to as bulk degree of charging. Absorption is the next step in the charging process, which occurs when the batteries are close to their full charge condition (SOC). Every day, the controller maintains the battery bank voltage for a long period of time. Furthermore, the pulses off time was extended to gradually drop the current level while the electricity banking institution was shut down.

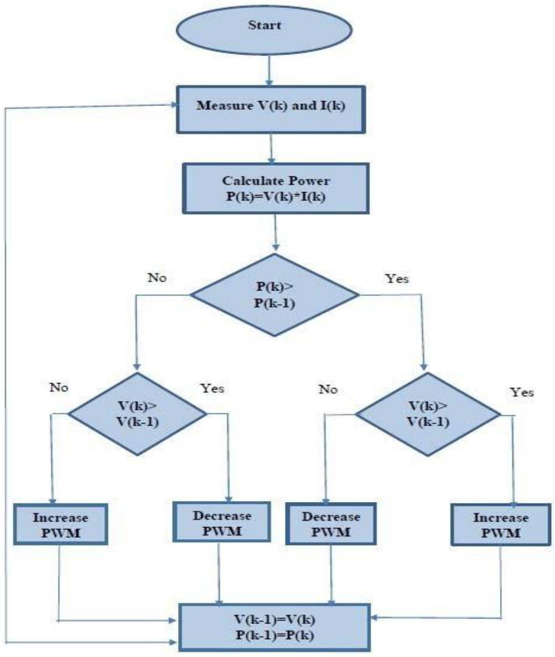

Figure 4: Tracking Algorithm of Maximum Power Point Tracker

The float charge stage refers to the full potential of the batteries. The sophisticated battery charger can operate in one of four modes:

• **On State**: Is the charge for solar strength fee in the United States between the lowest solar strength value and the coffee solar strength rate (minimal sun electricity, solar energy, and low sun power) [12]. The solar wattage input in this country is very low for bulk charging, but not so low to enter the off zone. Pulse width modulation is ready to be ninety-nine to achieve a low level of strength. The percentage is 9%.

• **Bulk State**: Is the United States of America, where solar electricity is greater than the minimum solar power. The Peak Power Tracking set of laws is employed in this country for the majority of battery charging, which entails running the highest amount of current in the circuit that the solar panels produce into the battery.

• **Float State**: In this state, the voltage rises until the battery voltage reaches its maximum. As a result, the country is known as the Drift Kingdom. The battery voltage is maintained at its maximum in the United States of America by modifying the PWM fee. Because battery voltage cannot be stored at its maximum, if PWM reaches 100 percent, the battery is being sucked down by some load.

• **Off State**: When no power is created from the sun panels' usable resource, the charger enters the off kingdom (minimum solar electricity). Because energy from the battery could be replicated into the solar panel in this condition, all MOSFETs are turned off to avoid this. It's probably nighttime if the sun panel isn't providing power.

The Arduino Uno (AT Mega 328P) microcontroller is used as a simple programming platform. There are 14 digital input/output pins on it. Six of the 14 pins are used as PWM outputs, while the other six are used as analogue inputs. It contains a reset button and is powered by a USB connection to a computer. The working voltage is 5 volts.

INTERFACE BETWEEN CONTROLLER AND GSM MODULE

The monitoring work is carried out with the help of a GSM module (ESP8266). It is a self-contained SOC (System on Chip) with an integrated TCP/IP protocol stack that provides any microcontroller with access to any GSM network. The ESP8266 can host or offload a utility from any other software processor that is responsible for all GSM networking functions. Every ESP8266 module comes pre-programmed with a firmware and AT command set, allowing us to connect it to an Arduino tool and gain almost the same amount of GSM functionality as a GSM Shield. The statistics are sent via AT instructions from a computer to a serial adapter via USB in this project. The operation of the GSM module is investigated using the ESP8266 module Arduino Uno, which is a convenient approach to incorporate into the main circuit (Fig. Five). Firmware is a set of instructions that are installed into the ESP8266 module without delay by immediately connecting it to a computer. In order to establish spoken communication between the advanced gadget and the GSM module, a USB to TTL common sense converter was required. The firmware is then flashed into the ESP module using the flasher. Communication between the module and the network is enabled via AT commands. This circuit (GSM module) is applied to our most significant circuit after the connections are organized (Fig. 6).

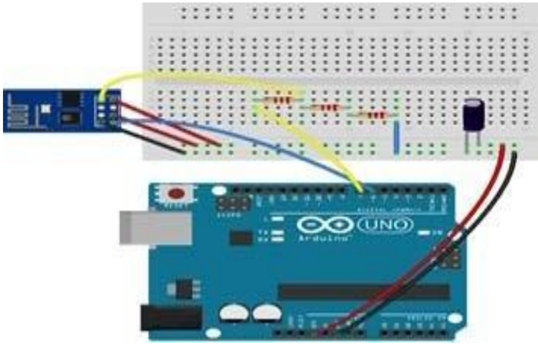

Figure 5: Interfacing of GSM module with Arduino

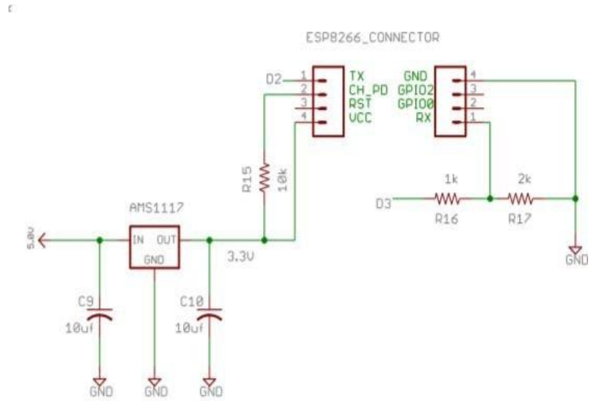

Figure 6: GSM interfacing with main Circuit

Data logging allows for the collection of statistics on solar PV machines and batteries for a variety of uses. Figure 7 shows how PV voltage changes over time.

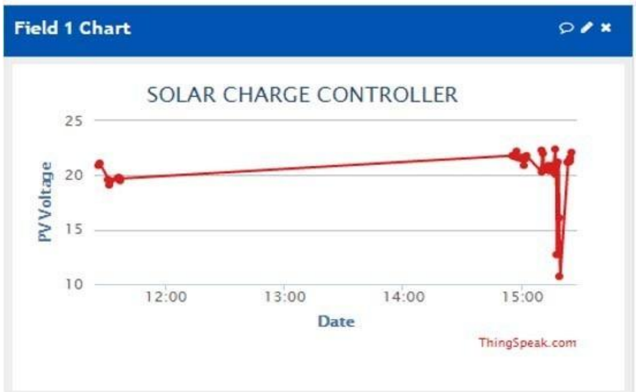

Figure 7: Solar PV voltage Vs Time

The records can also be sent to the users' smart phones at the locations of the nearest solar tree system. All of this could lead to the development of more efficient, IoT (Internet of Things)-enabled, and higher-related PV systems. The essential Components used are listed in Table 1.

Table 1: Listing of fundamental Components used

Component	Specifications
Solar PV Panel	Rated Power – 50W; Cell Type – Monocrystalline; Open Circuit Voltage: 21.6V; Short Circuit Current: 3.23 A; Max. Power Voltage: 17.20 V
Battery	Lithium-ion battery Voltage :12V
inverter	Dc- 12 v in Ac- 220v out
Load	Lamp; Voltage – 12 V; Rated Power - 50W
Microcontroller	Arduino Uno
GSM Module	EGSM900 Data transfer link Download: 85.6 kbps Upload: 42.8 kbps SMS: MT,MO, PDU Modes
Current and Voltage Sensors; LCD display	

Ⅲ RESULTS

Case 1: During the over voltage condition i.e. if the battery gets overcharged then the Arduino controller sends the signal to the relay and the relay activates and cuts off the power supply thus the battery is saved from overcharging.as shown in the below figure 8 the battery capacity is exceeded i.e. 26.53V the Arduino controller monitors the voltage level of the battery through the voltage and current sensor.

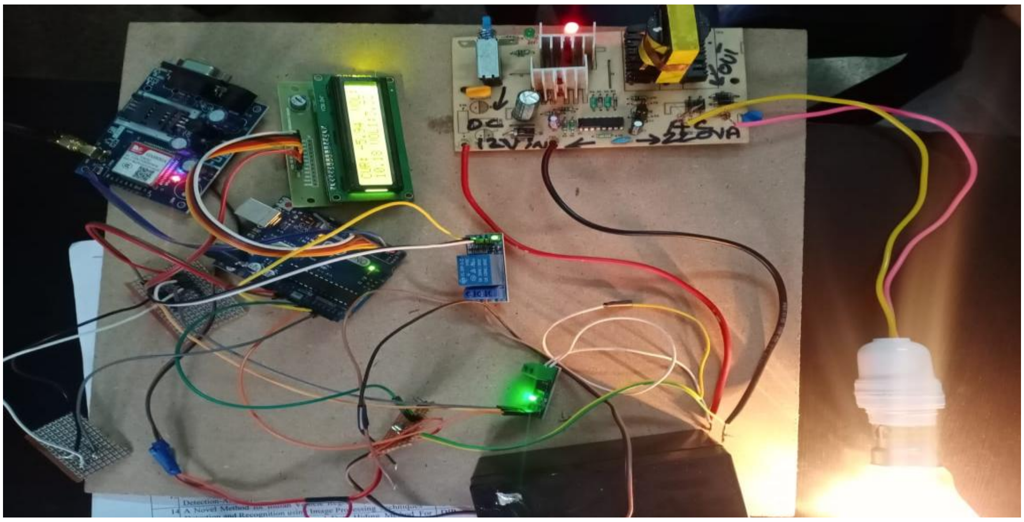

Figure 8: Circuit connection during over voltage condition

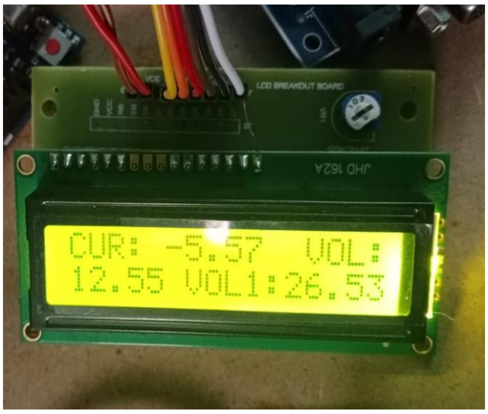

Figure 9: over voltage condition reading

Case 2: During the undervoltage condition i.e. if the amount of voltage present in the battery suppose if the battery gets discharged for the long time the battery may not be recharged again so the battery is operated with minimum cut off point less than 4v if the battery voltage falls below this voltage then the battery gets in its charging position.as shown in the below figure the battery voltage is less than 4v so the undervoltage condition occurs and the Arduino controller monitors the voltage of the battery through voltage and current sensor.

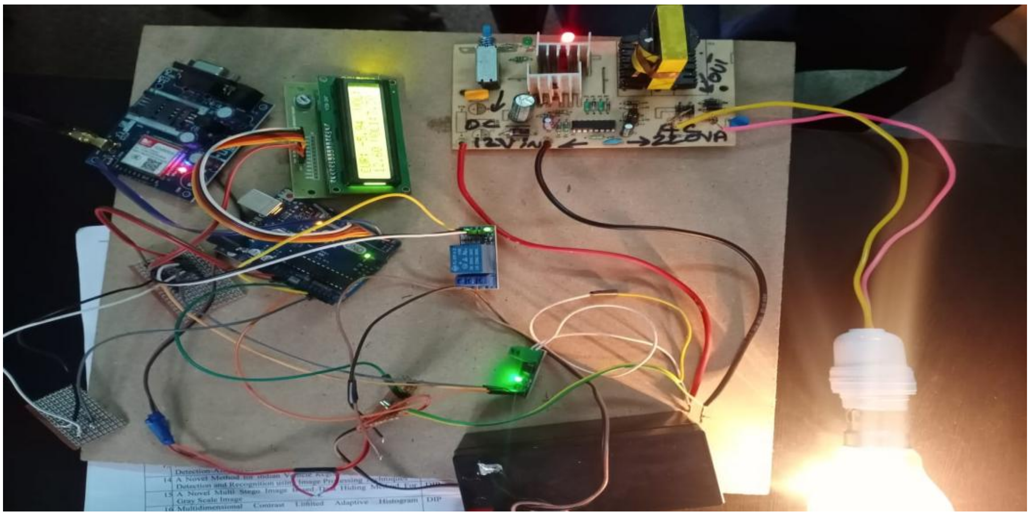

Figure 10: circuit connection during undervoltage condition

Figure 11: Under voltage condition reading

Ⅳ CONCLUSION

The design and development of a low-cost Arduino-based totally Advance Solar-powered Battery Charge Controller is presented in this work. The MPPT algorithm is used to complete the battery charging process. As a result, more strength harvest is acquired by working at the PV peak power point rather than the PV output voltage at any given time. The fee controller includes a battery management system, as well as an LCD display and a GSM module for data logging and messaging purposes. The outside and inner voltages, as well as the current flowing through the battery, the battery's state of charge, and the ability to turn off the battery when various restrictions are reached, are all displayed on the display.

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