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Design and Implementation of Solar Powered Mobile Charger

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ABSTRACT

This project introduces a solar-based mobile charging cap, designed to utilize renewable energy efficiently for charging small electronic devices such as smart phones. The system integrates two 3V solar panels, a buckboost converter to regulate the voltage to 5V, and a power bank module for energy storage and output. The cap harnesses solar energy, converting sunlight into electrical energy, which is either stored or used directly to charge devices through USB ports. The light weight and portable design make it suitable for outdoor enthusiasts, remote area inhabitants, and emergency applications. By leveraging clean energy, the system promotes sustainability, reduces dependence on fossil fuels, and offers an eco-friendly alternative for mobile charging needs.

Key words: Buckboost Converter, Solar energy, mobile charging

1. INTRODUCTION

The increasing global reliance on fossil fuels has raised significant concerns regarding their environmental and economic impacts. As these non-renewable energy sources face eventual depletion, the urgency to adopt alternative energy solutions has never been greater. Renewable energy sources, particularly solar energy, have emerged as a promising and sustainable substitute. Among various innovations in this field, solar-powered wearable devices like solar caps have garnered attention for their practical and eco-friendly applications.

A solar cap is an innovative accessory that combines the functionality of a traditional cap with the capability to harness solar energy for multiple purposes. Designed primarily for outdoor use, this cap is equipped with solar panels to capture sunlight and convert it into electrical energy. The integration of solar technology in wearable devices offers a portable and accessible solution for powering small electronic gadgets such as smartphones, GPS devices, and LED lights. It caters to the needs of individuals who frequently engage in outdoor activities, live in remote areas, or face unreliable access to conventional power sources.

The core components of the solar cap include photovoltaic (PV) solar panels, a buck-boost converter, a voltage regulator, and a power bank module. The PV panels convert sunlight into direct current (DC) electricity, which is then regulated and optimized to a stable 5V output by the buck-boost converter and voltage regulator. This regulated power is stored in the power bank module, enabling users to charge devices even in the absence of sunlight, such as during night time or cloudy weather conditions. The integration of a USB connector allows for easy and versatile charging of electronic devices. The Objectives of this our proposed hardware model are A solar charged power bank can be carried anywhere, allowing users to charge their phones on the go, especially in outdoor or remote areas and harness solar energy to charge smart phone using cap.

2. HARDWARE DESIGN

Solar Panel Integration: Two 3V solar panels are mounted on the cap to harness sunlight. These panels utilize photovoltaic cells to convert solar energy into direct current (DC) electricity.

Voltage Regulation: The generated electricity is fed into a buck-boost converter, which stabilizes and converts the varying input voltage from the solar panels into a consistent 5V output. This is achieved by using capacitors and a Zener diode for charging, discharging, and voltage boosting.

Power Distribution: The stabilized 5V DC is then supplied to a power bank module. The power bank module acts as a storage unit and facilitates charging mobile devices via USB ports. This ensures a reliable output for devices requiring up to 5V, even when sunlight is inconsistent.

Circuit Design:

The positive and negative terminals of the solar panels are connected to the buck-boost converter.

The output from the converter is connected to a voltage regulator (e.g., LM7805), which further ensures that the output remains precisely at 5V.

The regulated voltage is supplied to the USB connector, allowing devices to charge directly.

Testing and Validation: The entire system was tested under various lighting conditions to validate its functionality. Devices were connected to the USB ports to confirm efficient charging. Output voltages were measured to ensure stability and compliance with device requirements.

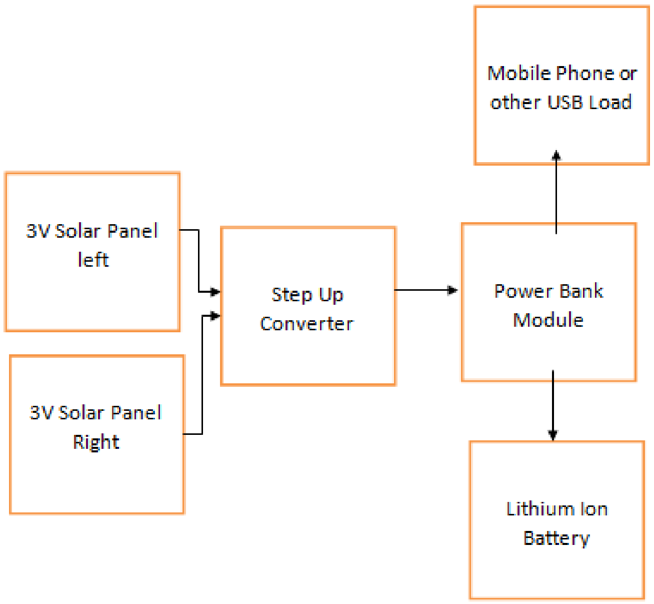

Fig 1: Block diagram of proposed hardware model

2.1 Working Principle

The solar-based mobile charging cap operates on the principle of converting solar energy into electrical energy to power mobile devices. Solar panels integrated into the cap absorb sunlight during daylight hours, utilizing photovoltaic (PV) cells to convert the solar radiation into direct current (DC) electricity. This electricity flows into a buck-boost converter, which stabilizes the varying input voltage from the solar panels and adjusts it to a higher or lower output voltage as needed, ensuring a consistent 5V output suitable for charging mobile devices.

The regulated voltage is supplied to a power bank module, which stores the electrical energy for later use or provides it directly to a USB port for immediate charging of electronic devices. This stored energy can be accessed even during non-sunny periods, such as night time or cloudy weather conditions. The system is efficient, lightweight, and capable of powering devices like smart phones and other gadgets requiring up to 5V, ensuring reliable performance and sustainability in remote and outdoor environments.

Solar Panels:

Two 3V solar panels are mounted on the cap to capture sunlight and convert it into electrical energy using photovoltaic cells. These panels serve as the primary source of energy, enabling renewable power generation.

Fig 2: Solar Panel

Specifications:

Max output power (without load): 0.45W

Max working voltage (without load): 3.3V

Max charging current (without load): 150mA

Min output power (without load): 0.45W

Min working voltage (without load): 3V

Width: 60 mm

Height: 95 mm

Depth: 5 mm

Weight: 20 g

Buck-Boost Converter:

This device is used to stabilize and adjust the voltage output from the solar panels. It ensures that the varying voltage generated by the solar panels is regulated to a consistent level, suitable for charging devices. The buck-boost converter can increase or decrease the voltage as needed to maintain a steady 5V output. The XH-M415 Micro Boost Module, powered by the SX1308 Boost DC-DC converter, accepts input voltages from 2-24V and delivers an output range of 3-28V with a peak current of 2A. Ideal for voltage-boosting applications, it provides efficient and reliable performance in a compact form factor.

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Fig 3: Buck Boost Converter

Specifications:

1. XH-M415 Micro Boost Module
2. SX1308 Boost DC-DC Converter
3. Input: 2-24V, Output: 3-28V
4. Peak Current: 2A
5. Efficient Voltage Boosting

Power Bank Module:

A power bank module is integrated to store the electrical energy produced by the solar panels. This allows for energy availability during periods when sunlight is insufficient, such as night time or cloudy conditions. The module also facilitates direct charging of devices via USB ports.

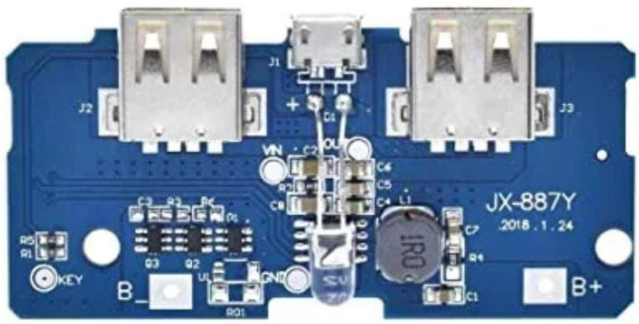

Fig 4: Power bank model

USB Connectors: These output ports are used to connect electronic devices for charging. The USB connectors provide a user-friendly interface to access the stored solar energy and charge devices conveniently.

Cap Structure: The cap serves as the base for mounting the solar panels and other components. It is designed to be lightweight and portable, ensuring comfort and usability for outdoor activities.

Battery: To store the charge the Lithium ion battery is used.

18650 battery is a Li-ion rechargeable battery with a 2500 mAh Battery Capacity. This is not a standard AA or AAA battery but is very useful for applications that require continuous high current or high current in short bursts like in cameras, DVD players, iPod, etc. A 18650 cell can be charged and discharged up to 1000 cycles without much loss in battery capacity. They are safe to use, environment friendly and have long battery life. It comes with high energy density and provides excellent continuous power sources to your device. It should be used with a protection circuit board that guards the battery against over-charge, over-discharge of the pack, and avoid over-current drawn.

Specifications

- Voltage: 3.7 Volts
- Capacity: 2500 mAh
- Rechargeable: Yes
- Battery Size: Diameter- 18mm x Length- 67mm
- Charging Method CC-CV

Advantages of proposed model are it utilizes renewable solar energy, reducing dependency on fossil fuels. Portable and lightweight design for easy outdoor use and it is Environmentally friendly with zero emissions. Cost-effective as it minimizes external energy dependency. Convenient for charging devices instantly, even in remote areas. The disadvantages are in areas with long winters or frequent rain, solar charging becomes impractical. It is not able to charge the solar panel during the night time.

Applications are Ideal for hiking, camping, trekking, and gardening. Useful in locations with limited access to electricity. Provides power during outages or natural disasters. Beneficial for construction workers and outdoor laborers. Charges small electronic devices like smartphones, GPS devices, and wearables.

3. RESULT AND DISCUSSION

In our model we used battery of 3.7V of the capacity 2500mAh. The below table shows the Charging and Discharging Pattern of Battery. Figure 5 shows image of proposed hardware model.

Table no.1: Charging and Discharging Pattern of Battery

Time(mins)	Discharging(Volts)	Charging(Volts)
0 min	*3.94*	*1.55*
5 min	3.85	1.86
10 min	3.54	2.04
15 min	3.02	2.54
20 min	2.75	2.95

Table no.2: Status of Mobile Battery Charging

Percentage of Battery Charge	Time to Charge
0%	2hr 45min
50%	1hr 20min
100%	0min

Figure no.5: Proposed hardware model

CONCLUSION

The solar-based mobile charger effectively harnesses renewable solar energy to provide a portable, eco-friendly, and reliable charging solution for electronic devices. By integrating solar panels, a buck-boost converter, and a power bank module, the system ensures consistent power output, even under varying environmental conditions. This innovative solution is particularly valuable for outdoor enthusiasts, remote area residents, and emergency use. Additionally, it promotes sustainability by reducing dependence on fossil fuels and minimizing environmental impact. The future Scope of Solar Powered Mobile Charger is the solar-based mobile charging has immense potential for further development and innovation. Future advancements could focus on integrating the cap with other wearable technologies such as smart watches, fitness trackers, or Bluetooth-enabled devices, enhancing its functionality and usability. Continued improvements in solar panel efficiency could result in lighter and more compact designs, making the cap even more appealing for daily use. Additionally, incorporating features like wireless charging, built-in LED lighting, or IOT-enabled connectivity could expand its applications beyond charging to include safety and convenience for outdoor workers and enthusiasts. With these enhancements, solar caps could see widespread adoption in diverse fields, including emergency response, outdoor activities, and labor-intensive industries, significantly reducing reliance on conventional energy sources and promoting sustainable practice.

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