

## Design of Solar Boost Bag

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**Abstract** - The solar boost bag is an innovative solution designed to meet the energy needs of modern lifestyles. It combines portability, renewable energy, and multifunctional utility, making it ideal for travelers, students, and professionals on the go. Despite the huge potential, solar photovoltaic only provides 1.2% of the world's electricity. Equipped with high-efficiency solar panels, this bag harnesses sunlight to charge electronic devices such as smartphones, tablets, and laptops, providing a sustainable alternative to conventional power sources.

This technology addresses the growing demand for eco-friendly and convenient energy solutions while promoting sustainability. With the integration of IoT features such as energy monitoring and optimization, the solar boost bag represents a leap forward in wearable technology, paving the way for a smarter and greener future.

**Key Words:** Microcontroller (ESP32 Module), GPS Modules, LED Modules, USB Modules, Solar Panel, Charging Module, Battery Level Indicator, Temperature Sensor, Battery/Power Bank, Zip Magnet.

### 1. INTRODUCTION

The solar boost bag is a revolutionary product that merges sustainability with advanced technology to address the growing demand for portable energy solutions. This innovative bag is equipped with high-efficiency solar panels capable of harnessing sunlight and converting it into electricity to charge devices such as smartphones, tablets, laptops, and other small electronic gadgets. Designed for convenience, the bag includes integrated USB and Type-C charging ports, ensuring compatibility with a wide range of devices.

The solar boost bag incorporates advanced battery storage technology, allowing users to store energy for

use during low-light conditions. It also features a sleek and ergonomic design with compartment for carrying personal belongings, integrated USB ports for seamless charging, and weather-resistant materials for durability in diverse environments. There are many applications where solar energy is utilized - from the very big application, such as generating electricity for homes and industry from solar fields, to the very small applications like powering the calculators.

### 2. Literature Review

**Mohammad Salah Uddin, et.al : Smart Anti-Theft Vehicle Tracking System Based on Internet of Things.** This study introduced a system using GPS, GSM, and microcontrollers for real-time tracking. It highlights the use of mobile applications for monitoring and controlling vehicles, with potential parallels for a smart bag system in tracking and security. The focus is on convenience and remote control for theft prevention.

**Roshahliza M Ramli, : Design and Implementation of Solar-Powered with IoT-Enabled Portable Irrigation System.** This study discusses a portable solar-powered system for IoT-enabled irrigation. It uses solar energy for powering devices and integrates real-time monitoring via a mobile app. The system demonstrates energy-efficient operations that can inspire the charging mechanism of the smart bag.

**Isha Goel, et.al: Design and Implementation of Android-Based Wearable Smart Locator Band.** This study introduced a wearable device for tracking children or individuals with memory related conditions using GPS and GSM technologies. The use of an Android app for monitoring highlights potential applications in child-tracking functionalities of the smart bag.

**Ahmed Sweleh Fasila Haneefa, et.al: Towards Smart Wearable Real-Time Airport Luggage Tracking.** This research introduces a luggage tracking system using Wi-Fi fingerprints and QR codes. The study emphasizes real-time tracking through smart devices, which aligns with the security and tracking aspects of the proposed smart bag.

**Mohsin Kamal, et.al: *Lightweight Security for Advanced Metering Infrastructure*.** This paper focuses on lightweight security solutions, such as RSSI-based adversarial detection. Similar methods could enhance the smart bag’s security system by detecting unauthorized access or tampering.

**Analysis:**

- Technology Alignment:** The proposed smart bag integrates several technologies covered in these papers, including GPS, GSM, IoT, solar charging, and microcontroller systems.
- Functionality Expansion:** By incorporating features like child tracking, luggage security, and portable solar charging, the smart bag can address a wide range of consumer needs.
- Innovation Potential:** Combining insights from multiple research areas, such as IoT enabled tracking and lightweight security, can make the bag adaptable for diverse applications like travel, education, or personal safety.

**Comparison Table**

S. No	Previous Smart Bags	Present Smart Bags
1	No Zip Lock System	Smart Zip Lock System
2	No Notification System	The Notification System is available
3	No Monitoring Mode	Monitoring Mode
4	No Charging Module	Charging module, we can use in emergency

**3. Working**

**Charging Circuit:** In a charging circuit, maintaining a regulated voltage output is crucial for effectively charging the load. This necessitates examining different types of voltage regulators, primarily switching and linear regulators. Switching regulators are further categorized into buck (stepdown), boost (step-up), and inverter types.

For a charging circuit to supply a consistent output voltage of 5V, suitable for phone batteries, a comparison between linear and switching regulators is essential, focusing on practicality, efficiency, and cost. Linear regulators are simpler and cheaper due to fewer external components, but they offer lower efficiency. On the other hand, switching regulators, despite their higher complexity and cost, deliver greater efficiency and versatility, enabling both boosting and buck operations.

However, switching regulators have higher output voltage ripple and generate more electromagnetic interference (EMI) and noise. Thus, while switching regulators are more efficient and versatile, linear regulators are more straightforward and cost-effective, with reduced noise and EMI.

**Buck and Boost Converters:**

**Advantages:** Achieve high efficiency (over 90%) thanks to inductors and capacitors that store and release energy efficiently, Inductors supply current during MOSFET off periods, reducing energy loss as heat, Capacitors charge during MOSFET on periods and provide energy to the load during off periods.

**Linear Regulators (LRs):**

**Advantages:** Minimal Output voltage ripple, Rapid response to changes in the load, Low electromagnetic interference (EMI) and noise due to the non-switching nature and absence of inductors.

**Disadvantages:** Lower efficiency, Requirement for heat sinks, Limited Capability to step down voltage efficiently

Considering these advantages and disadvantages, the linear regulator (LR) is selected for the voltage regulation due to its lower overall cost, reduced EMI and noise, and low output voltage ripple. Although Low Dropout Regulators (LDOs) offer higher efficiency, they were deemed impractical due to their operation with very low voltage drops, which can be problematic with the variable output of solar panels.

**ARRANGING THE BAGPACK FOR SOLAR PANEL:**

To securely attach the solar panels to the backpack, and to ensure the connection is robust, modifications are made to the bag's surface. Specifically, two strips of clips are sewn onto the front of the backpack. This allows the solar panel system to be firmly attached to the backpack and easily detached when necessary, such as for cleaning the bag, fixing a panel, or using the panel separately.

**Weight Distribution and Comfort:**

The backpack's center of gravity is crucial for comfort. The weight should be evenly distributed to prevent strain on the shoulders, which can affect the user's comfort and health. To address this, a pocket for the battery (the heaviest component) is positioned at the top of the backpack, close to the back, to avoid placing weight directly on the shoulders. This consideration is particularly important for the fixed weights of the bag, though there are no restrictions on the materials the user can carry.



Fig- a) Distribution of weight on the backpack b) Prototype of the backpack(one solar panel active) c) Prototype of the backpack (two solar panels active)

Electrical Connections:

The backpack will sit on the user's back, with USB and AC outlets positioned for easy access on the side. An external solar charge controller display is also visible on the side of the case, as shown in the red rectangles. This display provides access to control keys and shows essential information such as battery capacity, charging current, and charging voltage, helping the user monitor the solar panel system's performance. Figure 8 shows the cigarette lighter outlet and the charge controller screen, where the charging voltage is displayed, indicating that the battery is charged at 12.7V.

For detailed information on the prototype, refer to the link provided in the source [12].

Methodology:

1. Research and Ideation:
- Market Research:

Analyze existing solar bags, their features, and limitations. Identify target customer needs, such as charging capacity, portability, and durability.

Technology Trends:

Study advancements in flexible solar panels, battery technology, and lightweight materials.
2. Concept Design
- Sketching and Prototyping:

Create initial sketches and CAD designs of the bag.Include design considerations like panel placement, storage compartments, and weight distribution.

Functional Requirements:

Decide on the power output (e.g., 5W, 10W) and battery capacity (e.g., 10,000mAh). Integrate USB, USB-C, or wireless charging options.

User Ergonomics:

Optimize for comfort, style, and usability.

3. Material Selection
- Solar Panels:

Use lightweight, flexible, or semi-flexible solar panels (e.g., thin-film or monocrystalline panels).

Fabric:

Choose durable, water-resistant, and lightweight materials like ripstop nylon, polyester, or canvas.

Electronics:

Use efficient charge controllers and batteries with safety features like overcharge protection.
4. Engineering and Integration
- Solar Panel Integration:

Embed the solar panels into the bag’s surface, ensuring durability and weatherproofing.

Battery and Circuit Design:

Develop a compact battery pack with optimized energy storage and charging capabilities.

Wire Management:

Conceal wiring within the bag structure to protect against damage and maintain aesthetics.
5. Prototyping and Testing
- Build Prototypes:

Create functional prototypes using selected materials and components.

Performance Testing:

Test solar efficiency under different lighting conditions. Evaluate battery performance, durability, and charging capabilities.

Usability Testing:

Conduct user trials to gather feedback on comfort, practicality, and overall user experience.
6. Refinement
- Iterative Improvements:

Refine the design and functionality based on testing feedback. Address any ergonomic, durability, or performance issues.
7. Manufacturing and Production
- Scalability:

Develop manufacturing processes that ensure quality and efficiency.

Quality Control:

Implement rigorous quality checks for durability, performance, and safety.

- Sustainability:  
Use eco-friendly materials and production methods where possible.

## 8. Marketing and Launch

- Branding:  
Highlight unique features like solar efficiency, eco-friendliness, and multi-functionality.
- Targeted Advertising:  
Focus on outdoor enthusiasts, travelers, and tech-savvy users.
- Distribution:  
Leverage e-commerce platforms and retail partnerships.

**Functionality Expansion:** By incorporating features like child tracking, luggage security, and portable solar charging, the smart bag can address a wide range of consumer needs.

**Innovation Potential:** Combining insights from multiple research areas, such as IoT enabled tracking and lightweight security, can make the bag adaptable for diverse applications like travel, education, or personal safety.

## SELECTION OF SOLAR CELL:

Choosing the right solar cell/panel primarily involves balancing efficiency and cost. Here's a summary of the types and their pros and cons:

### Advantages and Disadvantages of Solar Cells:

Type	Advantages	Disadvantages
Monocrystalline	High efficiency (15%-20%)	Expensive, silicon waste during manufacture, decreased performance in higher temperatures
	Space-efficient, long operational life	
	Performs better than polycrystalline	
Polycrystalline	Less expensive than monocrystalline	Less space-efficient, lower efficiency (13%-16%) due to lower silicon purity
	Less silicon waste	
Amorphous	Less silicon needed	Low efficiency (10%-12%), thin film degrades faster, larger area needed
	Flexible, light materials	
	Performs well in poor light	
	Resistant to shading issues	

Hence, using two 6V 6W monocrystalline solar cells connected in series will provide more than the necessary 7V for the charging circuit.

## 4. CONCLUSIONS

This review paper has explored the evolution and current status of solar boost bags, which incorporate solar energy harvesting and energy storage systems into portable bags.

Integrating solar panels into bags provides a practical and eco-friendly solution for charging electronic devices on the go, offering both convenience and environmental benefits. Key components of solar boost bags include solar panel selection, battery storage, voltage regulation, and output port integration, which together enable reliable and efficient charging capabilities.

Despite the significant advancements in the development of solar boost bags, several challenges remain. These include optimizing solar panel efficiency, enhancing battery storage capacity, and improving the durability and weather resistance of the bags. Further research is also needed into cost-effective production methods and more compact, lightweight materials that do not compromise performance.

Future research should focus on increasing the energy conversion efficiency of solar panels, exploring advanced materials for better integration of solar panels into various bag designs, and addressing the environmental impact of production and disposal. The development of smart charging systems and the integration of newer energy storage technologies, such as solid-state batteries, could further enhance the functionality of solar boost bags.

In conclusion, solar boost bags offer an innovative and eco-friendly solution for charging electronic devices, especially for individuals who spend a lot of time outdoors or traveling. As solar technology and energy storage systems continue to improve, solar boost bags are expected to become even more efficient, durable, and widely adopted in the future, contributing to the growing trend of using renewable energy in everyday applications

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