Solar EV with Dual Cell Technology

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Abstract:-

With the increasing elderly population worldwide, there is a growing need for advanced healthcare solutions that offer real-time monitoring and timely medical assistance. This project focuses on the design and implementation of an IoT-based healthcare wristband for elderly people, utilizing the ESP32 microcontroller. The wristband is designed to monitor essential health parameters such as heart rate, body temperature, and physical activity. The system provides real-time data acquisition, analysis, and remote monitoring,enabling caregivers and medical professionals to track the health status of elderly patients from any location. In recent years, the integration of the Internet of Things (IoT) into healthcare systems has brought about transformative solutions for patient monitoring, especially for elderly individuals who often require continuous medical attention. This project presents the development of an IoT based health care wristband designed specifically for elderly people, utilizing the ESP32 microcontroller. The goal is to create a low-cost, compact, and efficient wearable device capable of real-time monitoring of vital health parameters while ensuring ease of use and reliability.The primary goal of this project is to enhance the quality of life for elderly individuals by providing continuous health monitoring and ensuring timely medical attention when needed.

Key Words:- Solar EV, Dual Cell Technology, Battery Management, Renewable Energy, Electric Vehicle, Solar Charging, Sustainable Transport, Energy Efficiency, Regenerative Braking, Hybrid Power System

1.INTRODUCTION:-

1.1. Objective:-

To design and develop a low-cost, real-time health monitoring wristband using the ESP32 microcontroller, aimed at improving the quality of life and safety of elderly individuals by continuously monitoring vital health parameters and enabling remote health management through IoT connectivity.

Real time data transmission that can be done by the ESP 32 built-in WiFi/Bluetooth to a mobile phone or cloud server for remote monitoring by care givers. Fall detection can be done by integrating the accelorometer or the gyroscope sensor to alert automatically for caregivers.Data visualization by Storing historical health data in the cloud

and provide visual reports through a user-friendly interface or dashboard.Low power consumption by optimizing the system for battery efficiency to ensure long-term usage without frequent charging,Emergency button for the elderly people at their emergency situations.

1.2. Description:-

The IoT-based healthcare wristband for elderly people using ESP32 is a smart wearable device designed to monitor vital health parameters in real time. It utilizes the ESP32 microcontroller, which offers built-in Wi-Fi and Bluetooth capabilities for seamless data transmission. The wristband continuously tracks vital signs such as heart rate, body temperature, and blood oxygen (SpO2) levels. This data is sent to a mobile app or cloud server, allowing caregivers and medical professionals to monitor the user's health remotely. In case of abnormal readings, the system can trigger alerts via app notifications, SMS, or email. An optional fall detection feature can also be included using motion sensors to enhance user safety.

The device is optimized for low power consumption to ensure longer battery life. Its compact and lightweight design makes it comfortable and convenient for daily use. Historical data is stored for trend analysis and visualization. This project aims to enhance elderly care by offering continuous health monitoring and timely interventions.

1.3. Focus Of The Project:- The focus of this project is to develop a smart wristband that ensures continuous health monitoring for elderly individuals. It uses the ESP32 microcontroller for real-time data collection and wireless communication.

The project also aims to provide emergency alerts in case of abnormal health readings or falls. Power efficiency and wearable comfort are key design priorities. Overall, it focuses on enhancing elderly safety and well-being through IoT technology.

2.COMPONENTS:-

Lithium-ion (Li-ion) batteries are widely used rechargeable energy storage devices that power a vast range of modern technologies, including smartphones, laptops, and electric vehicles. These batteries operate by allowing lithium ions to move back and forth between two electrodes: the anode (typically made of graphite) and the cathode (usually a lithium metal oxide). During the charging process, lithium ions are stored in the anode, while during discharge, they move to the cathode, releasing energy in the form of electrical power. This chemical process enables the battery to provide a steady and reliable power source over a long period of time.

One of the key advantages of lithium-ion batteries is their high energy density. They can store a significant amount of energy relative to their size and weight, making them ideal for portable devices where space is limited. Additionally, these batteries have a low self-discharge rate, meaning they lose charge slowly when not in use, and they can handle many charge and discharge cycles before their capacity starts to degrade. As a result, lithium-ion batteries offer a long lifespan compared to other battery technologies.

2.2. Solar Panel :-

A solar panel is a device that converts sunlight into electricity through the photovoltaic (PV) effect. It is made up of many individual solar cells, typically composed of semiconductor materials like silicon, which absorb sunlight and generate electrical charges. When sunlight hits the surface of a solar panel, photons (light particles) are absorbed by the semiconductor material, causing electrons to become energized and move, creating an electric current. This current is then harnessed and converted into usable electricity for homes, businesses, or even large-scale solar farms.

Solar panels have become a popular source of renewable energy due to their ability to generate clean electricity without emitting harmful pollutants. They can be used in a wide range of applications, from powering residential homes and commercial buildings to providing energy in remote areas that are not connected to the electrical grid. In addition to being environmentally friendly, solar panels are also cost-effective in the long term, as they require little maintenance once installed and can last for decades.

The efficiency of solar panels, or how effectively they convert sunlight into electricity, depends on various factors, including the quality of the materials used, the angle of installation, and the amount of sunlight the panel receives. Over time, technological advancements have led to the development of more efficient solar cells, which can generate more power from the same amount of sunlight. Solar panels are often used in combination with other technologies, such as batteries for energy storage, to ensure a steady power supply even when sunlight is not available.

Solar energy is a key player in the transition to clean and sustainable energy sources. It reduces reliance on fossil fuels, lowers electricity bills, and helps combat climate change by producing energy without releasing carbon dioxide or other greenhouse gases. With ongoing innovation and growing adoption

2.3. ARDUNO:

Arduino is an open-source electronics platform based on easy-to-use hardware and software, designed for creating interactive electronic projects. It consists of a microcontroller board, which is a small computer that can read inputs like light, temperature, or motion, and turn those inputs into outputs such as controlling lights, motors, or sending data to other devices. Arduino provides a simple way to prototype and develop electronic systems for people, whether they are beginners or experienced engineers.

The Arduino board is typically programmed using the Arduino Integrated Development Environment (IDE), which is a software application that allows users to write, compile, and upload code to the board. The language used in Arduino programming is a simplified version of C/C++, making it accessible even to those with limited programming experience. Users can connect sensors, actuators, and other components to the Arduino board using its digital and analog input/output pins, making it highly versatile for a variety of applications.

One of the most appealing aspects of Arduino is its accessibility. It is inexpensive compared to many other microcontroller platforms, and it comes with a large, supportive community. This community shares projects, code libraries, and resources that help beginners get started and also assist more advanced users in tackling complex projects. Arduino boards are widely used for building robots, home automation systems, wearables, weather stations, and more. They can also be integrated into larger systems, including Internet of Things (IoT) devices, where they can communicate over the internet to gather or share data.

Arduino is also highly adaptable due to its open-source nature. Users can customize hardware and software to meet specific needs, or even create their own Arduino-compatible boards. This flexibility, combined with the platform's ease of use, makes it a powerful tool for learning electronics, programming, and physical computing. Whether for hobbyists, students, or engineers, Arduino offers an intuitive gateway into the world of embedded systems and electronics.

2.4. Buck-Boost Converter :-

A Buck-Boost Converter is a type of DC-DC converter that is designed to provide an output voltage that can be either greater than or less than the input voltage, depending on the operating conditions. It is especially useful in applications where the input voltage fluctuates above and below the desired output voltage. The converter combines the functionalities of both a buck (step-down) and a boost (step-up) converter. It typically consists of an inductor, a semiconductor switch (such as a transistor), a diode, and a capacitor.

The working principle of the Buck-Boost Converter involves two main stages during each switching cycle. In the first stage, when the switch is closed (turned on), current flows through the inductor, and energy is stored in its magnetic field. During this period, the diode is reverse-biased, preventing current from reaching the output. In the second stage, when the switch is opened (turned off), the inductor releases the stored energy, which flows through the diode to the output, thereby transferring energy to the load and charging the output capacitor. The timing of the switching, determined by the duty cycle, controls the amount of energy transferred and thus regulates the output voltage.

There are two types of Buck-Boost Converters: inverting and non-inverting. The inverting type produces an output voltage of opposite polarity to the input, while the non-inverting type maintains the same polarity. The inverting version follows the relationship where DDD is the duty cycle. This means that by varying the duty cycle, the output voltage can be controlled regardless of whether it needs to be higher or lower than the input.

Buck-Boost Converters are commonly used in battery-powered devices, renewable energy systems, and portable electronics where consistent output voltage is essential despite changes in the input supply. Their main advantage is flexibility, as they can adapt to a wide range of input conditions. However, they can be more complex than pure buck or boost converters and may have lower efficiency depending on the design and components used.

3. METHODOLOGY:-

The methodology for the Solar Electric Vehicle (EV) with Dual Cell Technology project is centered on developing an eco-friendly transportation system that utilizes solar power as its primary energy source and incorporates a dual battery cell mechanism to ensure continuous and reliable performance. The process begins with the installation of solar photovoltaic (PV) panels on the vehicle's surface, typically on the roof and bonnet areas. These panels are responsible for harvesting solar energy and converting it into electrical energy through the photovoltaic effect. The energy generated from these panels is directed to a solar charge controller, which regulates the voltage and current supplied to the battery units. This regulation is critical to protect the batteries from overcharging and to enhance their overall lifespan.

To ensure uninterrupted operation and efficient energy management, the system is designed with dual battery cells—a primary battery and a secondary (backup) battery. The primary battery supplies power to the electric motor under normal driving conditions. The secondary battery, on the other hand, serves as a backup source of power and is charged either simultaneously with the primary battery using solar energy or alternately based on the system's logic. This dual cell setup enables the vehicle to maintain operation even when solar input is low, such as during cloudy weather or nighttime driving. An automatic battery switching circuit is used to manage the load between the two batteries, ensuring a seamless transition without interrupting the vehicle's motion.

The energy stored in the batteries is used to power the brushless DC motor (BLDC) or any efficient electric drive system. A motor controller is used to manage the speed, torque, and direction of the vehicle based on inputs from the driver and the sensors embedded in the system. The controller also interfaces with the battery management system (BMS), which is tasked with monitoring key parameters of both batteries, including state of charge (SoC), temperature, current, and voltage levels. This real-time monitoring ensures safe operation and protects the batteries from thermal runaway or deep discharge scenarios.

In addition to solar charging, the vehicle can also support plug-in charging for emergency or extended usage, making it a hybrid power input system. The vehicle includes a smart dashboard unit equipped with displays showing real-time data such as solar power generation, battery health, motor performance, and energy consumption. This interface helps the driver to monitor the system effectively and make informed decisions during travel.

Finally, the proposed system undergoes testing under various environmental and operational conditions to validate its performance, reliability, and energy efficiency. These tests are carried out to examine the solar panel output under different sunlight intensities, the switching efficiency between the dual batteries, and the overall range and performance of the vehicle. Through this structured and integrated methodology, the project aims to create a self-sustainable electric vehicle that addresses energy challenges and contributes to a greener future.

4. WORKING PROCESS:-

The working process of the Solar Electric Vehicle (EV) with Dual Cell Technology begins with the solar panels mounted on the vehicle's surface, typically on the roof or hood. These panels absorb sunlight and convert it into electrical energy using the photovoltaic effect. The generated direct current (DC) power is then passed through a solar charge controller, which plays a vital role in stabilizing the voltage and current before it reaches the batteries. The charge controller ensures that the batteries are charged safely and efficiently, preventing conditions like overcharging or deep discharging.

The electrical energy is stored in a dual battery cell system composed of a primary battery and a secondary (backup) battery. During regular vehicle operation, the primary battery supplies power to the electric motor, which drives the vehicle. The secondary battery is kept in standby mode and is charged either in parallel with the primary battery or alternately based on system requirements. A battery management circuit continuously monitors the charge levels of both batteries and automatically switches between them when needed. For instance, if the primary battery is depleted or requires rest, the system seamlessly transfers the load to the secondary battery without interrupting the vehicle's operation. This switching ensures continuous mobility even during unfavorable weather conditions or low sunlight availability.

The power from the selected battery (either primary or secondary) is delivered to the motor controller, which regulates the power supplied to the electric motor based on user inputs, such as throttle position, and real-time conditions. The motor controller manages speed, torque, and direction of rotation, enabling smooth acceleration and braking. Additionally, some systems may include regenerative braking, where kinetic energy from braking is converted back into electrical energy and stored in the batteries, further improving efficiency.

Throughout the operation, a Battery Management System (BMS) keeps track of battery temperature, voltage, current, and overall health. This system protects the batteries from overheating and ensures balanced charging and discharging cycles. To provide feedback to the driver, a digital dashboard displays essential data such as solar power input, battery charge status, current speed, and estimated range.

This well-coordinated process of solar energy harvesting, dual battery storage, and efficient power delivery allows the vehicle to function reliably under varying conditions, making it an ideal solution for sustainable and self-sufficient electric mobility.

5.FUTURE SCOPE:

The future scope of the *Solar Electric Vehicle (EV) with Dual Cell Technology* is highly promising and aligns with the global movement toward sustainable and renewable energy-based transportation systems. As the demand for eco-friendly alternatives to fossil fuel vehicles increases, solar EVs provide a clean and self-sufficient solution that reduces carbon emissions and operating costs. The incorporation of dual battery technology further enhances the practicality of solar EVs by ensuring uninterrupted operation and extending the driving range, even in low sunlight or unpredictable weather conditions. In the future, advancements in solar panel efficiency, lightweight materials, and solid-state battery technology could significantly improve the overall performance, storage capacity, and energy conversion rate of these vehicles. Moreover, integrating AI-powered energy management systems could enable smart switching between battery cells and real-time route optimization based on energy availability.

As smart cities and green infrastructure evolve, there is potential to develop solar charging stations or dedicated solar-powered EV lanes, further encouraging the adoption of such vehicles. Additionally, this technology could be expanded to commercial transport, public transit systems, and off-grid rural mobility solutions, helping to bridge energy access gaps and support environmental goals. Governments and industries are also expected to support this innovation through subsidies, research funding, and policy incentives, making it more feasible for mass production. Overall, the Solar EV with Dual Cell Technology stands as a stepping stone toward a cleaner, smarter, and more energy-resilient future.

CONCLUSION AND RESULTS:-

In conclusion, the Solar Electric Vehicle (EV) with Dual Cell Technology represents a significant step forward in the development of sustainable and energy-efficient transportation systems. By harnessing solar energy through photovoltaic panels and integrating a dual battery system, the project ensures continuous power supply and enhances the reliability of electric mobility. The intelligent switching between primary and secondary batteries helps maintain uninterrupted operation even under low sunlight or during extended usage, making the system practical for real-world conditions. This innovative approach not only reduces dependence on conventional energy sources but also contributes to reducing greenhouse gas emissions and lowering operational costs. The successful implementation of this project demonstrates the potential of combining renewable energy with smart battery management to build eco-friendly transportation solutions. With further improvements in solar technology and energy storage, this concept holds great promise for large-scale adoption and a cleaner, greener future in the field of electric vehicles.

Fig 1 working model of solar ev with dual cell technology

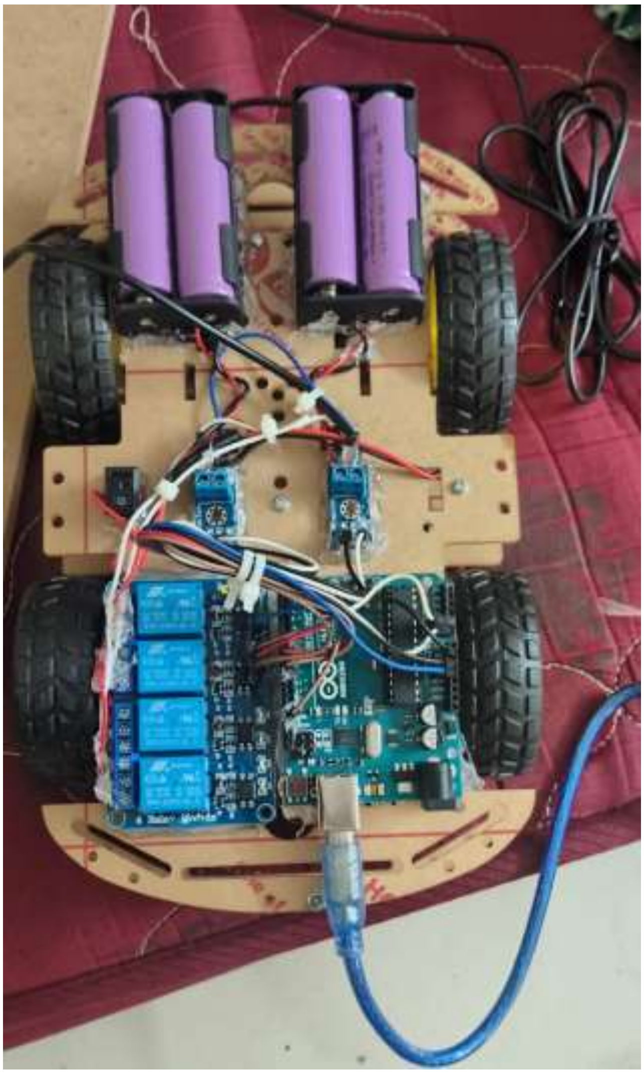

Fig 2

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