Implementation of Solar Charging System with Condition Monitoring Using AI in Electric Vehicle

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***Abstract*— This project focuses on improving the functionality and sustainability of electric vehicles (EVs) by addressing specific challenges and implementing new technologies. The project aims to improve reverse parking capabilities through a system equipped with sensors, ensuring smoother and more precise parking. Integrating solar power technology will capture sunlight and convert it into electricity, stored in batteries to extend the vehicle's range and reduce reliance on traditional electricity sources. An AI-powered driver monitoring system using a camera and sensors will analyse the driver's face and steering wheel input to prevent drowsy driving and issue alerts when necessary, prioritizing safety on the road. Furthermore, our project highlights real-time monitoring of EV performance and health, providing crucial data for users and fleet managers to make well-informed decisions. Overall, this project aims to make EVs more reliable, efficient, and user-friendly by tackling specific challenges and implementing advanced technologies. This advancement in the automotive industry will contribute to a more sustainable and safe transportation experience.**

***Index Terms*— Solar Car, Reverse Parking Assistance, Driving Drowsiness system, Fleet Management.**

I. INTRODUCTION

Electric vehicles (EVs) are changing how we think about cars, offering a cleaner option compared to traditional ones with gas engines. These cars use electric motors and batteries instead of burning fossil fuels, aligning with the global push to cut down on pollution and fight climate change.

The electric vehicle market has been growing a lot lately. Big car companies are getting on board, making different electric models to meet the rising demand for greener transportation. Governments worldwide are encouraging people to choose electric cars by giving them benefits like subsidies and tax breaks. They're also working on creating more places to charge these cars. This support has made more people interested in electric vehicles, helping the market grow even faster. The technology behind these cars is also getting better. New and improved batteries, smart features, and even using solar power are making electric vehicles more efficient and powerful. They're not just better for the environment; they're becoming smarter and more convenient for us too. Solar car technology, which uses sunlight to help power the car, is an exciting new area of development. Although it's not the only way these cars get power, it adds to their efficiency and lets them go even farther. As electric vehicles continue to evolve, they represent a big step toward a cleaner and more sustainable future for how we travel.

Also, the rapidly evolving world of automotive technology, three significant developments in the quickly developing field of automotive technology are changing the way we drive, park, and adopt electric mobility. First, a shining example of safety innovation is the driver drowsiness detection system. In order to maintain an eye on the driver's behavior in real-time, this cutting-edge technology integrates web camera sensors and artificial intelligence algorithms. Its main goal is to prevent the risks of drowsy driving, a dangerous state that could seriously compromise a driver's attention, reaction time, and decision-making skills, potentially resulting in dangerous circumstances on the road. As an attentive co-pilot, the technology monitors the driver's eye movements as well as important vehicle information like speed and lane position. It sounds the alarm as soon as it detects indicators of tiredness, such as drooping eyelids, to warn the driver to take appropriate action. A genuine guardian against accidents brought on by tiredness or inattention, some advanced versions of this system even have the ability to step in, autonomously controlling particular vehicle systems to ensure safety. The reverse parking assistant system, often known as the reverse parking aid or rearview parking system, is the next concept. The idea is going to completely change how we manage through the challenging aspects of parking in reverse. This device makes reverse parking easy by seamlessly integrating an ultrasonic sensor and camera into the back of the vehicle. Continuously monitoring surrounding areas of things, barriers, or other cars hiding behind your automobile. The technology transforms into your reliable companion as you approach possible risks, sending dashboard-based visual and audio signals in real time. These alerts provide essential direction, assisting you in accurately estimating distances and managing even the most challenging parking spaces. In some advanced modification, the system can even take partial control of steering or throttle, making semi-autonomous parking in both parallel and perpendicular spaces a reality. This technology goes above and beyond simple convenience, greatly lowering the likelihood of crashes, especially in confined or crowded parking locations. Finally, we switch to the monitoring system for electric vehicles (EVs), a key component of the fast-developing field of electric mobility. With real-time data into your EV's performance, health, and general status, this intelligent system serves as your EV's closest companion. Using a variety of sensors, cutting-edge connections, and sophisticated algorithms, EV monitoring systems provide an in-depth dashboard view of essential data. These systems provide users and fleet managers with the information they need to make wise decisions, from battery state of charge to precise range estimation and energy usage monitoring. They not only make sure that EVs run efficiently and continuously, but they also advance sustainability by maximizing energy utilization and extending the life of EV batteries—a crucial step in lowering transportation's environmental impact. In this project, we take an overview of these revolutionary technologies, highlighting their importance for improving safety, usability, and sustainability in the automotive industry.

II. SYSTEM OVERVIEW

COMPONENTS OF VEHICLE CHARGING SYSTEM

For successful implementation of the project, the following are the main components required:

1. Electric vehicle
2. Solar Photo-Voltaic module
3. Charge controllers

Electric Vehicle: The following section explains the requirements of the vehicle which will be charged by solar energy. The Graphical representation of electric vehicle is shown in Fig. 2.

Design calculations: Power (Watts) = Weight of vehicle

Battery

Battery power = V x Ah

= 48 x 48

= 2304 Wh

Nominal voltage per cell = 3.7 V

No of cell = 13

Total voltage of battery = 13 x 3.7 = 48 ...V

Charging Voltage per cell = 4.2 ...V

Charging voltage of battery = 4.2 x 13 = 54.6 ...V

(Hence, the solar panel should generate voltage of **54.76** V in order to charge the battery.)

Charging Time:

Voltage of battery = 54.6...V

Voltage after DC-DC converter = 54.6...V

Battery Capacity = 48...Ah

Battery voltage nominal = 48...V

Battery capacity in (Wh) = 48x24 =2304...Wh
= 2.304…kWh

Energy input require for full charging = 2304/0.85
=2710...Wh
(Efficiency of panels is 0.85)

Charging power = 54.6x3.15 =172...W
Charging time hours: = 2710 / 172 =15… h

Fig1. Graphical representation of the electric vehicle

A. SPEV Charging Module:

SPEV charging module comprises of Polycrystalline solar panels (150Watt), MPPT, Lead acid Batteries, Motor driver and BLDC Motor.figure.2 illustrates the SPEV charging module block diagram. This module is responsible for charging the battery from solar panel and discharges it to run the vehicle.

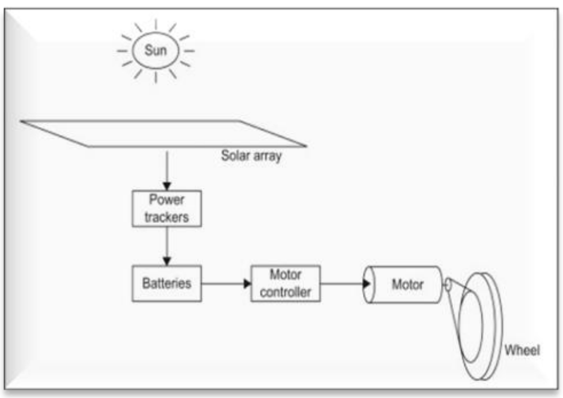

Fig. 2. Block diagram of Charging module

1) Solar Panel:

Polycrystalline solar panels are used because, making of polycrystalline solar panels are simpler and cost effective. Heat tolerance of polycrystalline solar panels is lower when compared to mono crystalline solar panels. The fig.2 illustrates the projection view of solar panel. Solar panel placed on roof of the vehicle is 150watt, hence totally 150watts solar panel was placed in SPEV. The top view solar panel is placed horizontal position. Therefore, 150watt power is generated from inbuilt solar panels on the vehicle during direct sunlight. Figure 2 projection view ensures the overview of 150watt panel arrangements in SPEV design [2]. Thus, 150watt polycrystalline solar panel is responsible for harvesting the power from direct sunlight.

2) Maximum Power Point Tracking (MPPT):

It is an electronic converter that determines the best power that solar panel can put out to charge its corresponding battery. Thus, charge controller looks at the output of the panels, and compares it to the battery voltage. Thereby higher voltage DC output down to the lower voltage required to charge its respective battery. It takes best power and converts it to voltage to get maximum ampere into the battery. Most modern MPPT's are around 93-97% efficient in the conversion. You typically get a 20 to 45% power gain in winter and 10-15% in summer. Actual gain can vary widely depending weather, temperature, battery state of charge, and other factors

3) Battery:

48 Volt 48Ah Lead acid batteries are used due to its less cost. The vehicle needs to run for 6 hours, so the total capacity will be 2304Watt hour. Battery in figure 1 illustrate the lead acid batteries. It is reliable and robust in nature.

Fig.3.3 Battery Pack

4) Motor:

Brushless DC Motor (BLDC) motor is chosen due to the higher efficiency (greater than 75%) and higher life time compared to Brushed DC motors. Hence conventional motor driver drives the BLDC with respect to the supply from lead acid battery.

Fig. BLDC Motor

III. COMPONENTS OF ADVANCE CONTROL & CONDITION MONITORING

A driver drowsiness system in an electric vehicle (EV) plays a crucial role in enhancing driver safety by continuously monitoring the driver's attentiveness and alertness while operating the vehicle. This advanced technology relies on a combination of sensors, including infrared cameras, facial recognition software, and eye-tracking sensors, to analyse the driver's behaviour and condition. It scrutinizes factors such as head position, eye movements, facial expressions, and driving behaviour to detect signs of drowsiness, distraction, or fatigue. When such signs are identified, the system issues immediate warnings or alerts to the driver, ensuring timely intervention. These alerts can take the form of audible notifications, visual warnings on the dashboard or instrument cluster, and haptic feedback like steering wheel or seat vibrations.

By operating in real-time and providing instant feedback, the driver drowsiness system aims to prevent accidents resulting from drowsy or inattentive driving. This technology significantly contributes to road safety and is often customizable to align with individual driver preferences and habits, making it an integral safety feature in modern electric vehicles. Reverse parking assistance in an electric vehicle (EV) is a valuable technology designed to simplify parking manoeuvres, particularly when parking in reverse. As the driver engages reverse gear, this system employs a combination of sensors, including ultrasonic sensors and cameras, to assess the environment behind the vehicle in real-time. It detects obstacles, other vehicles, pedestrians, and objects that could obstruct the parking process. The system then provides immediate feedback to the driver through visual cues displayed on the dashboard or infotainment system, typically in the form of coloured lines or graphics that represent the path the vehicle will take as the steering wheel is turned.

Audible warnings and alarms further indicate the proximity of obstacles, ensuring safe and accurate parking. Some advanced systems even offer semi-automated or fully automated parking, with the system taking control of the steering while the driver manages acceleration and braking. Ultimately, reverse parking assistance enhances driver confidence and safety in challenging parking situations, making it a valuable feature in modern electric vehicles, particularly in crowded urban settings and tight parking lots.

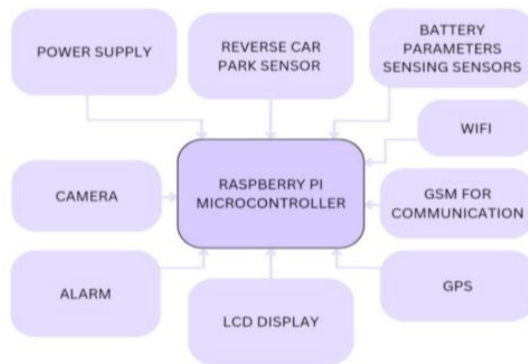

Fig. Block Diagram Driving Drowsiness System & Reverse Parking Assistance.

A. *Raspberry PI (3)*

Raspberry Pi is a credit card sized single-board computer. It has 5 models. Model A, Model A+, Model B, Model B+, Generation 2 Model B. Model A has 256Mb RAM, one USB port and no network connection. Model A+ has 256Mb RAM, one USB port and network connection. Model B has 512Mb RAM, 2 USB ports and an Ethernet port. Model B+ has 512Mb RAM, four USB ports, Ethernet port and HDMI and camera interface slot. Generation 2 Model B also has 4 USB ports, 1 GB RAM, 2 camera interface and 1HDMI interface. We implemented raspberry pi tablet using Model B+. IT has a Broadcom BCM2835 system on chip which include an ARM1176JZF-S 700 MHz processor, Video Core IV GPU, and an SD card. The GPU is capable of Blu-ray quality playback, using H.264 at 40MBits/s. It has a fast 3D core accessed using the supplied Open GL ES2.0 and Open VG libraries. The chip specifically provides HDMI and there is no VGA support. The foundation provides Debian and Arch Linux ARM distributions and also Python as the main programming language, with the support for BBC BASIC, C and Perl. Fig 2 RASSPBERRY PI 3 MODEL B VISION TO RASSPBERRY PPI The Raspberry Pi Camera Board plugs directly into the CSI connector on the Raspberry Pi. It's able to deliver a crystal clear 5MP resolution image, or 1080p HD video recording at 30fps The Raspberry Pi Camera

Board features a 5MP (2592×1944 pixels) Omni vision 5647 sensor in a fixed focus module. The module attaches to Raspberry Pi, by way of a 15 Pin Ribbon Cable, to the dedicated 15-pin MIPI Camera Serial Interface (CSI), which was designed especially for interfacing to camera.

Fig. Raspberry PI

B. Power Supply

To power a Raspberry Pi 3 Model B or Model B+, you should use a 5V 2.5A or higher power supply. This power supply should provide a stable 5V output to ensure the reliable operation of the Raspberry Pi. It's essential to choose a power supply with a micro-USB connector that fits the Raspberry Pi's power input. While the official recommendation is 2.5A, opting for a power supply with a slightly higher current rating, such as 3A, can be beneficial, especially if you plan to connect USB peripherals that draw power Using a power supply with a higher current rating provides a margin of safety and ensures your Raspberry Pi operates smoothly without power-related issues. You can find power supplies specifically designed for Raspberry Pi that meet these specifications, or if you have a power supply with a higher current rating that meets the voltage requirement, it should work well with the Raspberry Pi 3, provided it has a micro-USB connector or an adapter to fit the micro-USB port. Some Common Mistakes

Fig. Adaptor

Camera: - A 5-megapixel webcam is a type of webcam with a camera sensor that has a resolution of 5 megapixels. This means the camera is capable of capturing still images with 5 million pixels, which can provide relatively high-quality images and video compared to lower-resolution webcams. A 5-megapixel webcam can produce sharper and more detailed images, making it suitable for various applications, including video conferencing, streaming, and content creation. The higher resolution allows for clearer video and better performance in low-light conditions. It's particularly beneficial for scenarios where image quality is essential, such as online meetings, webinars, or recording videos for YouTube or other platforms. Additionally, a 5-megapixel webcam can be useful in situations where you might need to capture detailed documents, whiteboard content, or product demonstrations with clarity.

Fig. Camera

Alarm: - An alarm is a specialized device or system with the primary function of alerting individuals to specific events or conditions. Alarms are deployed in a multitude of contexts and serve various crucial purposes, including safety, security, and notification. They encompass a wide range of types, such as fire alarms, which detect and signal the presence of fires, and burglar alarms, designed to thwart unauthorized entry into homes or businesses. Car alarms deter theft and vandalism, while personal alarms offer portable safety by emitting loud sounds to attract attention during emergencies.

Fig. Alarm

Other forms include medical alarms for summoning aid in health crises, intrusion detection alarms to safeguard sensitive areas, and carbon monoxide alarms to warn of this deadly gas. These devices and systems play an indispensable role in enhancing safety, security, and situational awareness in both daily life and critical situations.

LCD Display (20x4): - A 20x4 LCD display is a commonly used alphanumeric liquid crystal display with the capability to show 20 characters in each of its four rows. These displays are widely employed in various electronic devices, particularly microcontroller-based projects, where providing textual information is essential. The "20x4" designation means that it can display 20 characters horizontally and 4 rows vertically. These displays are characterized by their simplicity and ease of use.

Fig. LCD Display (16x2)

They typically feature a parallel interface and are compatible with a variety of microcontrollers and development boards. Users can control the content displayed on the screen, allowing for real-time feedback or information presentation. 20x4 LCD displays are often employed in projects such as digital thermometers, clocks, and basic user interfaces in embedded systems. They offer a cost-effective means of adding text-based output to electronic projects and are a popular choice in the maker and electronics communities.

Wi-Fi :- Wi-Fi, short for "Wireless Fidelity," is a widely used technology that enables electronic devices like smartphones, laptops, and IoT devices to connect wirelessly to local area networks, providing internet access and facilitating communication with other devices on the network. Operating on various wireless standards such as 802.11n, 802.11ac, and 802.11ax, Wi-Fi can deliver different data speeds, with the two primary frequency bands being 2.4 GHz and 5 GHz.

Battery Parameters Sensing Sensors: -

1. Voltage Sensor: -

A voltage sensor is an electronic device used to measure and monitor electrical voltage within an electrical circuit. It serves a critical function in electronics, electrical engineering, and industrial automation, providing information about voltage levels, amplitudes, and waveforms. Voltage sensors come in various types, including analogy and digital sensors, as well as those designed for measuring alternating current (AC) or direct current (DC) voltage. Some sensors also offer electrical isolation, enhancing safety and reducing the risk of interference. They find applications in overvoltage and undervoltage protection, battery monitoring, industrial automation, electronic devices, and safety mechanisms. The accuracy and precision of voltage sensors are essential for reliable measurements, and calibration may be necessary to maintain accuracy. Output data from these sensors is typically used for monitoring or control, making them indispensable in ensuring the safety and proper operation of electrical and electronic systems.

Fig 3.2.7 Voltage Sensor

2. Current Sensor: -

The ACS712 current sensor is a versatile module used for measuring current, whether it's in the form of alternating current (AC) or direct current (DC). It relies on the Hall effect, which generates a voltage proportional to the current passing through a conductor when exposed to a magnetic field. ACS712 sensors come in different models with varying sensitivities and current ranges, allowing users to select the most suitable one for their specific applications. These sensors provide an analogy output voltage that corresponds to the measured current, which can be interfaced with microcontrollers or analog-to-digital converters. ACS712 sensors are commonly employed in a wide range of applications, including current monitoring in power systems, motor control, energy management, and various electronics and IoT projects. Calibration may be required to ensure precise measurements, aligning the output voltage with actual current values in the specific setup.

Fig. Current Sensor

Temperature Sensor: - The DHT11 is a widely used temperature and humidity sensor known for its cost-effectiveness and ease of use. It operates on a capacitive humidity measurement principle and a thermistor for temperature measurement, converting these values into a digital data stream that can be read by a microcontroller. The sensor typically offers temperature measurement in the range of 0°C to 50°C and humidity measurement between 20% and 80% RH with a moderate level of accuracy. With a 40-bit digital output, it can be seamlessly interfaced with microcontrollers like Arduino and Raspberry Pi, making it a popular choice for various applications. It finds uses in weather stations, home automation, greenhouse monitoring, and numerous DIY electronics projects where monitoring temperature and humidity is essential. However, for more demanding applications, sensors with higher accuracy and wider measurement ranges, such as the DHT22, may be preferred.

Fig 3.2.9 Temperature Sensor

CONCLUSION

Electric cars are becoming a more attractive option thanks to new technology and government support. They are better for the environment and more convenient to use, with features like solar power charging and smart systems to help drivers stay safe. In addition to these advances in electric vehicles, there are three key technologies that are changing the way we drive in general. First, drowsiness detection systems use cameras and AI to monitor drivers for signs of fatigue and warn them to take a break. This can help prevent accidents caused by tired drivers. Second, reverse parking assistant systems use sensors and cameras to help drivers park safely and easily, even in tight spaces. Finally, EV monitoring systems provide drivers with important information about their car's battery health and energy usage, which can help them optimize performance and extend battery life. These innovative technologies are making driving safer, easier, and more sustainable for everyone.

RESULT

Electric cars are becoming more popular because they're better for the environment and governments are offering incentives to buy them. New technology is making them even better, with features like longer lasting batteries, solar charging, and even systems to help drivers stay awake and park easier. These advances in electric car technology are making transportation safer, more convenient, and more sustainable for the future.

In addition to electric cars themselves, there are new technologies that are making driving better in general. Drowsiness detection systems can warn drivers if they're getting tired, and parking assistant systems can help you park in tight spots. Finally, monitoring systems for electric vehicles can track how the car is doing and help drivers get the most out of their battery. These technologies are making driving safer, easier, and better for the environment.

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