

IoT - based Hybrid EV Charging Station with Energy Analytics

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Abstract: - This paper discusses utilizing a solar panel to charge an E-vehicle module. The MPPT controller is used to track the maximum power output by the solar, and an IOT device is used to view the maximum power availability. Proteus software is used to create the simulation model. The Arduino UNO R3 is connected to the entire arrangement, and an LCD is used to show the battery level, generate, and distribute a quantity of battery.

When there is a power outage in the system, a GSM modem is used to get an alert message. The quantity of power supplied to the charging module, the charging station's available location, and the availability state of the charge are all shown on a webpage. This paper's primary goal is to cut back on fossil fuels and greenhouse gas emissions.

Keywords - Solar panel, DC-DC converter, Arduino UNO R3, Modem, Servo motor, Battery, MPPT controller.

INTRODUCTION:

Because of the increased need for traditional energy sources like coal, natural gas, and oil, researchers are compelled to explore non-conventional or renewable energy sources. Aside from the deregulation of gasoline and fossil fuel pricing, fuel costs have been the subject of much debate in the past few years. Additionally, the focus has shifted to alternative drive train technologies due to

these supply interruption issues. Electric vehicles were the first on the road in the 1800s. The first rudimentary electric carriage is introduced by British inventor Robert Anderson. William Morrison, a US chemist, was the first to successfully identify the possibility for alternative technologies in autos, such as electric vehicles. His six-person electric car has a top speed of 14 miles per hour, which is faster than the electric wage. There will be an increasing number of solar-electric vehicles in the coming year for the following reasons: (1) lowering fossil fuel emissions in order to extract electricity from renewable resources; (2) intelligently adhering to electronic regulations that make it easier to utilize IOT to monitor the availability of consumed power; and (3) tracking solar radiation over time. Passengers' perspectives are limited by electric vehicles, which draw power from rechargeable batteries. Hybrid electric vehicles (HEV), plug-in hybrid vehicles (PHEV), battery electric vehicles (BEV),

and extended range electric vehicles (EREV) are the three categories of electric vehicles. The primary goal of the paper is to supply power from solar PV cells to the charging station so that the car may be charged using a rechargeable battery. Additionally, the availability status of the charging station can be regularly monitored at any time with the aid of IOT.

FUNCTIONAL COMPONENTS:

Position Tracking Modelling:

A photovoltaic cell is a semiconductor device that collects energy whenever it comes into contact with sun radiation. The sun's angular position varies depending on the day, night, and climate. Monocrystalline silicon makes form a solar cell. Solar cells are delicate and extremely thin.

The module is surrounded by an aluminum frame that supports the structure and makes it easy to fix. A solar array, also known as a PV array, is made up of several solar cells connected together. Solar cells are joined to make a PV module (i.e., 36 cells connected in series). A PV array is a huge PV system made up of several solar panels that are electrically connected to one another. The connecting of mismatched solar cells will result in (i) losses as a result of the PV array. (ii) The module's temperature; (iii) the PV module's mode failure. The solar panel is automatically rotated in the direction of the sunshine using a servo motor that senses light using an LDR (Light Dependent Resistor). The path with the highest solar radiation is faced by the LDR sensor. Another name for an LDR is a photoresistor, which is a light-sensitive device. DR sensors are positioned on the solar panel's left and right sides. The servomotor rotates the solar panel. With the aid of the LDR sensor, the servomotor plays a significant part in tilting the solar panel. The electrical resistance of an LDR is dependent on how much light is falling.

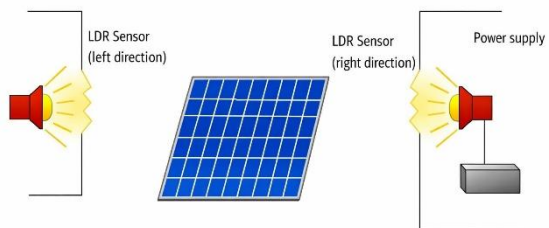


Figure 1: Solar tracking sensor.

Modelling of Arduino UNO R3 :

The Arduino UNO R3 is a microcontroller board built on the ATmega328 (datasheet). It features a 16 MHz crystal oscillator and 14 digital input/output pins. It features a reset button, an ICSP header, and a power jack. In Italian, the UNO stands for one. The reference version of Arduino that will be used going forward is UNO and version 1.0. The most recent in the line of USB Arduino boards is the Uno. Although the recommended input voltage is 7–12 volts, the functioning voltage is 5 volts. The Arduino board might become unstable if it provides less than 7 volts, and the voltage regulator might overheat and harm the board if it provides more than 12 volts. An ATmega328 is now used in Arduino devices. The Arduino UNO R3 has 32KB of flash memory, but only roughly 2KB of system RAM, 1KB of EEPROM, and a 16MHz clock

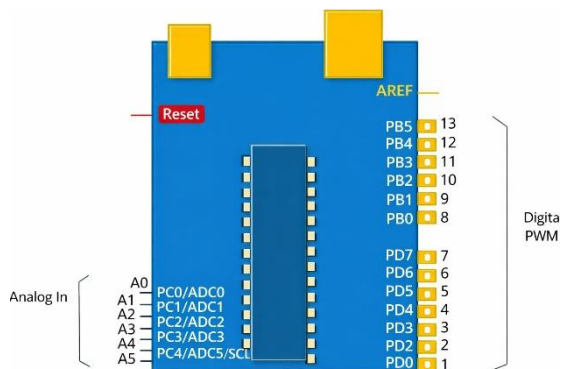


Figure 2: Arduino UNO R3

DC-DC CONVERTER MODELING:

An electromechanical device or electronic circuit that changes the voltage level of a direct current (DC) source is known as a dc-dc converter. It is a particular kind of electric power converter. From tiny batteries to high voltage power transmission, power levels vary from extremely low to extremely high. Even when the input voltage and output current change, a closed feedback loop keeps the voltage output constant.

Buck converters, boost converters, buck-boost converters, and SEPIC converters are four popular topologies.

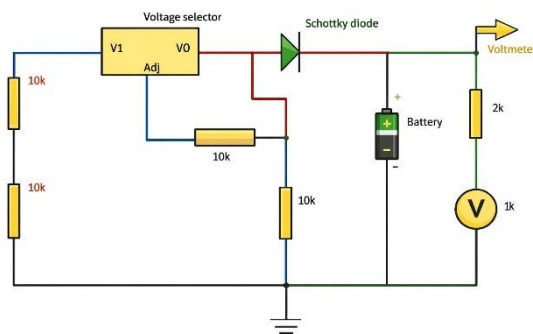


Figure 3: DC-DC converter.

Applying Kirchoff's law,

$$L (di_L/dt) + V_C = 0$$

$$i_0 + i_L = i_L$$

$$V_0 = V_C$$

$$i_0 = V_0/R$$

And,

$$i_C = C (dV_0/dt)$$

$$X_1 = -X_2/L$$

$$i_L = C (dV_C/dt) + V_0/R$$

$$X_2 = (X_2/C) - (X_2/RC)$$

The state equations are,

$$X = Ax + BV_s$$

$$V_0 = Cx$$

Transfer function,

$$V_0(s)/d(s) = (V_s/LC) / (s^2 + (1/RC)s + 1/LC)$$

Motor Drive Modelling:

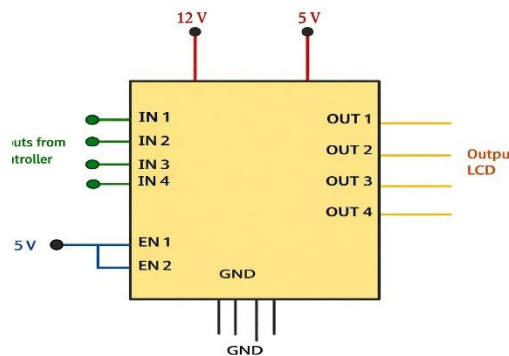


Figure 4: Motor drive-L293D

A motor drive is an amplifier which drives the function of the motor in either direction. The motor drives operation depends

upon the tracking position of the solar panel in either left or right direction. It also converts the low current signal from the circuit (solar panel) into a high current signal. Based on the angular position of the sun's radiation (or) maximum radiation absorbed from the solar panel. The motor drive initiates the speed of rotation. In addition to the functions, the overall output voltage can be controlled from maximum to minimum or vice versa with the help of potentiometer in order to satisfy the required charging capability. The function of the circuit is to convert the low current signal to the high current signal.

Battery Voltage Sensor:

In essence, a voltage sensor is used to determine the real voltage needed from the charging station and to help recharge a battery. In this case, it can detect both AC and DC voltage levels. The motor's variable resistor, which often raises or lowers the output voltage within the battery's capacity, can be used to alter the voltage perceived. The sensors respond to electrical or optical impulses with ease. Amplitude modulation, pulse width modulation, or frequency modulation outputs can be produced by certain voltage sensors, while sign or pulse trains can be produced by others.

Measurement Value = (Accuracy)
Current = 1mA ~ 1500A(+or- 1%)
Voltage = 6V ~ 18V(+or- 0.2%)
Temperature = -40°C ~ 105°C

Modelling of LCD:

The Liquid Crystal Display, or LCD for short, operates by blocking light instead of emitting it. One of its special advantages is that it uses less power than LEDs (light-emitting diodes). Light is projected from a lens onto a layer of liquid crystal, and it is made up of multiple layers, including two polarized panel filters and electrodes. The colored image is created by combining colored light with the grayscale image of the crystal, which is framed when an electric current travels through it. The applied current should regulate the image on the screen and LCD. It is necessary to use polarized light. It should be possible for liquid crystal to regulate both the transmission and the polarization of light. As a result, the battery voltage and the sensed signal are shown on the liquid crystal screen.

The Regulator's Description:

The MCP1612 is a fully integrated, 1A, 1.4MHz synchronous buck regulator with current mode control. The 8-pin MSOP and space-saving 3X3 DFN packaging contain the MCP1612. For applications requiring high power and high ambient temperatures, the DFN package also offers a low thermal resistance package option. An external resistive divider makes it simple to adjust the MCP1612's output voltage between 0.8 and 5.0 volts. They work with electrolytic output capacitors made of ceramic, tantalum, or

aluminum. The output ripple voltage can be kept low by using ceramic capacitors with values as low as 4.7uF. The output capacitor's value can be raised to 47uF for applications that need improved load step performance. The MCP1612 also has soft start, UVLO, overcurrent and overtemperature protection, and sudden capability.

IoT device modelling:

IOT, which connects electronic and computer equipment, has proven beneficial in every industry. It can transfer data or communicate over a network without the need for any interfaces. IOT is currently used as a tool to improve real-world utilization through wireless connection. It enhances time-space communication by offering an optimum outcome and giving the user a real-time experience. IoT offers an efficient user interface software to prevent flaws and blind spots that could compromise the system's correctness. Modern technology enhances and refines consumer interaction, enhances product functionality, and supports the rapid advancement of automation technology. It offers trustworthy data with demanding functionality that allows multiple users to interact and use it simultaneously. While IoT provides actual information that creates a secure and ideal environment for resource collection, existing data analytics only provides an external insight

Design for charging Model:

Working of Module:

Since a solar PV array is essential to a project, the model only employs torches with LDR sensors to detect the source's position in order to generate electricity and support the ongoing flow of energy. Given that the sun's tilting angle ranges from 0 to 180 degrees, two sensors—one on the left and one on the right—should be constructed for each direction. The PV cell's gathered electric source is then sent to the converter together with the buck regulator, which stabilizes the power. The complete DC-DC converter configuration preserves the cell's output dependability and should unbiased output when it surpasses the anticipated outcome to prevent a hysteresis loss. In order for the converter's output voltage to meet the power supply needed for the module, the DC-DC converter first accepts the DC input voltage and provides an output as DC voltage at the next level, either lower or higher depending on the requirement. The switch in the basic DC-DC converter circuit can be used to control the connection and disconnection from the supply to the load.

It gives the battery a DC-regulated power supply. The MCP1612 is a 1A synchronous buck regulator that offers overcurrent protection in the case of a brief load as well as quick reaction to abrupt load changes prior to passing to the converter. The output may be adjusted by correctly establishing an external resistor divider and running a range from 0.8V to VIN, while the input voltage range is 2.7 to

5.5V. The switching clock frequency is set to 1.4 MHz.

To reduce the complexity of the process, the regulated constant voltage is sent to an Arduino analog input. The meter need to assist in keeping an eye on the steady voltage. Twenty digital inputs and six analog inputs are available on the Arduino UNO R3 microcontroller board.

It can be loaded with the following simple Arduino computer software to track, deliver, and display the necessary power output supply. R3 is the most recent version of Arduino, and it has a large support community, making it a very simple method to get started with electronic equipment. Conversely, as an input, a battery voltage sensor and motor drives operate efficiently to eliminate overload or supply interruption issues.

The battery voltage sensor is made up of a potentiometer that connects two points to an electric circuit to produce a physical signal proportional to the voltage that is subsequently received as a digital input by the Arduino. The voltage across the battery is posted as the reference value to the sensor, and these battery management components measure the charge or discharge current passing through the battery.

The potentiometer is configured to grow as the predicted output when the sensor predicts a lower output; it can also be minimized based on the increase in that output. In addition to indicating the movement of charges through the circuit, the motor's direction changes in response to the torches' switching positions in relation to the LDR sensor. The motor seems to rotate counterclockwise if the torch is held in the left direction, and vice versa. The L293 driver makes it simple to sustain the LDR sensor in either direction by driving two motors at once. Maintaining the LDR sensor's two orientations is simple. Because of its automated thermal shutdown feature, the chip will shut off if it becomes too hot.

Every time the electrical circuit operates, the LCD displays the actual output from the Arduino. The most often used LCD that interfaces with different microcontrollers (either 8-bit or 16-bit) is the LM016L. Certain elements of the Arduino software contribute to the new battery voltage's frequent and clear results.

The LCD should show the battery voltage, the tilt position (left or right), and whether the motor is turned on or off. Prior to being used for display purposes, the LCD is initialized by both an internal reset circuit and a set of commands.

Acronyms and Abbreviation:

IoT	-	Internet of Thing	iL	-	current through inductor
DC	-	Direct current	t	-	time
AC	-	Alternating current	VC	-	voltage across capacitor
MPPT	-	Maximum Power Point Tracking	i0	-	initial current
LCD	-	Liquid Crystal Display	V0	-	initial voltage
LDR	-	Light Dependent Resistance	R	-	Resistance
PV	-	Photovoltaic	C	-	Capacitance
L	-	Inductance	X1	-	reactance 1
			X2	-	reactance 2



Figure 5: Block diagram of charging module

SIMULINK MODEL FOR THE PROPOSED CHARGING STATION SYSTEM FOR EVs OR CHARGING MODULE

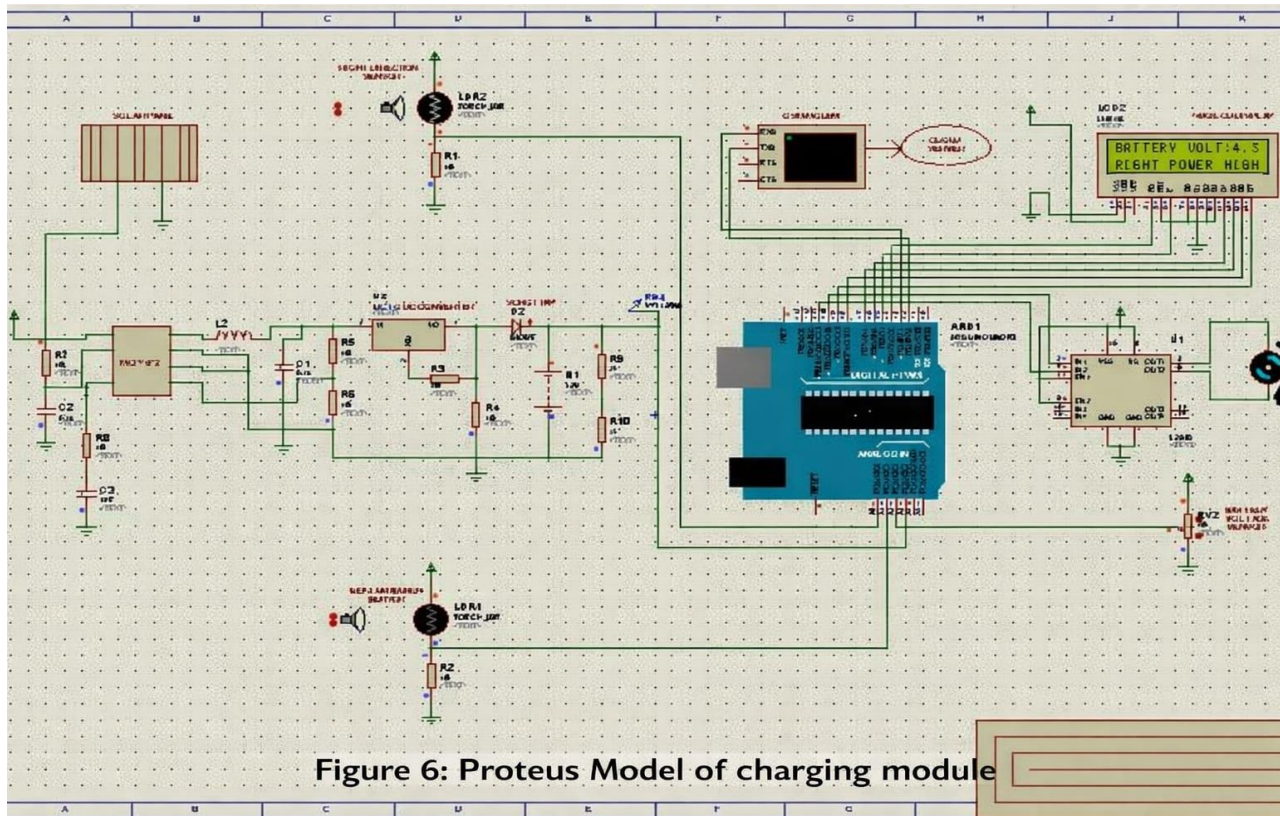


Figure 6: Proteus Model of charging module

BATTERY VOLTAGE GRAPH

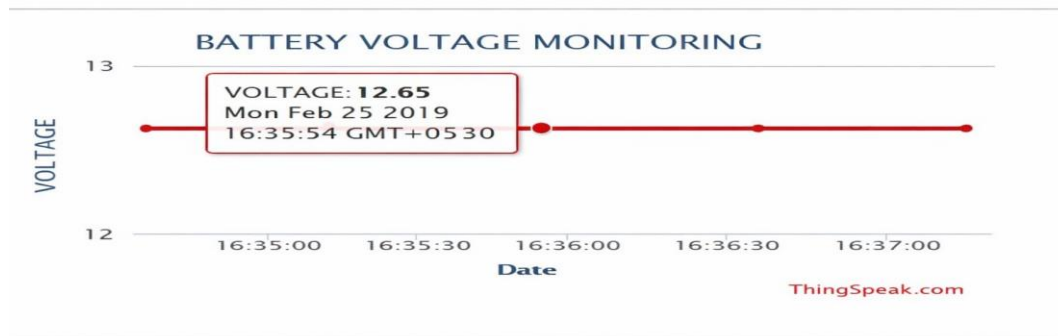


Figure 7 : Capacity of battery with time in the webpage

RESULT AND DISCUSSION:

This study focuses on using the Internet of Things to educate vehicle users about the availability of charging stations via a webpage. The webpage was created using the standard HTML technique to make the content easy to understand and utilize. The website might take into account the battery voltage and time graph as well as the charging station location tracking, which is comparable to a Google map. The user can gather the necessary information about battery charge details via an IoT-designed webpage. To load data using a URL address, all you need is a browser and a 24/7 network. Information such as battery voltage capacity, charging duration, and associated location is updated on a regular basis. These are open source data, and anyone with a secure internet connection can use the link address to check the status of this webpage.

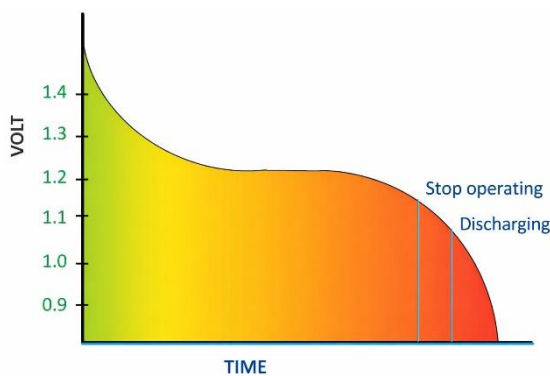


Figure 8: Continuous operation

CONCLUSION:

As an energy storage management system, an Internet of Things (IoT)-based battery sensor keeps track on the battery's condition in real time. For management purposes, the IoT created here makes use of a cloud platform. The user of the car can observe the battery voltage drain from the system and just check the destination to reach the charging station. The Arduino's data can endure till the battery runs out of power. Multiple users for the e-vehicle that settles the station are kept and updated in the database for future use so that the distribution to the various users may be tracked.

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