Development of a Smart Portable IoT Enabled Electric Vehicle Charging Station

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Abstract

For electric vehicles, traveling range and charging infrastructure are the two major issues affecting its adoption over conventional vehicles. To overcome the issue its important to provide charging options at multiple places. But due to high initial investment and infrastructure needs it is difficult to provide multiple charging stations. Here low cost and compact EV charging station will help to establish EV utilization. In this system, current sensor and voltage sensor are used to measure the power delivered to charge the vehicle. Both sensors will send signal to microcontroller. Microcontroller will calculate and measure the billing amount and display it. With the keypad and display user can set charging time or billing amount. Once the set value crosses, microcontroller will switch off the supply using cut off device. Microcontroller will send values and alert to the webpage through Wi-Fi module. Buzzer is used to provide audio signal. Power supply will provide the required power to every circuit element. Proposed system will provide 230V AC output for EV charging with power meter. This makes proposed system compatible with every vehicle charger so that every vehicle can be charged.

Keywords: *Electric Vehicle, Vehicle Charging, Billing Method, Trasportation*

1. INTRODUCTION

To satisfy the fuel need for petroleum vehicles become costly day by day. To solve this problem, use of electric vehicle is the best solutionE lectric vehicles are the best alternative for transportation to minimize use of petroleum products & reduction in pollution levels caused due to resources used presently. Government pushing people and researchers towards electric vehicles. Though charging mechanism and billing methods are still in the development phase. So now a day's world is shifting towards electrified mobility to reduce the pollutant emissions caused by nonrenewable fossil fueled vehicles and to provide the alternative to pricey fuel for transportation. In this project, a cost effective and compact system will be design which will work as an portable charging station to providealternative for conventional EV charging stations. This system will allow small shop owners to start the EV charging station. This will help to increase the number of charging stations. Also with solar power, it will reduce thedependency of AC supply from conventional grid Be available along roadside for EV charging. This will help to use EVs for long distance.

2. MODULES AND DESCRIPTION

2.1 Arduino UNO

The Arduino UNO is a popular microcontroller board based on The ATmega328. It has several features that make it versatile and easy to use.

It has 14 digital input/output (I/O) pins that can be used to connect and control various external devices. It has a dedicated ICSP header, which stands for In-Circuit Serial Programming. This allows for programming the microcontroller using an external programmer. It has a power jack that can be used to power the board using an external power source. It has a USB port which can be used to connect the board to a computer for programming and communication.

Figure 1: Arduino UNO

When connected to a computer, the Arduino UNO can be programmed using the Arduino IDE (Integrated Development Environment). This allows users to write code to control the board and interact with external devices. When connected to a computer, the Arduino UNO can be programmed using the Arduino IDE (Integrated Development Environment). This allows users to write code to control the board and interact with external devices.

2.2 Temperature Sensor

The LM35 is a precise temperature sensor with an analog output voltage that changes in response to temperature variations. As depicted in Figure 2, the sensor does not necessitate any additional circuitry for operation. With a sensitivity of 10 mV per degree Celsius, the output voltage of the LM35 rises along with temperature increments.

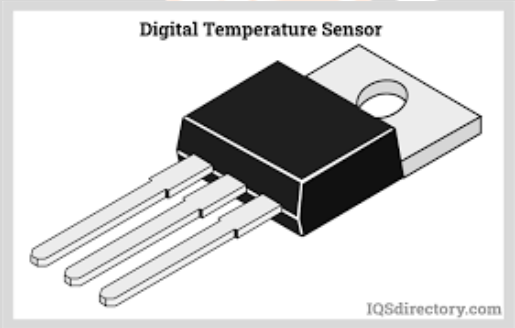

Figure 2: Temperature Sensor

Featuring three terminals - a positive voltage terminal, a negative voltage terminal, and a data output terminal - this sensor offers a broad temperature sensing range from -55°C to +150°C. Its ability to provide accurate temperature readings outshines that of a typical thermistor.

2.3 WiFi Module

The ESP8266 Wi-Fi module is a self-contained soc with integrated TCP/IP protocol stack that can give any microcontroller access to your Wi-Fi network. The esp8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor. Each esp8266 module comes pre-programmed with an at command set firmware, meaning, you can simply hook this up to your Arduino device and get about as much Wi-Fi-ability as a Wi-Fi shield offers (and that's just out of the box) The ESP8266 module is an extremely cost effective board with a huge, and ever growing, community. This module has a powerful enough on-board processing and storage capability that allows it to be integrated with the sensors and other application specific devices through its gpios with minimal development up-front and minimal loading during runtime. Its high degree of on-chip integration allows for minimal external circuitry, including the front-end module, is designed to occupy minimal PCB area.

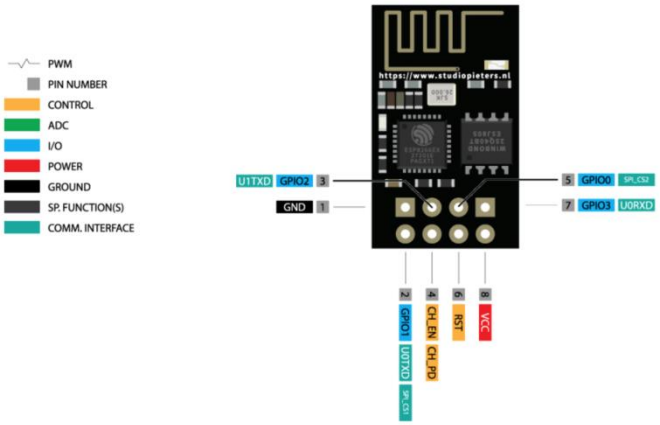

Figure 3: WiFi Module

2.4 Relay

It is the electrical operated switch. All relays use an electromagnet to mechanically operate a switch, but other operating ideologies are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a low power signal or where several circuits must be controlled by one signal. The first relays were used as long distance telegraph circuits as amplifiers, they repeated the signal coming in from one circuit and re-transmitted it on another circuit. Relays were used widely in telephone exchanges and early computers to perform logical operations. A type of relay that can handle the high power required to directly control an electric motor or other loads is labeled as a contact. Solid-state relays control power circuits with no moving parts, instead using a semiconductor device to perform switching. Relays with calibrated operating characteristics and sometimes multiple operating coils are used to protect electrical circuits from overload or faults in modern electric power systems these functions are done by digital instruments still called protective relays. In relays there have two operation part i.e. No and nc contact which is normally open and normally closed.

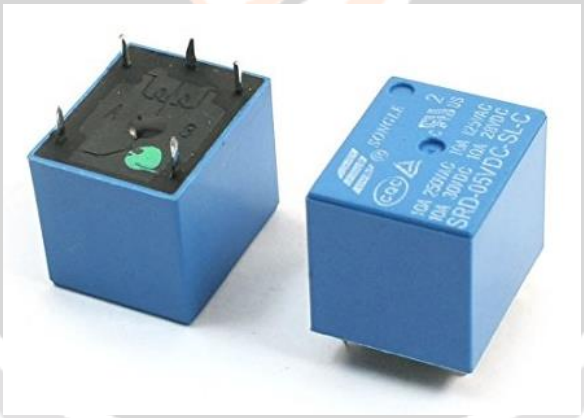

Figure 4:Relay

3. Proposed System

A proposed system for will measure the power delivered to control and measure the output power for vehicle charging. The keypad is used to accept input from a user. This input entered is sensed by microcontroller and shown on LCD. Buzer is used to provide a sound indication on key press. To measure the power delivered a voltage measurement block and current sensor are used. Microcontroller calculate the power delivered and give a signal to the cutoff device to disconnect or connect the power at output.

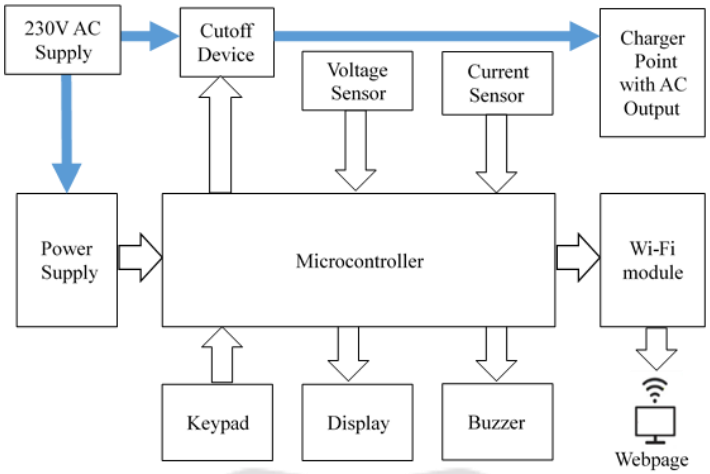

Figure 4:Architecture of System

Circuit Diagram

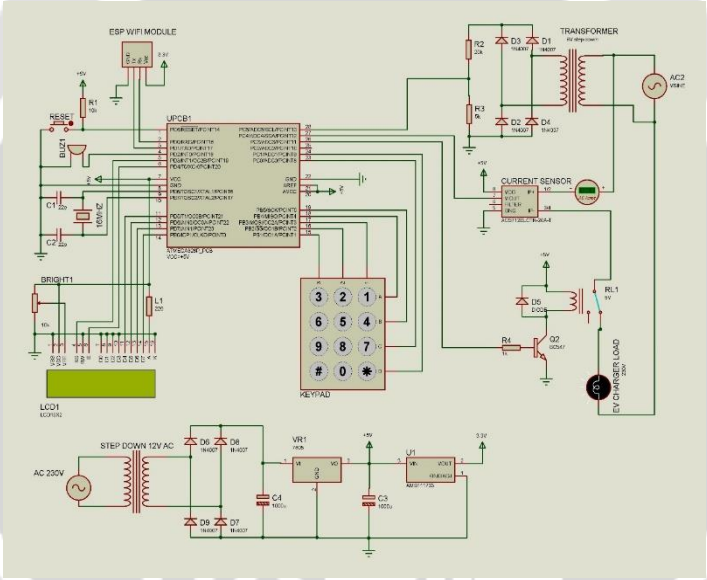

Figure 5 : Circuit Diagram of System

Hardware Implementation

This Project present an Cost Effective and system which will work on as an solar and AC supply portable charging station to provide alternative for conventional EV Charging station.

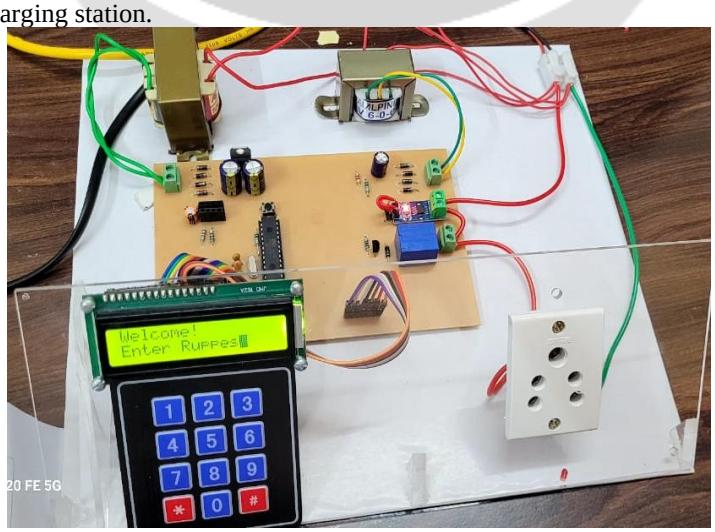

Figure 6: Hardware model of System

System Final Specification

- Output supply available at charging plug: 230V, AC
- Current sensor used for metering: ACS712, Hall effect type, 5Amp capacity
- Supply control switch: Relay with capacity of 230V, 7Amp
- Maximum Allowed Load Current: 7Amp
- Controller Used: ATmega328
- Output on 16x2 LCD display
- Audio alert type: Single tone piezo buzzer
- Communication Features: Thingspeak Server
- Working temperature range: 0 to 70 ℃

4. LITERATURE SURVEY

After the environmental crisis, Electric Vehicles (EV) are the best alternative of the Internal Combustion Engine (ICE) vehicle. But focusing only on EV is not only sufficient as an Electrical Vehicle Charging Station (EVCS) is equally important for deploying these vehicles. Since these vehicles are electrically powered there are certain challenges in installing these charging stations. Former major problem is grid overloading and load forecasting. Latter is charging time and traffic-crowd management at charging stations. This paper reviews about the basic terminologies of charging station like charging station types, levels. To overcome these challenges, various technologies are discussed along with brief introduction of lithium ion batteries charging strategies and Battery Management System (BMS). Since, Indian Government is concentrating towards environmental friendly ecosystem and as per its mission to reduce carbon emission from the transport sector, deployment of EV's and installation of EVCS is the biggest concern. Since, government has reduced the tax on EV's and providing subsidy for installing charging station, this is an easy task. Hence, in this paper certain guidelines by the Ministry of Power and Ministry of Housing (Government of India) is discussed which can help an individual to set up a charging station at their end [2].This paper states that the grid integration of plug-in electric vehicles (PEVs) requires a comprehensive analysis and effective control strategies to prevent any violation of the electrical constraints of the power systems. When renewable energy sources (RESs) are available, they can be used to supply the energy demand of the PEVs. In this study, a photovoltaic (PV) power plant and IoT based remote control of PEV charging are proposed as a virtual power plant (VPP). Particularly, the concept for the use of LoRaWAN to remotely monitor and control the PEV charging loads is presented. Moreover, a hierarchical VPP control (VPPC) system based on the model predictive control (MPC) method is proposed for the optimal energy management (EM) of the VPP. The EM of the VPP is scheduled based on the predicted information initially and based on the optimal values for the EM and the intermittency of PV generation, the charging rate of the PEVs is modified during the real-time process. The results of the case studies show that the proposed VPPC can minimize the energy costs to the VPP and satisfy the energy balancing for the VPP entities while fulfilling the charging demand of the PEVs under system uncertainties [3]. An Android mobile app was developed to access the vehicle's data. This app communicates with the wireless sensor nodes of an intra-vehicular wireless sensor network (IVWSN), which was developed using the Bluetooth Low Energy (BLE) protocol. A real-time notification system was also implemented to alert users about certain events, such as low battery and full battery charge. The main features of the proposed IoT system are validated through experimental results [4]. In this paper states the battery chargers are the energy transmission part of electric vehicles between the grid (or electric energy source) and the vehicle. This energy transmission process has a great effect on the technology of electric vehicles. Charging a vehicle as fast as possible is necessary for an electric vehicle to compete with the internal combustion engine vehicles. Technology has been dealing with this process in past, while charging a car took a few hours, this time is reducing day after day. In this paper aims to give some information about the current technologies of chargers (only the chargers with cable not wireless chargers) and it also aims to design a trial Simulink model for chargers. When the literature is considered, simulation samples of chargers are little so increasing these samples is important to improve the technology of fast charging [9].

5. EXPERIMENTAL ANALYSIS

The developed technology was rigorously tested on individuals of all ages and under varying conditions. In the tests conducted, our system was able to accurately measure all sensor parameters, including heart rate, body temperature, ECG, and room temperature. In this particular example, the room temperature sensor was utilized to monitor humidity levels. To assess the performance of the system, error rates were calculated using the collected data to demonstrate our system's superiority and robustness.

We conducted extensive testing of the developed technology, encompassing individuals across diverse age groups and various environmental conditions. The robustness of our system was verified through the precise measurement of multiple sensor parameters, including heart rate, body temperature, ECG, and room temperature. Notably, the room temperature sensor was leveraged specifically for monitoring humidity levels in this particular instance. The comprehensive data collected from thesetests was utilized to calculate error rates, underscoring the exceptional performance and reliability of our system in real-world scenarios.

Algorithm 1

Step 1: Initialize LCD

Step 2: Wait for user input

Step 3: If the value is entered and cancel is pressed, go to step 2.

Step 4: If the value is entered and the ok is pressed, turn on the relay to supply power

Step 5: Upload parameters to webserver.

Step 6: Calculate power (VxI) delivered every second, multiply it with the billing rate, and update the bill amount on LCD

Step 7: If cancel is pressed, turn off the relay and display the total bill on LCD.

Step 8: If bill amount crosses the entered value turn off the relay and display the bill amount on LCD.

Step 9: Upload parameters to web server. And go to step 2.

6. SYSTEM FLOW CHART

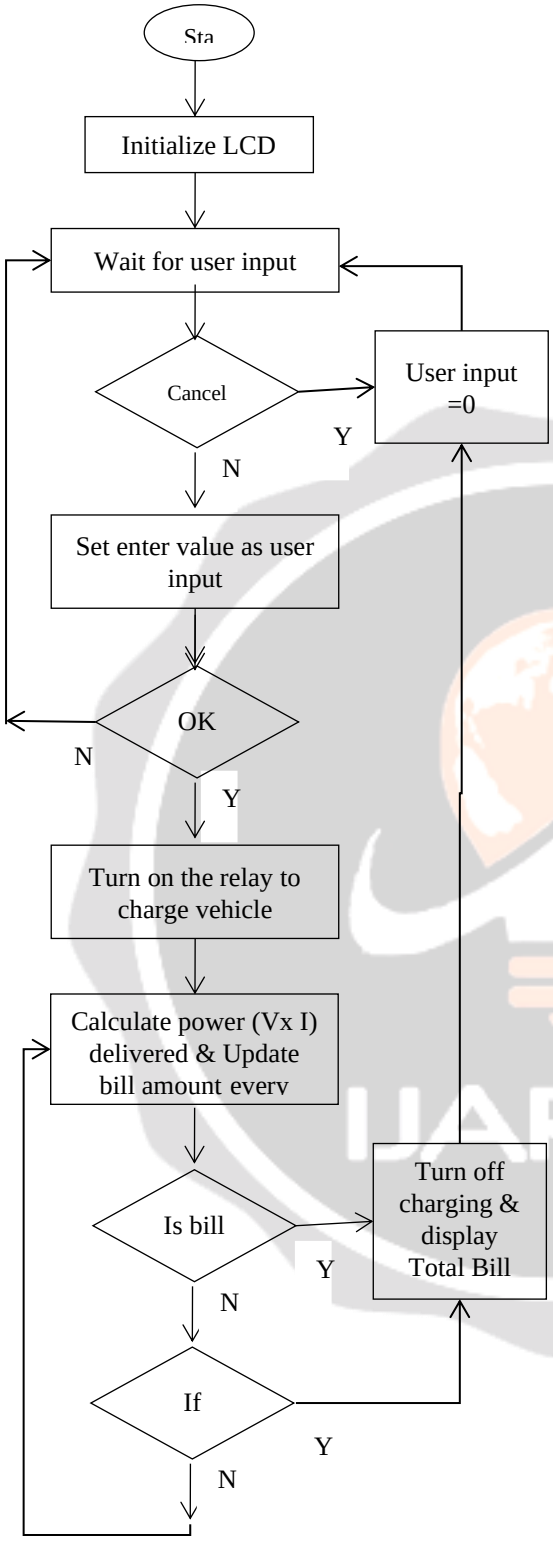

Figure 7: Flow Diagram

PCB Layout Design :

PCB Layout is conducting pattern of a circuit diagram or in other words the layout is a conducting lines between the various components on the PCB as per the circuit diagram and physical dimension (size of component, distance between lead of components etc.) of the components. The process of drawing the rough layout on the paper is called 'Art working'. The artwork can also be prepared on transparent paper with the self-adhesive tapes and pads are available in different ranges or dimensions in mm.

PCB Making :

Process of screen printing is suitable for large scale production. This process uses resist ink applied through a stencil or mask to the surface of blank circuit board. The stencil is produced and attached to a fine mesh, metal, nylon, polyester or silk screen. The resist ink is forced through openings in the stencil onto the surface of the blank board. This process produces positive of the copper foil. When it dries, the board is ready for etching. Here screen printing method is used for transforming layout on Copper clad. In this method PCB printout is placed on copper clad and heat is applied so that ink from printout melts and transfer on copper

Screen Printing :

Once the data is collected by the sensor, it is transmitted to the Arduino UNO microcontroller. The Arduino serves as the processing unit that receives and handles the incoming pulse data.

7. RESULTS

This project presents, a cost effective and compact system which will work as a solar and AC supply portable charging station to provide alternative for conventional EV charging stations

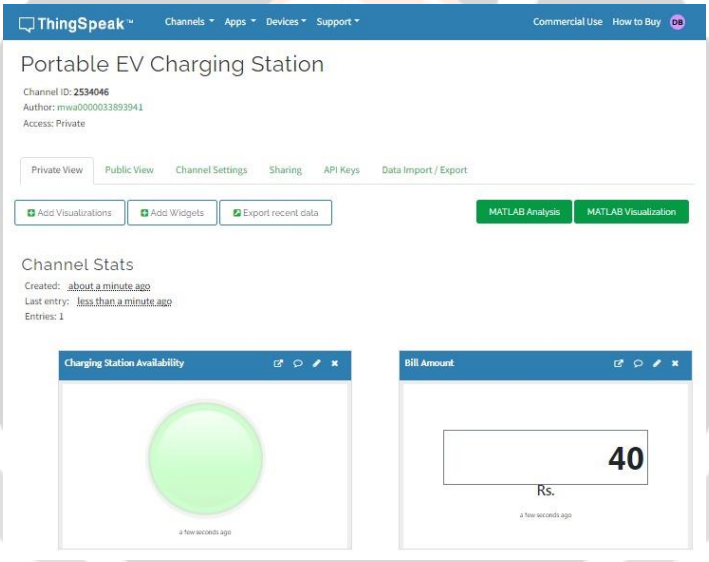

Figure 8: Webpage Screenshot

8. CONCLUSION

The electric vehicle revolution changed the transportation industry. It reduces the dependency on petroleum vehicles and also helps to minimize pollution. But due low availability of EV charging station infrastructure EV has the limited traveling range. So solve this issue, portable EV charging station is the best solution.

Proposed device will provide low cost setup as alternative to conventional EV charging stations. This will make EV charging stations affordable and help to increase the number of charging stations along roadside. This will ultimately result in long distance use of EVs. In this phase of project, we have studied all theground situation and designed the system according.

9. FUTURE SCOPE

Though design system fulfills all the defined objectives, there is always scope to advancement in future. Since improvement is endless process, in future, system can also be integrated with other natural resources of energy like windmill. This will help to run systems on natural energy throughout the day.

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