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IoT Based EV Charger Using Arduino UNO

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ABSTRACT: Electric vehicle supply equipment (EVSE) is the basic unit of EV charging infrastructure. The EVSE accesses power from the local electricity supply and utilizes a control system and wired connection to safely charge EVs. An EVSE control system enables various functions such as user authentication, authorization for charging, information recording and exchange for network management, and data privacy and security. It is recommended to use EVSEs with at least basic control and management functions, for all charging purposes.

In this project, we apply the Internet of Things (IoT) model to managing electric vehicle (EV) charging in shared spaces, such as condominiums. The mobile application manages the user authentication mechanism to initiate the electric vehicle charging process, where a sensor is used to measure the current and based on the microcontroller, the device establishes communication data with the mobile application. A user interface has been developed to visualize the process happening, show the various sensor data to the user and send alerts.

KEYWORDS: Energy efficient algorithm; Manets; total transmission energy; maximum number of hops; network lifetime

I. INTRODUCTION

Electric vehicles are recharged by electricity. Whether you already drive an electric vehicle (EV) or are thinking of getting one, charging plays a critical role in driving an EV.

With the mass adoption of electric vehicles (EV's) on the horizon, the importance of smart electric vehicle charging will become essential for both the charging point network operators, and the National electricity grid

One of the major challenges when entering the electric vehicle (EV) market is the charging process, where the main problems are related to the lack of proper infrastructure in residential (apartment) buildings due to their unpreparedness for this new reality. The apartment has a shared electricity problem, which does not meet the requirements of EV owners. Based on new advances in the Internet of Things (IoT) and related sensors and communication platforms, systems have the potential to create new solutions to these problems. Another aspect of this challenge is related to rental housing and the possibility of needing electric vehicle charging assistance in these circumstances. In condominiums, unfortunately, there is a general reluctance to install EV charging stations, which will only be used by a few owners.

In addition, there is also an issue related to the safety of the electrical systems, as they are not actively built to support EV charging stations, and the adjustment of the electrical infrastructure of the apartment will not only requires consensus among a majority of owners, which can be difficult, but can also be difficult to obtain, from government building safety authorities. Considering the fact that most residential buildings have common spaces with shared electrical installations and are not prepared for the installation of new EV charging systems, this is a barrier to adoption. A study identified four key problem areas in the context of charging infrastructure unavailable, building boundaries, regulatory issues, and availability of the parking lot.

II. PROBLEM STATEMENT

This project has been developed within the context of a time where EVs sales have skyrocketed. The government is also pushing hard for encouraging people to choose EVs over conventional vehicles. But one of the major challenges with electric vehicle (EV) is the charging process, where the main problems are related to the lack of proper infrastructure in residential (apartment) buildings, streets and alongside roads due to their unpreparedness for this new reality. Also, different EVs have different power plugs as they have different input current ratings while most of them operate at 230VAC.

Such hurdles related to charging discourage people from buying EVs and limit the overall usage, range and reliability of EVs. These drawbacks of EVs can be easily reduced by introducing IoT based EV chargers which have universal power plug support along with smart payment and monitoring method, which can be installed at every possible location to facilitate ease of access to charging.

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III. LITERATURE SURVEY

●NITI Ayog website for reference of EV technology and current scenario.
https://e-amrit.niti.gov.in/home

- YoCharge.com for reference of charging types and connectors.

https://yocharge.com/different-types-of-ev-charging-connectors-in-india/

- Evstreetcharge.com for similar implementation of charging units.

https://www.evstreetcharge.co.uk/

- "Design of an IoT-based Smart EV Charger using ESP32 and MQTT Protocol" by A. Kumar et al. (2019) This paper proposes a smart EV charger system that employs ESP32 and the MQTT protocol for communication. It discusses the architecture, implementation, and integration of sensors, along with the MQTT-based communication between the charger and a remote server. The study highlights the benefits of real-time data monitoring and control.

- "Secure IoT-enabled Electric Vehicle Charging Infrastructure" by B. Nain et al. (2020) This research focuses on the security aspects of IoT-enabled EV charging infrastructure. It discusses potential security vulnerabilities and proposes a secure framework using the ESP32 module. The study emphasizes authentication, encryption, and secure communication protocols to protect the charging system from unauthorized access or malicious activities.

- "Energy Management System for IoT-Based Electric Vehicle Charging Stations" by M. Sharma et al. (2021) This study presents an energy management system for IoT-based EV charging stations. It explores the integration of renewable energy sources and battery storage systems for efficient utilization of energy. The paper highlights the role of ESP32 in collecting and analyzing data to optimize charging operations and manage energy resources effectively.

- "IoT-Based Electric Vehicle Charging Infrastructure: A Comprehensive Review" by S. Gupta et al. (2022) This comprehensive review paper surveys various aspects of IoT-based EV charging infrastructure. It discusses different communication protocols, hardware platforms, and system architectures. The study provides an overview of the challenges, opportunities, and future directions in the field of IoT-based EC charging, including the utilization of ESP32 in charger systems.

IV. BLOCK DIAGRAM

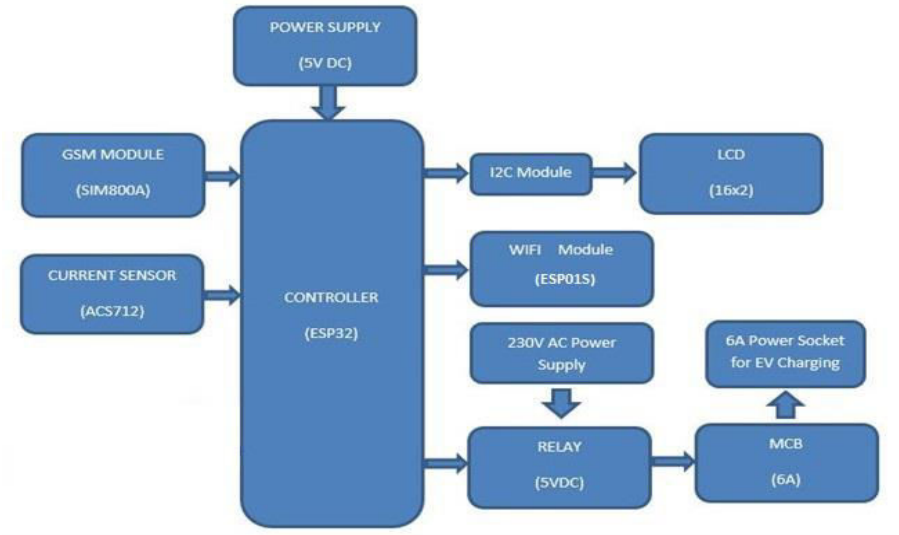

Fig. 1 Block Diagram

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V. FLOW CHART

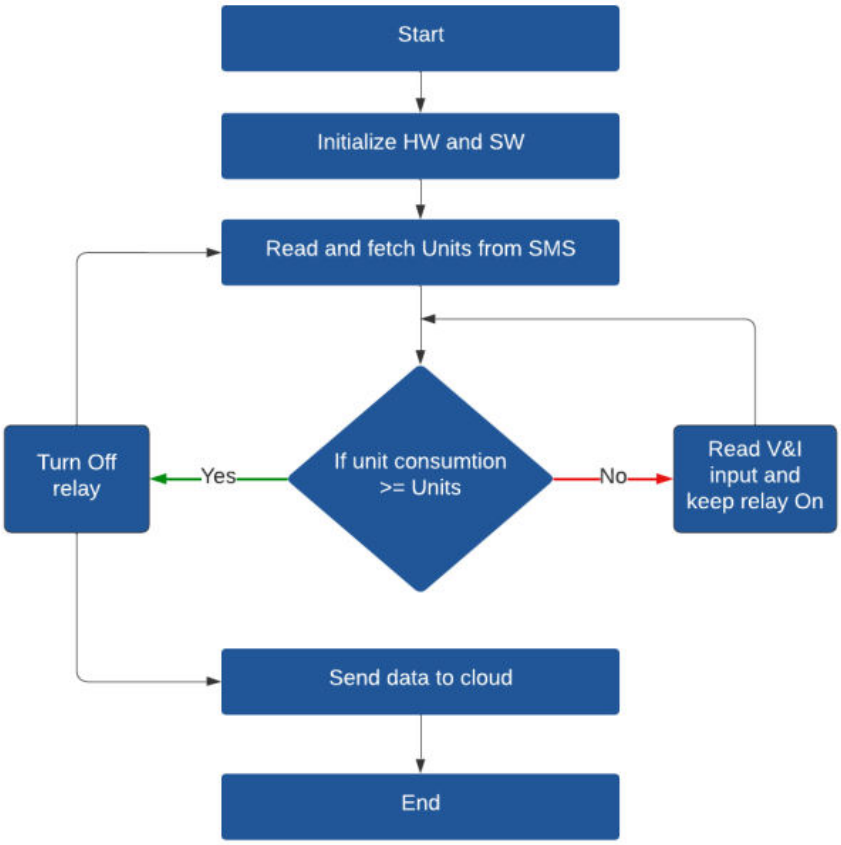

Fig. 2 Flow Chart

VI. HARDWARE DESCRIPTION

1) *Arduino Uno*

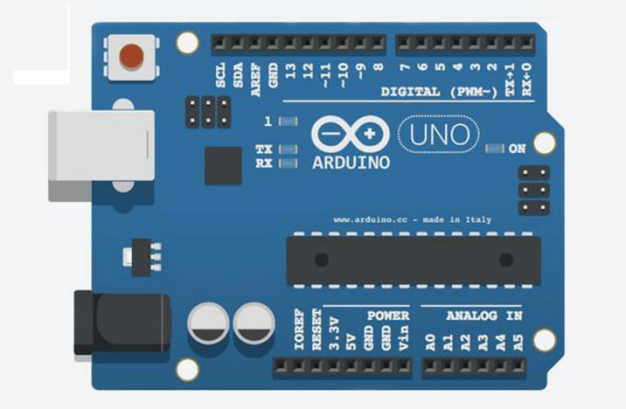

Fig. 3 Arduino Uno IoT Board

Arduino Uno is a microcontroller board based on the ATmega328P (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator (CSTCE16M0V53-R0), a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to

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get started. You can tinker with your Uno without worrying too much about doing something wrong, worst-case scenario you can replace the chip for a few dollars and start over again.

"Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform; for an extensive list of current, past or outdated boards see the Arduino index of boards.

2) ACS712 Current Sensor

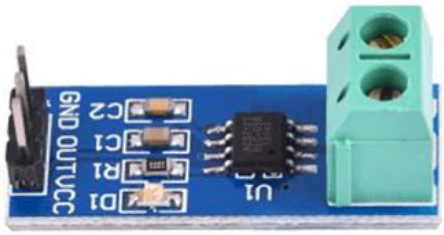

Fig. 4 ACS712 Current Sensor

The ACS712 is a fully integrated, hall effect-based linear current sensor with 2.1kVRMS voltage isolation and a integrated low-resistance current conductor. Simply put forth as a current sensor that uses its conductor to calculate and measure the amount of current applied.

The ACS712 IC being able to detect both AC/DC current, it can be used in a wider range of applications apart from electrical appliances. Be it Arduino/other microcontroller usages, or industrial, commercial, and communication applications, it can be found applicable.

Current flows through the onboard hall sensor circuit in its IC. The hall effect sensor detects the incoming current through its magnetic field generation. Once detected, the hall effect sensor generates a voltage proportional to its magnetic field that's then used to measure the amount of current.

3) 16x2 LCD Display with I2C Board

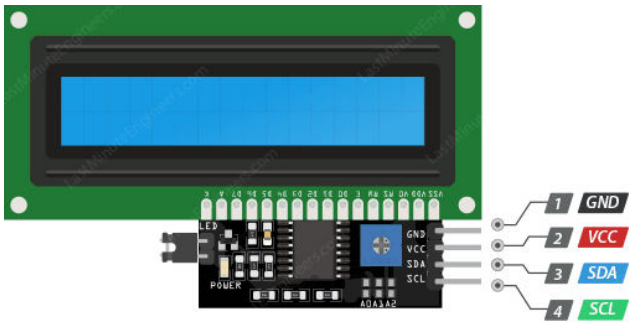

Fig. 5 16x2 LCD Display with I2C Board

This is LCD1602 Parallel LCD display that provides a simple and cost-effective solution for adding a 16x2 Liquid Crystal Display into a project. The display is 16 characters by 2 lines display has a very clear and high contrast.I2C Module is a parallel to serial converter compatible with LCD2004 and LCD1602. By using this module, LCD can be interfaced with using only 2 wires. LCD displays take 8 pins so sometimes user can get out of resources, mostly using All type of development boards, but this device helps to save the resources as it takes only 4 pins.

The I2C protocol involves using two lines to send and receive data: a serial clock pin (SCL) that the Arduino Master board pulses at a regular interval, and a serial data pin (SDA) over which data is sent between the two devices. As the clock line changes from low to high (known as the rising edge of the clock pulse), a single bit of information – that will form in sequence the address of a specific device and a command or data – is transferred from the board to the I2C device over the SDA line. When this information is sent – bit after bit -, the called upon device executes the request

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and transmits its data back – if required – to the board over the same line using the clock signal still generated by the Master on SCL as timing.

4) SIM800A GSM Module

Fig. 6 SIM800A GSM Module

The SIM800A Quad-Band GSM/GPRS Module with RS232 Interface is a complete Quad-band GSM/GPRS solution in an LGA (Land grid array) type which can be embedded in the customer applications. SIM800A support Quad-band 850/900/1800/1900 MHz, it can transmit Voice, SMS and data information with low power consumption.

With a tiny size, it can fit into slim and compact demands of custom design. Featuring and Embedded AT, it allows total cost savings and fast time-to-market for customer applications.

The SIM800A modem has a SIM800A GSM chip and RS232 interface while enables easy connection with the computer or laptop using the USB to the Serial connector or to the micro-controller using the RS232 to TTL converter.

5) ESP-01S Wi-Fi Module

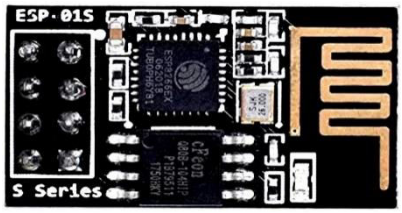

Fig. 7 ESP-01S Wi-Fi Module

The ESP-01S 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 ESP-01S 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 ESP-01S 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. The ESP8266 supports APSD for VoIP applications and Bluetooth co-existence interfaces, it contains a self-calibrated RF allowing it to work under all operating conditions and requires no external RF parts.

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6) 5V Relay Module

Fig. 8 5V Relay Module

This is 1 Channel 5V Relay Board Module for Arduino PIC AVR DSP ARM. A wide range of microcontrollers such as Arduino, AVR, PIC, ARM and so on can control it.

Each one needs 15mA - 20mA driver current and equipped with high current relay: DC 5V / 10A, AC 250V / 10A. Standard interface that can be compatible with microcontroller.

VII. SOFTWARE DESCRIPTION

1) Arduino IDE

Fig. 9 Arduino IDE

Arduino IDE is an open-source software program that allows users to write and upload code within a real-time work environment. As this code will thereafter be stored within the cloud, it is often utilized by those who have been searching for an extra level of redundancy. The system is fully compatible with any Arduino software board.

Arduino IDE can be implemented within Windows (11, 10, 8.1, 8, 7), Mac and Linux operating systems. The majority of its components are written in JavaScript for easy editing and compiling. While its primary intention is based around writing codes, there are several other features worth noting. It has been equipped with a means to easily share any details with other project stakeholders. Users can modify internal layouts and schematics when required. There are in-depth help guides which will prove useful during the initial installation process. Tutorials are likewise available for those who might not have a substantial amount of experience with the Arduino framework.

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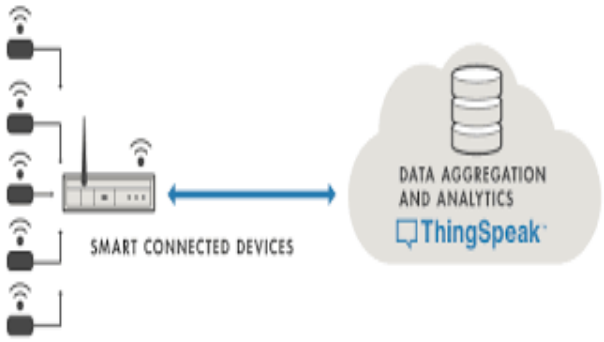
2) Thinkspeak Cloud Platform



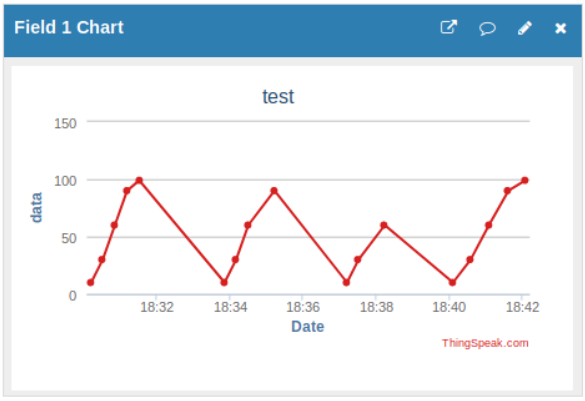


Fig. 10 Thinkspeak Cloud PlatformFig. 11 Thinkspeak Sample Graph

ThingSpeak™ is an IoT analytics service that allows you to aggregate, visualize, and analyze live data streams in the cloud. ThingSpeak provides instant visualizations of data posted by your devices to ThingSpeak. With the ability to execute MATLAB® code in ThingSpeak, you can perform online analysis and process data as it comes in. ThingSpeak is often used for prototyping and proof-of-concept IoT systems that require analytics.

You can send data from any internet-connected device directly to ThingSpeak using a Rest API or MQTT. In addition, cloud-to-cloud integrations with The Things Network, Senet, the LibeliumMeshlium gateway, and Particle.io enable sensor data to reach ThingSpeak over LoRaWAN® and 4G/3G cellular connections.

With ThingSpeak, you can store and analyze data in the cloud without configuring web servers, and you can create sophisticated event-based email alerts that trigger based on data coming in from your connected devices.

VIII. ADVANTAGES AND APPLICATIONS

a) Advantages

1) User-friendly interface
2) Compatibility to almost all EVs
3) Online Payment can be integrated
4) Fully automatic, so no manpower requirement for operation
5) Realtime Monitoring of Data is possible.

b) Applications

1) Can be installed on Street Lights
2) Shops and Private installations alongside roads
3) Can be integrated with solar to support charging at remote locations
4) Public and Private Parking Spaces

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IX. RESULT

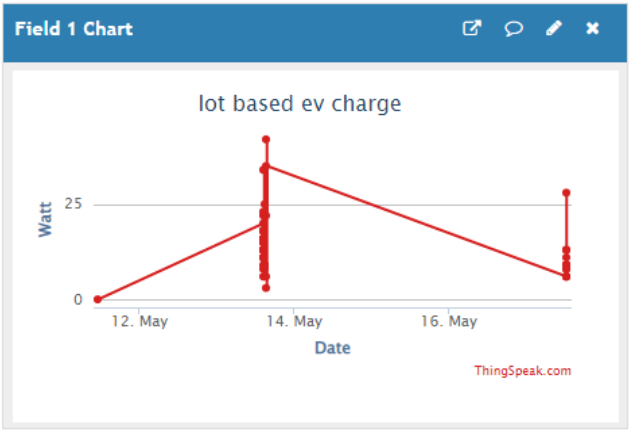

Fig. 12 Thinkspeak Watt Graph

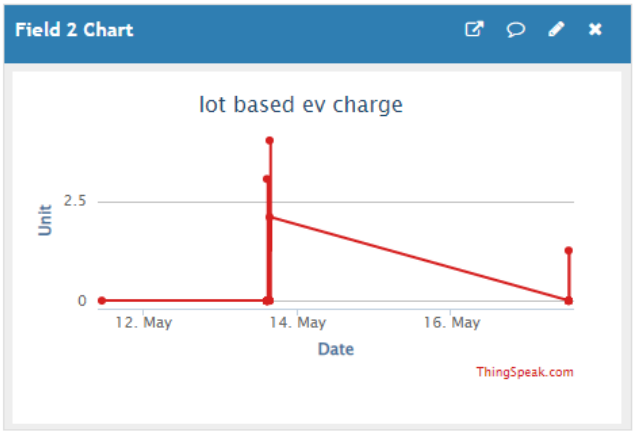

Fig. 13 Thinkspeak Unit Graph

X. CONCLUSION AND FUTURE WORK

This project enables user to pay for desired amount for charging his/her EV. Arduino Board receives SMS through GSM module and starts charging relay along with monitoring the power consumption. As soon as the power consumed equals the equivalent units with respect to the paid amount, the relay is turned off and charging stops. The real-time wattage and unit consumption data can be monitored on Thinkspeak IoT cloud platform.

We can put a QR code through which payments can be made. A mobile app can be developed for improving user experience providing real time charging data, charging history, payment ease, refund provision in case of any failure.

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