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REAL TIME IOT BASED AUTOMATIZED POWER STATIONS

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Abstract

In this research study, we employ the Internet of Things (IoT) concept along with a decentralized blockchain approach to manage the process of electric vehicle (EV) charging in shared spaces like residential societies. The initiation of the EV charging process is facilitated through a mobile application that handles user authentication. Energy consumption is measured using a set of sensors, and data communication with the mobile app is established through a microcontroller. Financial transactions are managed through a blockchain, and this methodology can be extended to other EV charging scenarios, such as public charging systems within a city, where authentication is provided by the mobile device. To visualize transactions, gather user preferences, and address power charging limitations arising from shared infrastructure usage, a user interface was developed..

1.INTRODUCTION

Real time Automatized Power Stations are an emerging technology that aims to improve the efficiency, reliability, and sustainability of power generation. This Research will explore the key components and benefits of this technology as well as the challenges that must be overcome to implement it successfully.

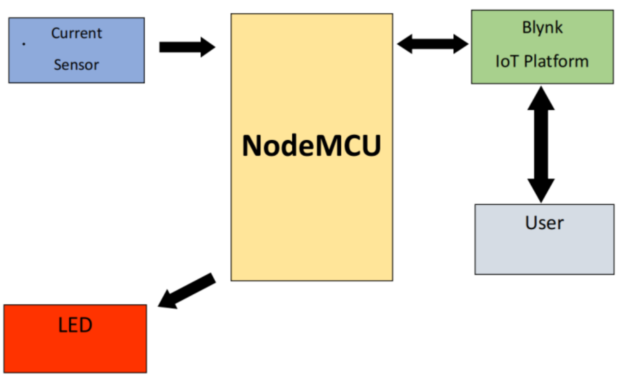

Fig-1: Block Diagram

1.1 Design and Working Principle

There are three major elements of the proposed EV charging platform: IoT units (sensors/actuator devices), a mobile app, and a management unit.

1. IoT Unit

The IoT unit was developed considering the approach described in our previous work, with improvements to the hardware and transmission process, as well as the creation of a prototype towards a possible commercial system. To review the system design approach, the first step was to assess the surrounding environment and context. In order to achieve a potential commercial system's architecture, a flexible design was considered, where different network transmission/device requirements, current sensor devices, and power switching devices were considered.

2. Mobile App

A mobile application was created using Xamarin. Forms framework in C# to enable EV owners to engage with the platform. Forms. Allows multi-platform development for Android, iOS, and UWP (Universal Windows Platform).

3. Management Unit

A platform's heart lies in its management unit. There are three subsections in this section: Hardware and Network Infrastructure; Software and Applications Infrastructure and management services. Web application for managing blockchains and block chains

2. TITLE INFORMATION

Electric Vehicles(EV) market penetration is challenged by the charging process, which is mainly due to a lack of proper infrastructure in residential buildings (condominiums), which are not prepared for this new reality. Societies have the problem of shared electricity, which does not meet the EV owner's requirements. Based on new advances in the Internet of Things (IoT) and the associated sensing devices and communication platforms, blockchain and information systems have the potential to create new solutions for these problems. It is also necessary to support EV charging in rental houses as part of this challenge. In societies, unfortunately, there is general reluctance regarding the installation of EV charging stations that will only be used by a few homeowners. As well, the electrical installations in the condominiums are not designed to support EV charging stations, which poses a safety issue. As well as obtaining approvals from the building safety agencies, adapting the condominium electrical infrastructure will require not only reaching a consensus between the majority of owners, which may be difficult to accomplish but also obtaining approvals from the government. The lack of infrastructure for installing EV charging systems in shared spaces with common electrical installations in residential buildings poses a significant barrier to the adoption of electric vehicles. A study by Lopez-Behar et al. Identified the main problem domains in the field of sharing EV Charging in shared societies: unavailable charging infrastructure, building limitations, regulation issues, and parking availability.

3. LITERATURE REVIEW

A Review on IoT based Electric Vehicle Charging System K.S. Phadtare1 , S.S. Wadkar2 , S.S. Thorat3 , A.S. Ghorpade4 Dept. of Electrical Engineering, ADCET Astha, Shivaji University, Kolhapur, India.

Currently, we are experiencing fuel scarcity issues, which has led to a growing interest in electric vehicles (EVs) as an alternative. However, people are hesitant to adopt EVs due to their higher prices and the limited availability of charging stations. Even when charging stations are accessible, the process of charging an EV requires additional time. Furthermore, urban cities are facing significant challenges in terms of car parking. To address these concerns, a solution can be implemented by integrating smart parking facilities with EV charging availability in commercial buildings. This approach would alleviate the need for extensive parking searches while eliminating the time-consuming task of locating and charging at separate charging stations. This research paper focuses on wireless power transfer technology for EVs and charging systems using IoT. It examines various IoT-based smart parking methods that have been implemented and compares the effectiveness of combined parking and charging systems versus separate parking and charging systems.

3.1 Components

3.1.1 Node MCU

NodeMCU is a development board that uses the ESP8266 Wi-Fi module. It is designed to provide an easy-to-use platform for IoT projects and prototyping. The NodeMCU board features an onboard USB-to-serial converter for easy programming and a Lua-based firmware that makes it simple to create web applications and IoT projects.

3.1.2 ESP8266 WiFi Module

The ESP8266 Wi-Fi module is a popular and versatile wireless communication module that combines a microcontroller unit (MCU) with built-in Wi-Fi capabilities. It is commonly used in Internet of Things (IoT) projects and allows devices to connect to a wireless network and communicate with other devices or services over the internet. The ESP8266 module is based on the ESP8266EX system-on-chip (SoC) developed by Espressif Systems. It features a powerful 32-bit Tensilica L106 RISC microcontroller running at 80 MHz, with built-in Wi-Fi functionality. The module supports 802.11 b/g/n wireless standards, allowing it to connect to both 2.4 GHz Wi-Fi networks.

3.1.3 LCD: (Liquid crystal display)

Liquid crystal displays are also known as LCDs. Electronic display modules are used in a wide range of circuits & devices, such as mobile phones, calculators, computers, TVs, etc. Displays like these are preferred for light-emitting diodes with multiple segments and seven segments. Using this module has several advantages, including being inexpensive, easily programmable, and animations, and displaying custom characters, special effects, even animations is not limited.

3.1.4 Non-Intrusive Current Sensor SCT-013-000 (nonintrusive)

A non-intrusive sensor is used to measure the current passing through a conductor without cutting or modifying the conductor itself. Measurements are made by electromagnetic induction, which is proportional to the intensity of the current passing through the conductor. This sensor collects measurements up to 100 A, and outputs 50 mA. In terms of accuracy, it may deviate from 1% to 2% of the actual value.

3.1.5. Intrusive Current Sensor 20 A (based on ACS712)

ACS712 this intrusive Hall effect current sensor can be used to measure currents between −20 A and +20 A, with an output ratio of 100 mV/A.

3.1.6 Resistance

In electronics, a resistor is a passive two-terminal electrical component that resists electric current. A resistor is designed to provide specific resistance to current flow, which can be used to control current flowing through a circuit. It can also be used to create a voltage drop across a circuit element.

3.1.7 Temperature and Humidity Sensor (DHT11 based)

From DF Robot, it can work from 0 to 50 ◦ C and humidity from 20% to 90%. It has low power consumption, with 2 C precision.

4. WORKING PRINCIPLE OF Real time IoT based automatized power stations

The EV charging platform is composed of these major elements:

1. IoT units (sensors/actuators devices),
2. A mobile app and
3. A management unit

4.1 IoT Unit

When considering the comparison between a wired (Ethernet) and wireless (Wi-Fi) network, it is important to note that most existing condominiums lack a wired network infrastructure. In such cases, utilizing a Wi-Fi network simplifies the platform deployment since no additional infrastructure components are required, especially when utilizing the Wi-Fi network provided by the management unit. However, for new or larger installations, a cable-based approach may be more suitable and less prone to errors. In terms of power sensing, the non-intrusive approach allows for energy measurement without significant modifications to the existing infrastructure. This method involves attaching a sensor around the power cable that powers the EV charger device socket. Nevertheless, since there are no physical devices between the power plug and the EV charging device, the ability to enable or disable the charging process must be implemented by the EV or the charging device itself, exposing it as a service to the charging platform. This could potentially involve utilizing the platform network or other communication technologies like Bluetooth Low Energy (BLE) to allow the management unit to start or stop the process based on user commands.

On the other hand, the intrusive approach requires the platform owner to introduce an IoT device between the power grid and the power socket, which necessitates intervention in the existing infrastructure. However, this approach offers a comprehensive solution by providing an all-in-one unit capable of measuring and controlling the energy delivery (enabling or disabling) simultaneously. It also ensures energy is supplied only to authenticated users or within the context of blockchain transactions, offering a secure solution to the platform owner.

4.2 Mobile App

As To allow EV owners to interact with the platform, a mobile app was developed in C# using the framework Xamarin. Forms. allows multi-platform development for Android, iOS, and UWP (Universal Windows Platform).

Differentiating between the automatic and manual starting processes of EV charging.

The primary function of the mobile app is to initiate the EV charging process, which is also the most frequently performed operation since the entire system is designed for charging the EV. However, the current requirement of connecting to a network accessible by the management unit in order to start the charging process creates a non-practical and time-consuming step for EV owners. To enhance the user experience during this operation, we have implemented two approaches: an automatic approach utilizing the NFC capabilities of the user's mobile device, and a manual approach exclusively relying on the mobile app itself. With the more automatic approach, users can initiate the charging process by authenticating the operation through the NFC capabilities of their mobile device. By placing the mobile device near the IoT unit's NFC reader, the process leverages statistical data from previous operations to verify user authentication, estimate power requirements, and determine the expected duration of EV connection to the charging plug.

Feature Extraction

The mobile app implements several features, outside of the EV charging process, that, although not as important, are required to reach a production-grade design stage.

1. Application splash screen.
2. Current usage pattern.
3. Application settings.
4. Energy costs calculated on the basis of kWh and sensor statistical measures.
5. List of sensor readings received.
6. Sensor configuration details.
7. About screen.

4.3 Management Unit.

The management unit is the heart of the platform. This section is divided into the following subsections: Hardware and Network Infrastructure; Software and Services Infrastructure; Management Services; Management Web Application; and the Block chain

Hardware and Network Infrastructure

The management unit was built using a Raspberry Pi 3 Model B+ hardware, and the Raspbian operating system. All platform components (management unit, sensor units, and mobile app) communicate wirelessly through the unit configured as a Wi-Fi access point. This configuration allows the deployment of a completely self-contained, plug gable,low-cost solution, without requiring any other infrastructure components (apart from the energy power grid),The overall solution's vulnerability to external network intrusions is also reduced, increasing its security.

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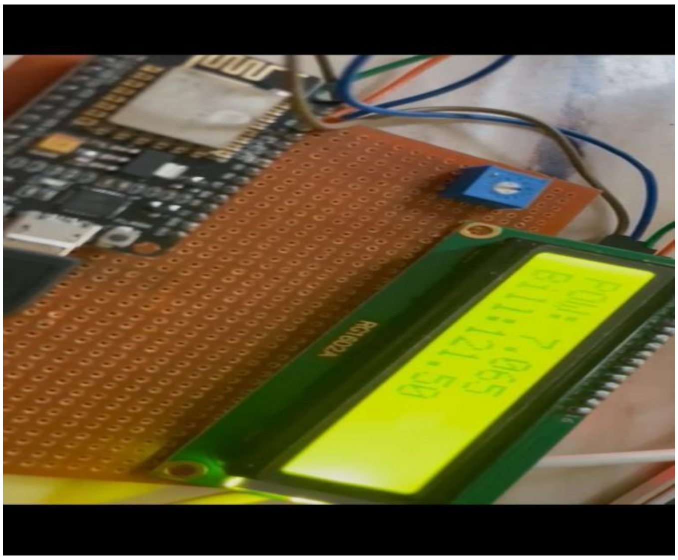
Complementary, if deployed in a location with existing network support, the management unit can be connected to the network using the RJ45 Ethernet connector of the Raspberry Pi, allowing the platform to benefit from the existing infrastructure and to eventually be deployed in setups where the use of a Wi-Fi network may not be available or the most suitable option Suppose, for example, there were multiple levels in a condominium parking lot, or if there were several areas and only one management unit shared by several parking lots.

Software and Services Infrastructure

The platform services, built using the Spring Framework and SpringBoot, are exposed as a set of Representational State Transfer (REST) endpoints, self-documented through the use of the Swagger Framework. This approach exposes an API (Application Programming Interface) that can be easily used by third-party applications, using standard interoperability tools, allowing the development of custom-made integration (for instance, to integrate the platform with a condominium management system). A standard HTTPS protocol has been archived by the installation for the transmission of data between the management console, mobile app, and central unit in order to guarantee its security. HTTPS certificates (provided free of charge by Let's Encrypt) are configured and installed in an NGINX (Engine X) web server, which acts as a proxy between the "external world" and the services layer, and are configured on the server.

1. Results



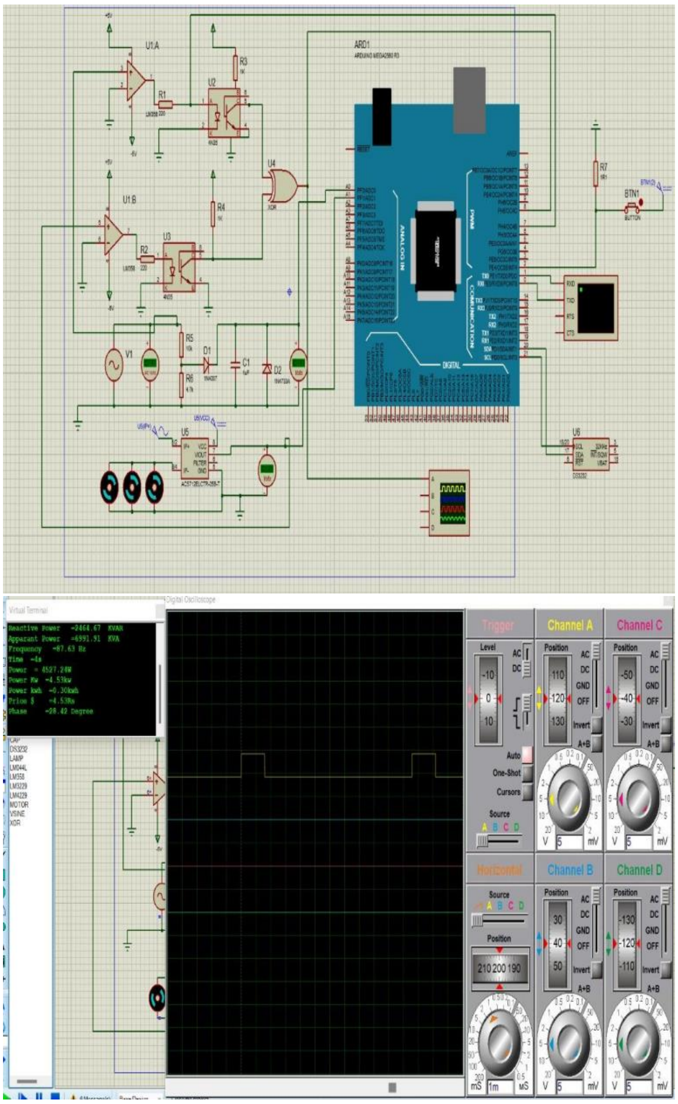


Fig 2,3,4 - The Simulation and output of power station

2. Advantages and Disadvantages

Advantage

Real time IOT based Automatized power station offer several key benefits including improved efficiency, increased reliability and enhanced sustainability By leveraging the power of IoT and data analytics, these power stations can help to optimize power generation,reduce downtime,and improve overall system performance.

Real time monitoring and control of power station can also help to reduce energy waste and lower carbon emissions making these power stations more sustainable options for energy production. Additionally, the use of advanced analytics algorithms can help to identify and diagnose issues before they become major problems. Reducing the risk of equipment failure and minimizing the maintenance cost

Disadvantage

There are several challenges that must be addressed to implement real-time IoT-based automated power stations successfully. These challenges include data security, data privacy, and interoperability.

Data security is a critical concern, as real-time IoT-based automated power stations rely heavily on the collection and analysis of sensitive data. Ensuring that this data is protected from unauthorized access and hacking is essential to maintain the integrity of the power station and prevent potential disasters.

Data privacy is also a concern, as the collection and analysis of sensitive data could potentially infringe on the privacy rights of individuals. Ensuring that proper privacy protocols are in place to protect individual data rights is critical to maintaining public trust in the technology.

Interoperability is another challenge, as real-time IoT-based automated power stations often rely on a complex network of devices and systems to function properly. Ensuring that all these components can communicate and work together seamlessly is essential to the success of the power station

6. Conclusion

Real-time IoT-based automated power stations offer significant benefits over traditional power generation methods, including improved efficiency, increased reliability, and enhanced sustainability. However, several challenges must be addressed to implement this technology successfully, including data security, data privacy, and interoperability. By addressing these challenges and continuing to innovate in this field, real-time IoT-based automated power stations have the potential to revolutionize the power generation industry and create a more sustainable and resilient energy infrastructure.

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