Lora Technology Enable Secure and Energy Efficient Smart Parking System

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***Abstract*—The administration of parking systems must be done intelligently if current infrastructure is to be transformed into smart cities. Finding the closest accessible parking place is a challenge that is particularly prevalent in locations with high population densities (including metro cities). This issue, which raises concerns about car safety as well, becomes more serious every day as the number of vehicles increases. In this study, an IoT-based technique is used to address the problem of locating parking spots in smart cities.**

The suggested Parking System is made up of an IoT framework that gathers real-time data, sends it to the cloud, and then recommends to the user a good place to park the car at a nearby area. A mobile application that is a part of the framework has been created to allow users to check the availability of nearby parking places and then book a spot.The paper also discusses several scenarios in which a person could discover a parking spot and leave their vehicle in the appropriate location. Utilising has been used to implement the suggested system. The outcomes covered in the following sections support this system suitability for use.

Keywords—Parking lots,Automation,IOT,Smart cities

I. INTRODUCTION

India is the second-most populated country in the world. The growth and development of Indian cities lacks a suitable architectural design for parking spaces. If this continues for a while, the outcome would be that the number of automobiles increasing would be inversely proportionate to the number of parking spots available. Due to the fact that so many individuals travel to different places for employment, there is a good probability they won't be familiar with the neighbourhood. As a result, they might not be aware of where the parking spaces are. As a result, they could find up parking their cars in prohibited zones, which could result in fines and other repercussions at work. Furthermore, even if they are aware of the location, they must obtain an assurance that a slot will be available before travelling to the parking site to avoid wasting their precious time. These days, finding a parking spot in a big city during rush hour is the biggest issue [1].

As a result, the authors suggested an intelligent framework to locate the parking spot effectively (i.e., without wasting parking space and with less time spent seeking). The architecture that is being presented in this article aims to track available parking spaces in real-time and, after confirming a user's location, to display the closest parking spots and slots to them. Due to a lack of local knowledge or a lack of time to go and reserve a parking space, many individuals just park their cars.

Additionally, once they get in the parking lot, a spot might not be available. They wind up receiving penalties for leaving their cars in prohibited parking zones. The public would thus greatly benefit from a system that shows the location of parking spots and the number of available slots to visitors. Additionally, it enables people to book the spot and even displays the parking space's path. This method will save a tonne of time in our hectic everyday lives, when everyone is focused on the next thing, and it will also be beneficial because it will spare the user from having to pay hefty fines.

As a result, we put forth and created a prototype for a smart parking system that attempts to address the aforementioned issues. The application, cloud, and interface make up the three key parts of this system's design. Fig. 1 discusses the interior parts and a few additional elements. The smartphone application first assists us in locating the closest parking space, which is indicated with the colours red and green.Green denotes at least one open parking space, while red means that all available spaces are taken. The real-time cloud database from which this real-time data is retrieved provides accurate information to the user. The parking slot sign provides information about the parking

space, including the name, address, and the number of open spots for cars and bicycles.

The following are some of the authors' significant contributions:

- A novel method for creating a mobile application for the Smart Parking System is suggested.
- Various use-cases for locating a parking spot are suggested and put into practise in the planned research.

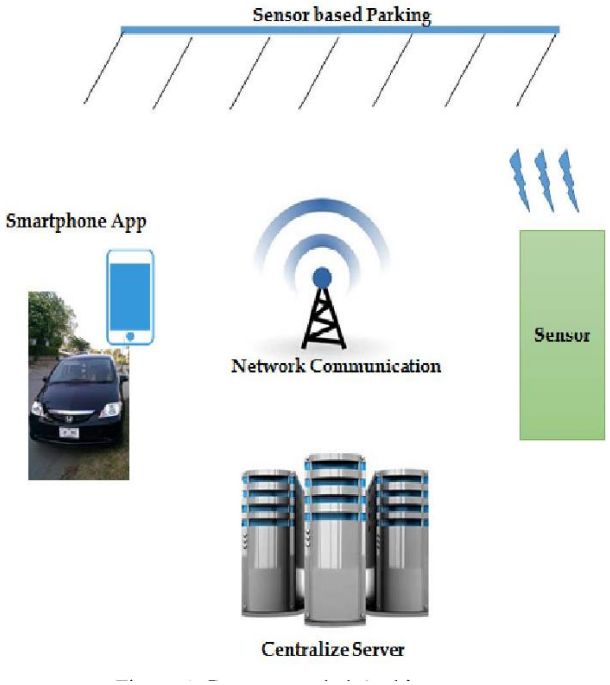


Fig. 1. The architecture of the smart parking system.

II. Use Case

Long-distance communication between devices is made possible via LoRa (Long Range) technology, a low-power wide-area networking (LPWAN) protocol. Smart parking systems, which demand secure and energy-efficient communication between devices, are a good fit for LoRa technology.

Here is an example of how LoRa technology may be used in a smart parking system:

Imagine a city that wishes to put in place a smart parking system to make it easier for cars to locate available spaces quickly and effectively. Every parking space has sensors installed by the city that can determine if a car is parked there or not. These sensors connect to a central hub using LoRa technology, and the hub then gathers data from all the sensors and transmits it to a cloud-based server for analysis.The sensors can broadcast data over long distances using LoRa technology, even in densely populated metropolitan areas with numerous buildings and other obstructions. This makes it possible for the central hub to get precise and timely data from all the sensors, regardless of how far apart they are from one another.

A smart parking system has to be extremely energy-efficient, which LoRa technology provides. The sensors must use as little energy as possible to prevent fast depleting their batteries since they must run continually to detect parked automobiles. The sensors can function on a very low power level thanks to LoRa technology, extending their battery life and lowering maintenance expenses.

A wireless communication system called LoRa technology was created primarily for long-distance communication between low-power devices. Even in densely populated metropolitan areas with numerous buildings and other obstructions, it uses radio waves to deliver data across great distances. The LoRaWAN protocol, which offers a standardised communication protocol for IoT devices, is the foundation of the technology.

Using LoRa technology, a central hub, a cloud-based server, and parking sensor communication can all be made possible in a smart parking system. Each parking place has a parking sensor installed, which communicates with a central hub using LoRa technology. The central hub then gathers data from all the sensors and delivers it to a cloud-based server for analysis.

The sensors' ability to send data over long distances, especially in metropolitan areas with potential radio wave obstructions, is ensured through the use of LoRa technology. This enables the central hub, which is crucial for a successful smart parking system, to collect accurate and timely data from all the sensors.

Fig. 2. Architecture of Parking System

The energy-efficiency of LoRa technology is also crucial for a smart parking system. The sensors must use as little energy as possible to prevent fast depleting their batteries since they must run continually to detect parked automobiles. The sensors can function on a very low power level thanks to LoRa technology, extending their battery life and lowering maintenance expenses.

The security aspects of LoRa technology are yet another major benefit. Data transfers using LoRa technology are protected from hackers and other bad actors by built-in encryption and authentication capabilities. By doing this, the possibility of data breaches or other security concerns is eliminated, allowing the smart parking system to function safely and dependably.

Taking everything considered, LoRa technology is the best option for allowing safe and effective smart parking

systems. LoRa technology can assist cities and businesses in developing more efficient and effective parking solutions by enabling long-range communication between sensors and a central hub, using little energy to increase battery life, and ensuring data security through built-in encryption and authentication features.

III. Material Used

A. LoRa Module(SX1276)

A LoRa module created by Semtech Corporation is the SX1276. LoRa, which stands for Long Range, is a sort of wireless communication technology created for the Internet of Things (IoT) and other applications that require long-range, low-power communication. One of the most well-liked LoRa modules on the market, the SX1276 module is utilised in a variety of IoT applications.

Spread spectrum modulation is used by the SX1276 LoRa module to facilitate long-distance communication with little power usage. Depending on the application and environmental factors, it can give a range of up to several kilometres while operating in the unlicensed frequency spectrum between 868 MHz and 915 MHz.

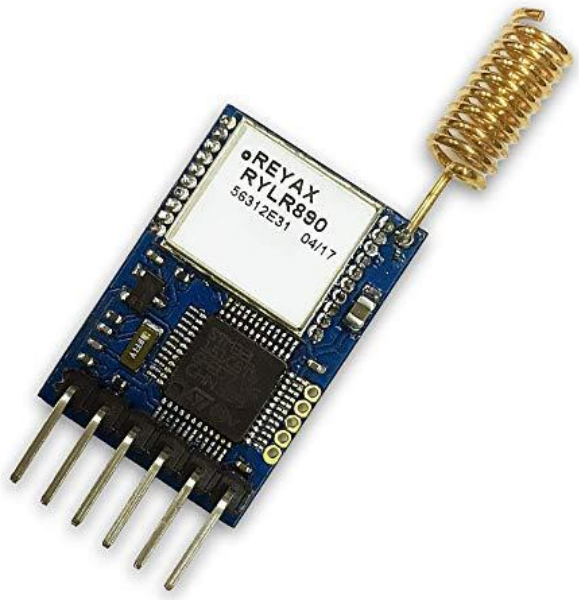


Fig. 3. LoRa Module

B. Node MCU

An open-source development board called NodeMCU is built on the ESP8266 Wi-Fi module. With built-in support for Wi-Fi networking and several additional sensors and modules, it enables users to programme and construct IoT applications quickly.

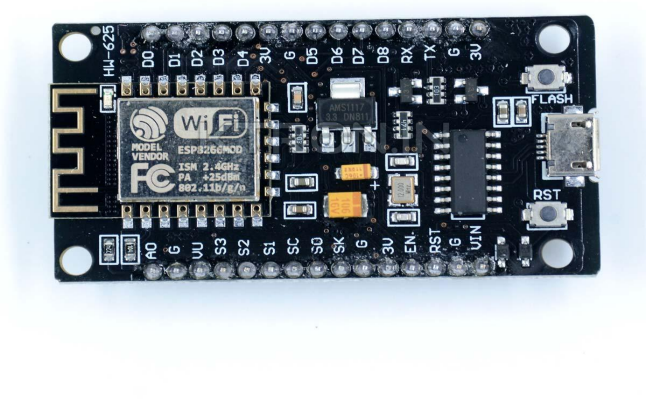


Fig. 4. Node MCU

C. LCD Display

A liquid crystal display, or LCD , is a type of electronic display that shows information and pictures. It is composed of a panel of pixels, which may be made transparent or opaque to produce text, numbers, or graphical pictures. In addition to being employed in industrial and medical equipment, LCD displays are frequently found in consumer devices like televisions, computer monitors, and digital watches. They provide a compact, energy-efficient, and adaptable option for information display in a range of

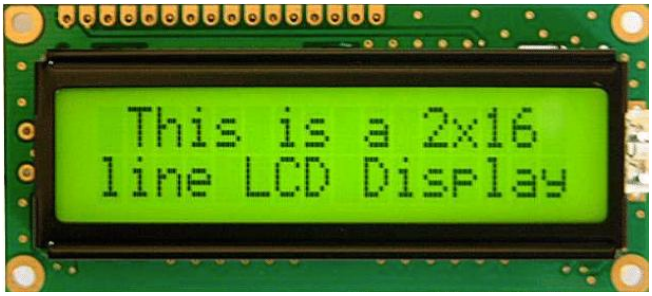


Fig. 5. LCD Display

D. Ultrasonic sensor

An ultrasonic sensor is a device that detects and calculates distances to objects by using sound waves with frequencies higher than those heard by humans. Short bursts of high-frequency sound waves are emitted, and the system then listens for echoes that return from surrounding objects. The sensor can calculate the distance to the object by timing how long it takes for the echoes to return. To find items and barriers, ultrasonic sensors are frequently employed in robotics, automation, and security systems.

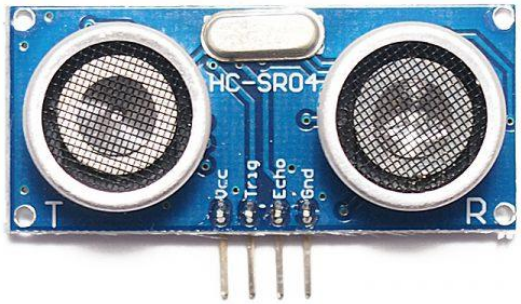


Fig. 6. Ultrasonic Sensor

E. *Ardinuo*

The open-source electronics platform Arduino has simple hardware and software. It is composed of a microcontroller, commonly referred to as a programmable circuit board, which has the ability to operate numerous sensors and electrical equipment. Arduino boards are extensively utilised by amateurs, artists, and professionals in a range of applications because they are meant to be usable by everyone, regardless of their degree of technical competence. Users may develop interactive projects and prototypes by writing and uploading code to the board using the Arduino software, often known as the Integrated Development Environment (IDE). Overall, Arduino is a strong and adaptable tool for anybody with a love of programming and electronics.

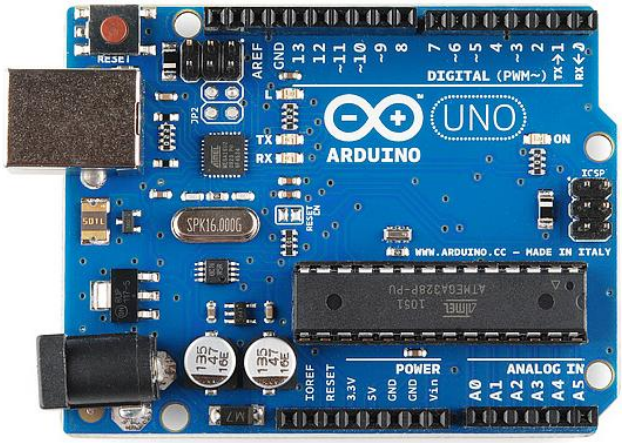


Fig. 7. Arduino

IV. Proposed Methodology

Investigating and determining what a smart parking system would require to function effectively would be the first course of action. This would include comprehending the required hardware and software components, such as sensors, LoRa modules, microcontrollers, and servers. Additionally, the investigation would need to identify the specific needs for the parking lot and the surrounding area, such as the required number of parking spaces and the traffic flow patterns.

After the requirements have been established, the system architecture would then be designed. To do this, the system's requisite data flow, communication protocols, and security precautions would need to be specified. The system must be able to provide users with accurate and timely information while also being secure and energy-efficient.

After creating the system architecture, the hardware components would need to be developed and integrated. This would include creating and integrating sensors, microcontrollers, and LoRa modules into the smart parking system. The amount of energy the system uses would need to be closely monitored to ensure that it is energy-efficient.

After the hardware components are configured, the software components need to be created and integrated. Making the server-side code, database management system, and mobile application would be required. The interplay between the software and hardware components would enable the system to collect and analyse data from the parking lot sensors.

Security precautions including encryption, authentication, and accessibility control would need to be put in place in order to guarantee the system's security. This would guarantee the security of the data processed by the system and acquired by the sensors against unauthorised access and modification.

Extensive testing would be necessary after the system has been fully developed to make sure it is operating as intended. This would entail evaluating the system's energy use as well as assessing the hardware and software components. Prior to doing the testing in the actual world, a controlled environment would be used.

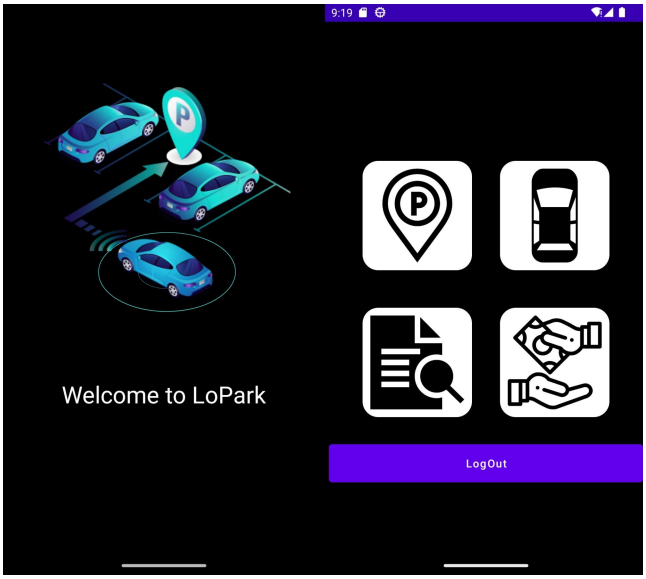
The device may be put into use in a real-world setting, like a parking lot, after testing is complete. It's critical to check that the system is installed, configured, and instructed on how to be used correctly throughout the deployment phase.

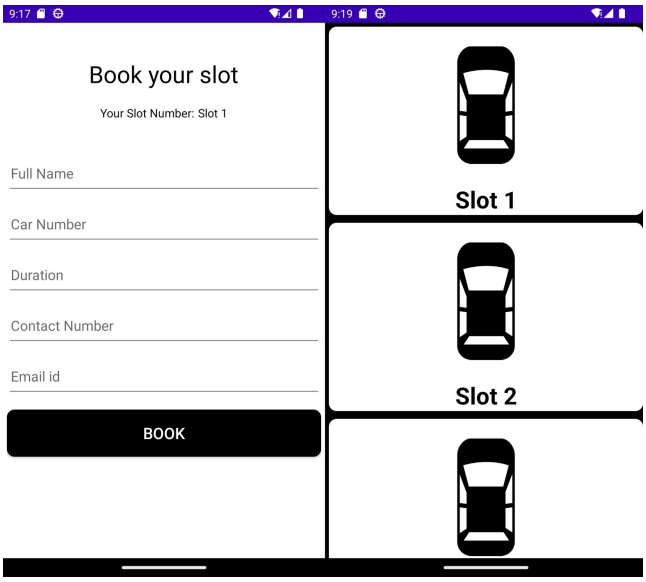
To measure the system's usefulness and pinpoint any potential for improvement, its performance and energy efficiency would need to be assessed. This assessment will assist in ensuring that the system is reliable, secure, and meets the demands of the parking lot and its users.

V. Mobile Application & Website

- Users will be able to monitor real-time parking availability and reserve parking places via the mobile application.
- On the app , users can register and set up an account, giving them access to extra features like payment options and parking history.
- The mobile application will interface with the sensors and servers of the smart parking system using LoRa technology.
- A user will enter their location and desired parking time into the app to book a parking place.
- The app will then determine whether parking spaces are available in the user's chosen area and show them on a map.

- Using the app , the user can choose and reserve a parking space.
- The system will send a confirmation and the address of the parking place to the user's mobile device after the user has reserved a parking space.
- The user can extend their parking period if necessary, and the app will offer real-time updates on the parking spot's availability.
- Through the mobile application or users can pay for parking using safe payment options like debit or credit cards, digital wallets, or other payment methods.
- On the app, consumers can also view their parking past history and payment history.
- Using Website,user can contact us for any query and this data is going to store in our database.





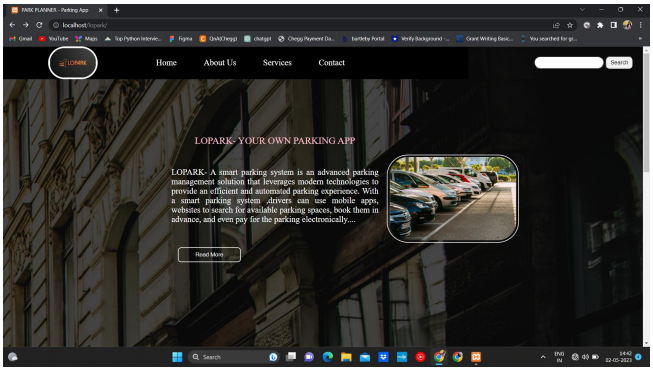


Fig. 8. Website

VI. Conclusion

A great project for college students interested in IoT and embedded systems is LoRa Technology Enabled Secure and Energy-Efficient Smart Parking System. With an emphasis on assuring security and energy efficiency, the suggested technique comprises phases of research, design, development, testing, implementation, and assessment. The system is made up of a number of parts that work together to deliver a smooth parking experience, including sensors, microcontrollers, LoRa modules, servers, mobile applications, and websites. Users can easily locate and use parking spots thanks to the mobile application and website's real-time parking information, reservation, and payment options. Overall, this project provides students with a great chance to enhance IoT-based smart systems while also honing their technical abilities.

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