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Smart Parking System with research on Thread Communication Protocol

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Abstract— Nowadays, enhancements in technology and areas in the automobile community has resulted in almost every individual making use of an automobile entity, due to this there has been significant increase in industrial and personal advancements but this has also resulted in increase in traffic, congestion, pollution and many more areas of concern. Smart parking systems (SPS) has been a topic of discussion for several years. Blockchain, IoT and network solutions have been proposed in order to ease the use of parking systems and tackle inconveniences caused due to lack of parking spaces. A major route of research in this domain is the use of IoT devices and wireless communication protocols to back it up. Many devices such as sensors, actuators, RFID's, Zigbee communication protocol, NB-IoT communication protocol, Edge computing and much more have contributed to significant positive changes in the parking sector. In this paper, we intend on implementing a new communication protocol which eases the use of connectivity between IoT devices in an environment known as Thread Mesh protocol which was introduced in 2015 by Thread inc. Even though there has been extensive research done on IoT based SPS's, security seems to be a major concern in majority of IoT devices and protocols, Thread communication protocol aims at reducing the risk of security attacks in a smart parking- system due to its in-built cryptography, commissioning, adaptation to PAN (Personal Area Network) and many more features that we intend on discussing and implementing in this paper.

Keywords- *Smart Parking Systems, Thread Protocol, Cryptography, PAN, Internet of Things*

I. INTRODUCTION

The world has advanced significantly in both economics and technology today. The bulk of the population has invested in cars, bikes, and other vehicles as a result of significant breakthroughs in the automotive industry during the previous few decades. Drivers can identify available parking spaces and reserve them in advance with the use of smart parking systems. This can include mobile apps that display real-time information on available space, cameras, and sensors built into parking spaces. Additionally, smart parking systems can assist cities and parking lot owners in better managing their parking resources and lowering traffic and emissions. A smart parking system's goal is to effectively manage parking space usage, particularly in urban areas. To do this, it gives drivers real-time information about available spots, directs them to those places, and may even automate the payment process. By making it simpler for individuals to locate and use parking spaces, this can decrease the congestion and pollution that come from automobiles turning around in search of parking. It can also enhance revenue for parking operators.

II. PROBLEM STATEMENT

To incorporate and integrate a smart parking system (SPS) that operates optimally through a thread communication protocol; to increase accuracy and communication between IoT and network protocols present in the environment.

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III. LITERATURE SURVEY

A. Key Terminologies

1. ***Smart Parking System (SPS):*** Smart Parking is the parking strategy that combines technology and human innovation in an effort to use as few resources as possible—such as fuel, time and space—to achieve faster, easier and denser parking of vehicles for the majority of time they remain idle.
2. ***Edge Artificial Intelligence:*** Edge Artificial Intelligence is the combination of Edge Computing and Artificial Intelligence.AI algorithms are processed locally, either directly on the device or on the server near the device. The algorithms utilize the data generated by the devices themselves. Devices can make independent decisions in a matter of milliseconds without having to connect to the Internet nor the cloud.
3. ***Edge Computing:*** Edge computing consist of multiple techniques that bring data collection, analysis, and processing to the edge of the network. This means that the computing power and data storage are located where the actual data collection happens.
4. ***Z-Wave:*** Z-Wave is a wireless communication protocol that is mainly used in smart home networks. It enables smart devices to connect and communicate with one another to share control commands and data.
5. ***Zigbee:*** *ZigBee is an open, universal standard for wireless technology that enables personal area networks to operate with low-power digital radio transmissions. ZigBee is used to build networks that need low data transfer rates, energy efficiency, and secure networking. It runs on the IEEE 802.15.4 standard.*
6. ***Bluetooth Low Energy:*** Bluetooth Low Energy (BLE) is a wireless, low-power personal area network that operates in the 2.4 GHz ISM band. Its goal is to connect devices over a relatively short range. BLE was created with IoT applications in mind, which has particular implications for its design.
7. ***Object Detection:*** The goal of object detection is to locate instances of semantic objects of a particular class (such as people, structures, or vehicles) in digital images and videos. Object detection is a branch of computer vision and image processing.
8. ***YOLOv3:*** YOLOv3 (You Only Look Once, Version 3) is a real-time object detection algorithm that identifies specific objects in videos, live feeds, or images. The YOLO machine learning algorithm uses features learned by a deep convolutional neural network to detect an object.
9. ***NodeMCU:*** A LUA-based open-source software called NodeMCU was created for the ESP8266 Wi-Fi chip. NodeMCU firmware is included with the ESP8266 Development board/kit, also known as the NodeMCU Development board, in order to explore ESP8266 chip capabilities.
10. ***Ultrasonic Sensors:*** They measure distance by using ultrasonic waves. The sensor head emits an ultrasonic wave and receives the wave reflected back from the target. Ultrasonic Sensors measure the distance to the target by measuring the time between the emission and reception.
11. ***Infrared Sensor:*** A sensor that measures and detects infrared radiation in its surroundings is known as an infrared (IR) sensor. What then is infrared radiation? Infrared radiation - also known as infrared light - refers to radiation that has wavelengths longer than those of visible light. In reality, it is claimed to cover wavelengths between 700 nanometers and 1 millimeter. As a result, it is invisible to the human sight but can be felt as skin warmth.
12. ***QR code:*** A barcode with a matrix of dots is known as a QR code (short for "quick response" code). A smartphone with a built-in camera or a QR reader can be used to scan it. The dots in the code are converted into numbers or a series of characters by the device's software after it has been scanned.
13. ***Automatic number plate recognition:*** Automatic number-plate recognition (ANPR) is a technology that reads car license plates using optical character recognition on images to produce vehicle location data. It can make use of already-installed closed-circuit television, cameras for enforcing traffic laws, or specially made cameras.
14. ***Thread Protocol:*** Thread is a low-power, low- latency mesh network that enables direct "talking" between smart devices. Each Thread-capable smart gadget could be compared to a node in its own network. In other words, Thread turns each device (or component) in the system into an access point, resulting in a mesh network. The network becomes more stable as you add more hubs or devices. Thread distributes the duty among devices rather than needing communication with a single hub or bridge for every device. You won't need to deal with external routers or Wi-Fi bridges because each Thread-enabled device will function as a mini- router.
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B. Existing Systems

S. Gokul Krishna et. al. [1] aims to create a secure and efficient parking smart parking system using IoT and weighbridge loaded sensors. Research and implementation are still ongoing within the large field of the Internet of Things (IoT). Many IoT-based applications increase advantages while lowering labor requirements. The need for transportation grows along with the population as it grows every day. This makes parking vehicles more necessary. Parking issues are a problem among the people in public areas in various urban interiors such as temples, parks, shopping malls, theaters, etc. Despite the fact that numerous systems have been described in documents, manual parking systems still dominate most locations in smart cities, the majority of tourist attractions only have a well- organized indoor parking system. Vehicle parking guidelines have not yet been established and must be observed. Traditional parking structures are far too outdated and cumbersome for metropolitan areas where it can be difficult to locate open spaces. This could result in traffic congestion, minor crashes, and public setbacks. As a result, to curb these issues a smart parking system using Internet of Things (IoT) and weighbridge load sensors can be created for the planned, punctual, adaptable, practical, and secure parking of automobiles in public.

Y. Agarwal et. al. [2] aims to reduce the difficulty in finding available parking spaces and also providing the proximity to them. The issues with conventional parking lots are covered in this essay. It also includes a list of the effects and inconveniences brought on by conventional parking spots inefficiency. In this survey, the authors suggest and create a smart parking system with the help of IoT that would allow users to find available parking spots in a certain area. Additionally, the system prevents superfluous parking lot travel through crowded lots. - [] The authors of this article offer a novel parking system that makes use of IoT via Wi-Fi and RFID.S. Kim et. al. [3] aims to provide the users with personalized parking experience based on the foundation of edge computing. In metropolitan settings, parking is a common practice. In other words, finding a good parking spot quickly is the most fundamental and common demand of all drivers in a parking lot. Nowadays, most parking spaces incorporate a sensing- based display system to indicate the number of available spaces.[4] aims to explore the viability of utilizing edge computing for real-time video-based parking occupancy identification in smart parking monitoring jobs. Cloud computing has long been a popular type of computing service. Due to the recent urbanization, massive amounts of video surveillance data are now being generated at a never-before-seen rate. A few more algorithms were developed in order to achieve the highest level of system accuracy and effectiveness, either on the centralized data server or locally at the system's edge. The proposed smart parking monitoring system used in smart cities, may be well-founded for future applications in the field of intelligent transportation systems.

To achieve anonymous authentication among automobiles, in [5] the parking server, and the fog node, using a novel group signature mechanism. Searching an empty parking lot in a busy or downtown area requires time and effort. Smart parking systems have been described in documents, manual parking systems still dominate most locations in smart cities, the majority of tourist attractions only have a well- organized indoor parking system. Vehicle parking guidelines have not yet been established and must be observed. Traditional parking structures are far too outdated and cumbersome for metropolitan areas where it can be difficult to locate open spaces. This could result in traffic congestion, minor crashes, and public setbacks. As a result, to curb these issues a smart parking system using Internet of Things (IoT) and weighbridge load sensors can be created for the planned, punctual, adaptable, practical, and secure parking of automobiles in public.

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area requires time and effort. Smart parking systems allows vehicles to access real-time parking information, which offers a good probability of minimizing the parking problem. Cooperative parking information sharing based on vehicle crowdsourcing is more precise and less expensive when compared to current parking systems. However, there is a chance that identification and trajectory leaks will occur in vehicles. We suggest a smart parking system with dual privacy preservation to deliver a reliable and safe parking service.

Faris Alshehri [6] aims to solve the problem of wrongful parking. In order to attain the perfect efficiency without incurring excessive costs or having numerous sensors in one parking, the main aim of this study is to address one of the issues that people have with wrong parking. To display the results of this project, they use a PIR motion sensor, a Next ion display, Arduino, and an ultrasonic sensor. A motion sensor that can detect movement from 360 degrees detects when a car enters the underground garage, sends a sequence of commands to the DC motor to move to the first park, and then uses two ultrasonic sensors to read each step for each line and park on the opposite side.

Chris Henry [7] suggested a technique for identifying international license plates. Automatic license plate recognition (ALPR) is recognized as a problem that has been solved in the field of computer vision. The majority of ALPR research being done today is focused on license plates (LP) from one particular country and they use country-specific information which limits their practical applicability. Some changes must be made to the algorithm in order for these ALPR devices to work with license plates from other countries. This study demonstrates a sophisticated ALPR system that can be used with license plates from various countries, demonstrating how they overcame the issue.

Shi-Yong Chen [8] proposed numerous intelligent parking allocation algorithms that took parking grid reservations into account and made suggestions. However, there is still room for improvement in the parking regulations to maximize parking rates and benefits. In this research, a smart parking allocation algorithm (SPA) is proposed. The SPA strives to provide high-quality parking services while maximizing the advantages produced by a particular parking lot. Based on previous parking data, the proposed SPA algorithm forecasts future driving patterns and anticipated traffic in parking.

Ruimin Ke [9] proposes a way to use AI on IOT parts to create a sophisticated reliable parking surveillance system. In this study, we explore the viability of utilizing edge computing for real-time video-based parking occupancy identification in smart parking monitoring jobs. When designing the system's power pipeline, flexibility, online monitoring, data transmission, detection accuracy, and system reliability was all meticulously taken into account. To achieve the best system efficiency, a new system architecture utilizing IoT and AI technologies will divide the compute load between local IoT devices and servers. This model will be used for a real-time smart parking monitoring system. In order to address the real-time video analytics problem of restricted network capacity, the data transfer volume has been designed to be modest.

Leonardo Babun et al. [10] set out to investigate in order to better understand how the various IoT platforms handle security and privacy concerns that could potentially influence the most basic security functions, such as confidentiality, integrity, availability, and access control. Additionally, it offers several ideas that might be used to improve the IoT solution's security and privacy. Ishaq unwala et. al.

[11] shone light on IoT protocols made up of many different components, many of which contain security elements. The paper explores various IoT system attack types and how the protocols respond to them. As soon as a new device is added to an IoT system, it is one of the most revered moments. The new gadget needs to be authorized in order to prevent intrusion. Z-Wave and Thread protocol approaches to new network device authentication are reviewed. This work should act as a starting point for additional research into these and other IoT protocols because IoT protocols are complicated and the security concerns are also quite complicated. According to Abrar Fahim, et. al. parking allocation in [12] modern cities has become a significant problem, prompting the creation of multiple smart parking systems. The main of objective of this study is to provide a thorough assessment, distinction, and expanded analysis of SPSs in terms of technological approach like networking technologies, sensors used, user interface, computational approaches, and services supplied.

Wojciech Rzepecki and Piotr Ryba [13] compared thread mesh to Bluetooth Mesh, Zig-Bee, NB-IoT, Sigfox, and LoRa. It is investigated what wireless connectivity needs are for smart homes, smart cities, and rural regions. In addition, the usability of the Thread and other systems in IoTSP (Internet of Things, Services, and People) apps is taken into consideration. The Thread protocol is built on the IEEE 802.15.4 radio standard, which enables 2.4 GHz radio communication.

A. Mackey et. al. [14] introduces a smart parking solution that works both indoors and outside. This parking system uses

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particle approaches to increase its overall accuracy and is based on Bluetooth low energy beacons. The technology couples every parking space with a distinct BLE and provides users with space. Beacons are nothing but tiny transmitters designed for a range of Internet of Things (IoT) applications. They are also known as Bluetooth low energy beacons. These beacons send out data packets that are uniquely identified. Beacons are chosen over Wi-Fi because they are far less expensive, smaller, and easier to install on top of any existing infrastructure. The user's smartphone can access the system. Each and every parking lot that has registered can offer real-time data on the prices and available parking spaces.

W. Weihong et. al. [15] utilized deep learning to learn about license plate recognition algorithms. The conventional location recognition method fails because it is easily impacted by light, shadow, a complicated background, and other elements. The detection and identification accuracy of the license plate recognition algorithm has been significantly improved by deep learning. The location of the license plate and the recognition of the characters on the plate are the two main purposes of the license plate recognition technology. Character segmentation, recognition, and license plate detection are the three steps that make up the complete process. Character segmentation is commonly used in conventional text recognition algorithms. Project-oriented methods, component connection analysis, fixed character spacing, and other techniques that rely on prior knowledge are used to execute these algorithms.

V. R. Tripathi et. al. [16], wanted to develop a system that will allow users to get, wherever they are, real- time data about the accessibility of parking spaces nearby. GPS (global positioning system), IR sensors, RFID, and GSM are all utilized in this system. To determine how many spaces are open at a specific parking lot, several sensors are turned on at the lot to identify the vehicles and relay this information to the server. In this approach, the fastest route is determined after checking parking availability. Slot reservations are possible, and when a car is parked, a special QR is created. Access to the parking lot is granted via an RFID card and token. When leaving, a QR code is scanned and payment is made. The IR sensor and Arduino Mega microcontroller board are used to determine whether or not there are any cars in the parking lot.

A. Anand et. al. [17] used a real-time technology that enables drivers to discover and control vacant parking spaces remotely via website and Android app. Automatic parking system with Bluetooth capability: S When Bluetooth is used in a parking system, security is boosted and an autonomous system is created, eliminating the need for manual involvement. This parking system's Bluetooth reader allows user identification and authentication. The user needs to activate the mobile Bluetooth in order to register and identify themselves. This has the advantage of doing away with paper bills. GSM-based secure parking system: With this approach, users may conveniently assistance to spaces that are within easy reach as well as a safe payment system based on the actual use of the parking

reserve a place via SMS (Short messaging service).

IV. SUMMARY

A smart parking system's goal is to effectively manage parking space usage, particularly in urban areas. To do this, it gives drivers real-time information about available spots, directs them to those places, and may even automate the payment process. By making it simpler for individuals to locate and use parking spaces, this can decrease the congestion and pollution that come from automobiles turning around in search of parking. It can also enhance revenue for parking operators. The scope of this project is to increase the level of security that currently resides within smart parking systems. IoT implementations have been constantly implemented with respect to SPS's. Although proven effective, security still remains an issue in IoT implementations. Wireless communication protocols are used to establish communication between IoT devices in the environment, we intend on using an enhanced communication protocol favorable in smart environments.

V. PROPOSED SOLUTION

A. High Level Design

User input is fed into the mobile application and a parking space is dedicated to the user; on arrival the number plate characters will be matched with the number plate in the database using the number plate recognition scanner. The vehicle is required to pull into the spot and is monitored using IoT devices. All the IoT devices in the proposed system are managed through thread protocol increasing accuracy.

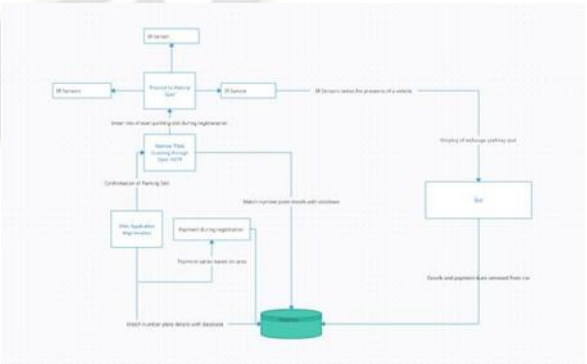

Fig.1: High level design

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V. IMPLEMENTATION

A. Overview of technologies used

1. VS Code: Visual Studio Code, also commonly referred to as VS Code, is a source-code editor made by Microsoft with the Electron Framework, for Windows, Linux and macOS. Features include support for debugging, syntax highlighting, intelligent code completion, snippets, code refactoring, and embedded Git.

2. SQLite: SQLite is a database engine written in the C programming language. It is not a standalone app; rather, it is a library that software developers embed in their apps. As such, it belongs to the family of embedded databases.

3. Python: Python is a dynamic language which is interpreted line by line and not compiled. Python is a strongly typed language and high-level language which makes it easy to understand. It supports object- oriented programming, functional programming and procedural programming. Python is especially preferred for implementing machine learning projects since it supports a variety of popular machine learning libraries like TensorFlow, matplotlib, sklearn, surprise, pandas, NumPy, all of which were used to implement this project.

4. Flask: Flask is a lightweight WSGI web application framework. It is designed to make getting started quick and easy, with the ability to scale up to complex applications.

5. IoT Devices: The Internet of things describes physical objects with sensors, processing ability, software and other technologies that connect and exchange data with other devices and systems over the Internet or other communications networks.

B. Implementation details of modules

Hardware

Arduino Uno

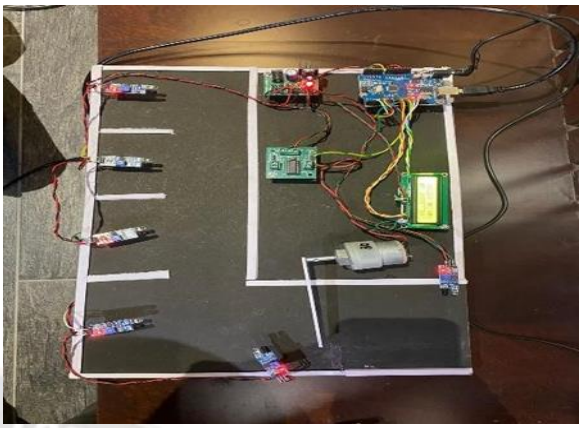
The Arduino Uno is used to create a smart car parking system. The device uses IR sensors mounted in the parking slots to detect empty slots and assists the driver in finding parking in a new city. The system lacks a payment mechanism as well as guide technology that can automatically find available parking spaces.

IR Sensors

The IR sensor is used to detect the absence or presence of a car when it enters the parking slot, and the LCD screen is then used to display the vacant parking slot to the driver. The parking slots are continuously monitored, and the data is continuously updated in the LCD screen.

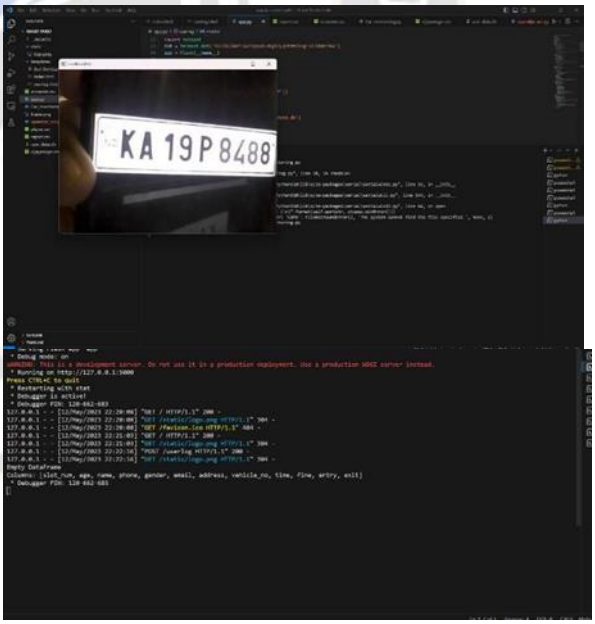
Motor Driver Module

In a smart parking system, a motor driver is used to control and manage the movement of physical barriers such as gates or barriers that restrict access to parking areas. The motor driver is responsible for opening and closing these barriers based on various inputs and signals received from the smart parking system.



Software

A Flask web application is developed written in python. It implements a simple smart parking system with user registration, login, slot booking, and payment functionality. For the front end, HTML, CSS and jQuery is used for user log in and user registration. SQLite is used to create and manage a database called 'user_data.db'. Tables are created to store user registration details and parking slot bookings. CSV files are used to store booking details for each parking area. The code checks if the CSV file exists and creates one if necessary. The OpenCV library is imported and used for computer vision tasks such as vehicle detection, license plate recognition, and image processing. Optical Character Recognition: This is done by using the OpenALPR API. It is mainly used for vehicle number plate recognition.



Web Application

This project serves end users as a web application. The web application enables users to register into our parking system and book a particular spot to park. Once the slot is booked the vehicle can go to the particular parking spot.

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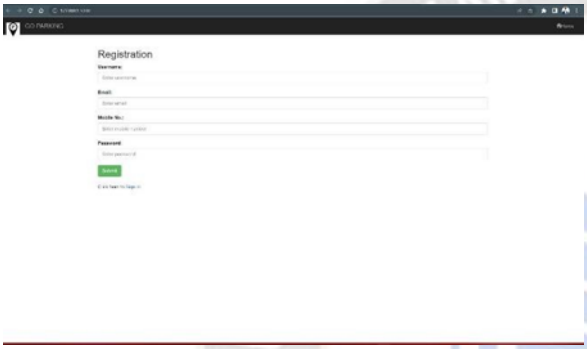
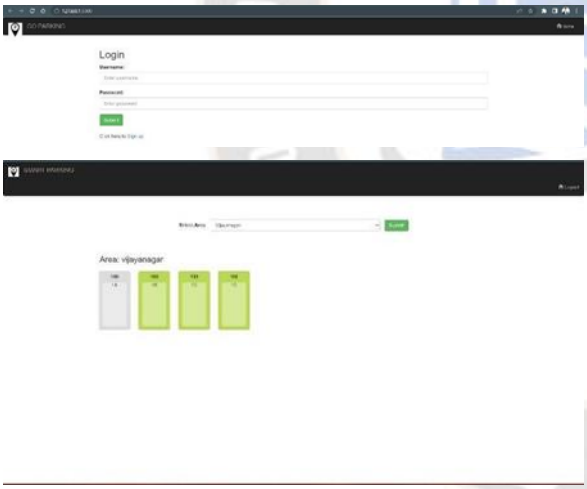
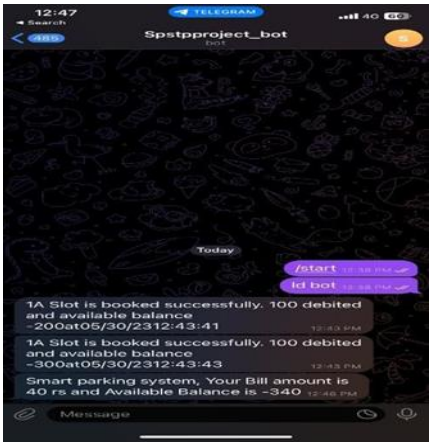
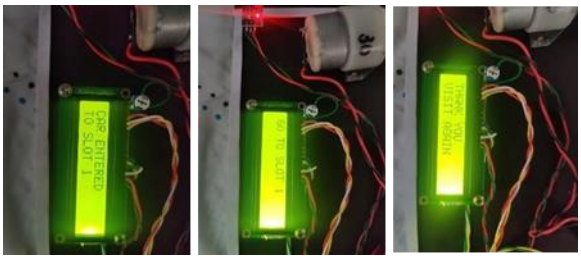
RESULTS

The said Smart Parking System focuses on an IoT implementation and thorough research on thread communication protocol. The ease of navigating through a parking system with sensors and an application to support is unmatched. The use of OpenALPR securely detects rightful owners of the parking slot and displays the slot number they have to proceed to. The payment system integrated follows the convention of fixed amounts for the selected four areas in this project all around Bangalore. Fine induction has been done as a protocol to avoid mishaps in the parking system. Validity and securing of parking slot on the web application is done to avoid double booking. A telegram bot has been introduced as a conventional way of message receiving through a network-oriented area, for example- WIFI.









CONCLUSION

In this paper we have discussed the various smart parking systems introduced in the past along with its technologies. Based on the thorough research we learnt that there was a way to make smart parking systems more efficient and secure. The overall outcome of the research conducted is to develop a smart parking system using IoT devices with a thorough research of thread protocol and its possibility of being a communication protocol for smart parking systems. The main objective of the research was to find a different approach to increase the efficiency and security of a smart parking system using IoT devices.

FUTURE ENHANCEMENTS

Although there have been significant implementations of smart parking systems, communication protocol security is where most of them lack, through our team's research we found out that thread protocol provides an internal commissioning procedure as a means to cryptographic security in the vicinity of IoT devices.

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