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Implementation of Agent-based Smart Parking using IoT

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Abstract: *With the day-by-day increase in the number of automobiles on the road worldwide, numerous cities and towns face parking problems with drivers frequently spending the maximum of their time before looking for a place to park. This document presents an agent-based model for a smart mobile parking reservation system for the situation mentioned above. The system considers the position of the wheelman and the speed at which his vehicle is moving. It calculates the most suitable and accessible parking place for him based on the location he wants to go, his destination arrival time, and the parking price he wants to pay. The system is modelled using an agent-oriented approach, whereby each agent tackles a specific challenge. Like, the model proposes seven different agents, assigned specific tasks and working without each other in order to help move a wheelman to a parking place. One of the main benefits of this model is that it considers the wheelman's destination arrival time among other factors when allocating parking places. It also takes into account the analytics for parking place allocations to get on with the allocation process.*

Keywords: Smart parking system, Agent-based modelling, Agent-based parking systems, Internet of Things, Smart Devices, Raspberry Pi

I. INTRODUCTION

A smart parking system is an innovative solution that plays a significant role in the overall transportation system by effectively reducing traffic congestion caused by parking issues. It assists drivers in finding the most appropriate parking space and resolves conflicts that may arise when multiple individuals have similar parking requirements. Regarding the development of smart parking systems, there are various common methods and approaches. Agent technologies have been proposed in numerous workshops as a favourable option for creating such applications. Agents are autonomous programs capable of independent execution, adapted to dynamic environments commonly encountered in parking systems. In many locations, paid parking is prevalent, requiring drivers to display parking tickets while utilizing designated parking areas. These areas are typically divided into different zones, such as Zone 1 and Zone 2, each with varying hourly tariffs. Upon identifying their parking space, drivers need to fill out a ticket and are allowed to occupy the spot for a maximum of 2 hours. Additionally, privately owned parking lots are available in city centres and towns. One of the primary challenges faced by drivers is the lack of real-time information about parking space availability. Consequently, they have to physically visit parking areas to determine if any spots are open. Furthermore, even if drivers manage to secure a parking spot, it often turns out to be far from their intended destination.

This paper presents the development of a smart mobile parking reservation system that addresses these challenges. The system considers the driver's location, driving speed, and arrival time to suggest the most suitable and available parking space based on the desired destination and the desired parking fee. The system is modelled using an agent-oriented approach, wherein each agent is responsible for addressing a specific challenge.

II. LITERATURE REVIEW

1. The paper which we have referred to is "**Smart Parking System using Sensors and Cloud based Network for Smart Cities Applications**". Which was published in 2019 by IEEE. The authors of this paper are VaaniRajvanshi ,

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Swasti Chaturvedi, Dinesh Yadav and Lokesh Sharma.The paper proposes a smart parking system for smart cities that utilizes sensors and a cloud-based network. The system aims to assist users in finding vacant parking spaces more efficiently. The system consists of two phases. In the first phase, an ultrasonic sensor detects the presence of vehicles in parking spaces and displays the information on an LCD screen using cloud technology. In the second phase, IR sensors detect improper parking by monitoring the boundaries of the parking spaces and triggering an alarm if a vehicle is parked outside the designated area.

2. The second paper which we have referred to is " **An IoT Based Intelligent Parking System for the Unutilized Parking Area With Real-Time Monitoring Using Mobile and Web Application**". The authors of this paper are A. Z. M. TahmidulKabir , Al Mamun Mizan , Plabon Kumar Saha , Md. Shajedul Hasan , MohitoshPramanik. In this paper Authors have discussed an IoT-based intelligent parking system that utilizes mobile and web applications for real-time monitoring and management of unutilized parking areas. The system aims to address the problem of parking scarcity by providing information on available parking spots to users. It integrates technologies such as IoT, GPS-GSM module, and image processing for parking management, availability monitoring, invoice generation, and payment system. The system offers both web and Android app-based solutions, as well as an offline mode.

3. The paper which we have referred to is about "**IoT based Smart Parking System**". The authors of this research paper are Abhirup Khanna and Rishi Anand. In this research paper, The IoT-based Smart Parking System is a cloud-integrated solution that addresses issues such as traffic congestion and limited parking facilities in urban areas. It utilizes sensors to monitor parking space availability and a mobile application for users to check and book parking slots. The system architecture involves parking sensors, a processing unit (Raspberry Pi), a mobile application, and the cloud (IBM MQTT server) for data storage. The implementation involves wireless sensor connectivity, data transmission to the cloud, and user interaction through the mobile application.

III. PROBLEM STATEMENT

With the fast growth of urbanization and the escalating number of vehicles on the roads, the demand for parking spaces has become a critical issue in urban areas. Traditional parking operation systems frequently face challenges similar as inefficient space application, business traffic, and lack of real- time information for motorists. To address these problems, the perpetration of an agent- based smart parking system using IoT technologies can offer a potential result.
This study aims to develop an effective and intelligent parking management system by using IoT technologies and agent- based approaches. The problem statement is to design and apply a smart parking system that optimizes parking space application, reduces business traffic, and provides real- time data to wheelmen, perfecting the overall parking experience.

IV. PROPOSED ARCHITECTURE

Hardware Components: The hardware components required for the smart parking system are IoT sensors, microcontrollers, etc. The sensors will be utilized to detect the presence of vehicles in parking spaces, while the microcontrollers will collect data from the sensors and control the actuators to manage parking spaces.
IoT Connectivity and Cloud Infrastructure: The system will leverage IoT connectivity to enable seamless communication between the parking infrastructure and the cloud. A reliable and scalable cloud infrastructure will be employed to store and process real-time parking data, enabling efficient data analysis and decision-making.
Agent-Based Optimization: The implementation will involve intelligent agents that can analyse and optimize parking space allocation in real-time. These agents will consider various factors such as parking availability, vehicle types, and user preferences to allocate the most suitable parking spaces to incoming vehicles.
Smart Payment Systems: To streamline the payment process, the implementation will incorporate smart payment systems that allow users to make cashless transactions using mobile apps or other contactless payment methods. This will enhance convenience for users and facilitate efficient revenue management.

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Web User Interfaces: User-friendly interfaces will be developed to provide users with access to real-time parking information, reservation services, and personalized notifications. These interfaces will enhance user engagement and facilitate seamless interactions with the smart parking system.

Overall, the goal is to implement an agent-based smart parking system using IoT that optimizes parking space utilization, reduces traffic congestion, and enhances user convenience through real-time guidance and intelligent decision-making.

V. SYSTEM ARCHITECTURE

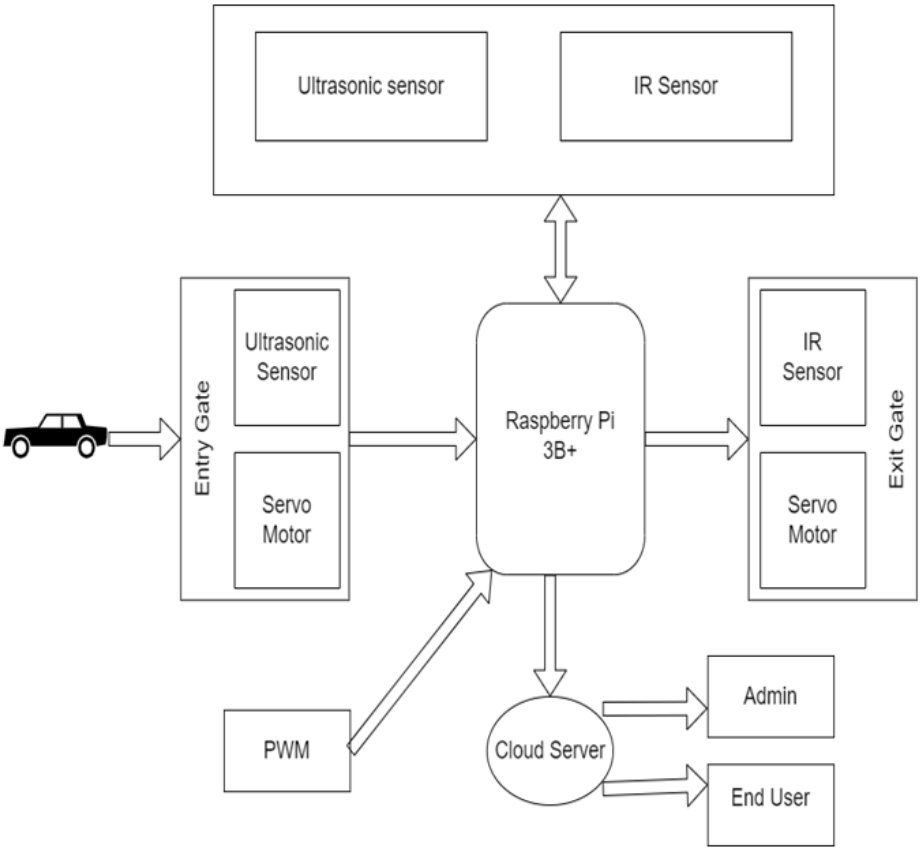

Fig 1: System Design

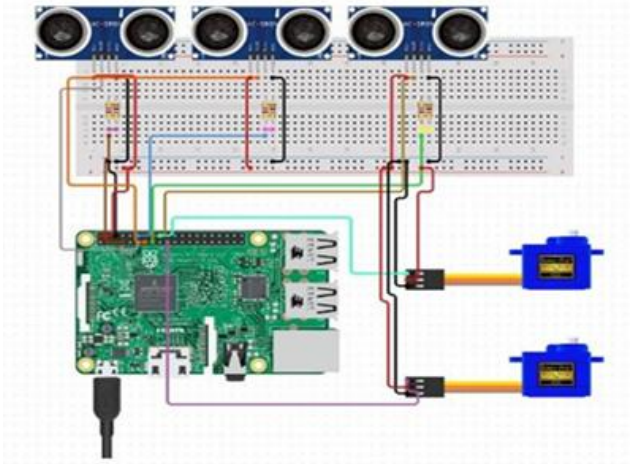

Fig 2: Circuit Diagram

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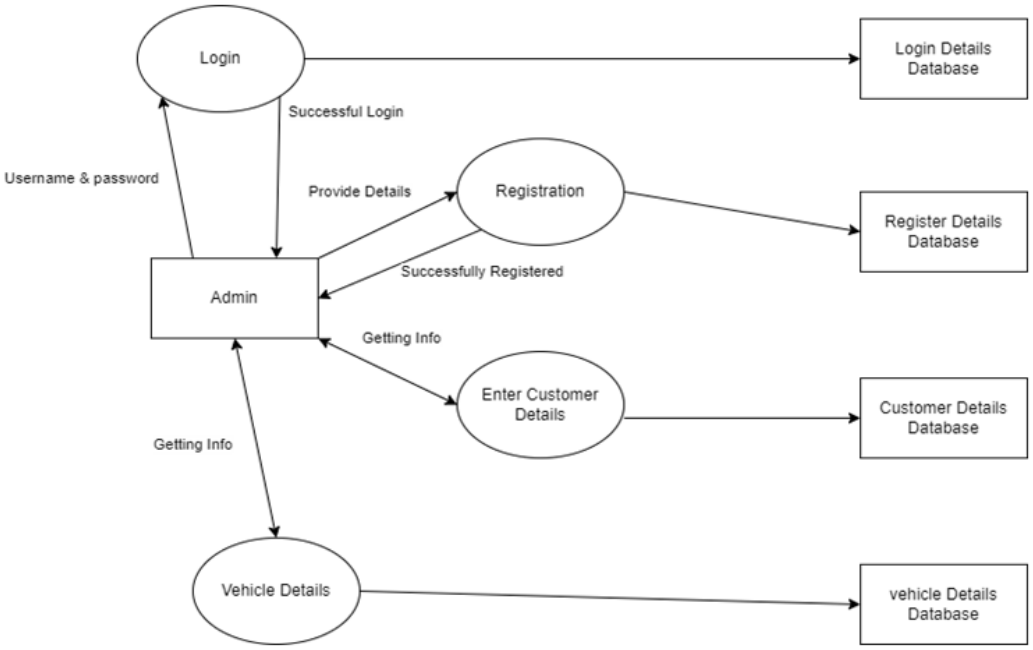

Fig 3. Data Flow Diagram

VI. PROPOSED WORK

To successfully implement an agent-based smart parking system using IoT, it is essential to design a comprehensive system that optimizes parking space utilization, enhances user experience, and improves overall parking management. The following stages and components are crucial for the successful implementation of the system:

- **System Architecture Design**: The initial step is to design the architecture and components of the smart parking system. This involves selecting appropriate IoT devices such as sensors, microcontrollers, and actuators. Additionally, designing the data collection, storage mechanism, and agent-based decision-making system is vital for efficient parking management.
- **Data Collection:** The next stage involves collecting real-time parking data using IoT sensors strategically placed at parking spaces. These sensors will detect the presence of vehicles and transmit the data to a centralized database. The collected data will be used for real-time monitoring and analysis.
- **Agent-Based Decision-Making:** Intelligent agents will be developed to analyse the data and make optimal parking space allocation decisions. These agents will consider various factors such as parking availability, vehicle types, user preferences, and traffic conditions to efficiently manage parking spaces in real-time.
- **Smart Payment Systems:** The implementation will incorporate smart payment systems that enable cashless transactions through mobile apps or other contactless methods. This will streamline the payment process, enhance convenience for users, and enable efficient revenue management.
- **Integration:** The smart parking system will be integrated with existing urban infrastructure and management systems such as traffic control systems and parking fee systems. This integration will ensure seamless coordination and facilitate better traffic flow and parking management.
- **Testing and Evaluation:** Once the system is developed, it will undergo rigorous testing and evaluation to ensure its reliability, accuracy, and scalability. Different scenarios and usage patterns will be tested to identify potential issues and improve system performance.

Overall, the proposed implementation of an agent-based smart parking system using IoT involves designing the system architecture, collecting real-time parking data, pre-processing the data, employing agent-based decision-making, providing real-time parking guidance, integrating with existing infrastructure, and conducting comprehensive testing

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and evaluation. The successful implementation of this system has the potential to revolutionize parking management, optimize space utilization, and enhance the overall parking experience for users.

VII SYSTEM OVERVIEW

The objective of this project is to implement an agent-based smart parking system using IoT to address the challenges of traditional parking management systems. The proposed system aims to optimize parking space utilization, reduce traffic congestion, and provide real-time information to drivers, ultimately improving the overall parking experience. The proposed system's project overview includes the following:

1. **Project Objectives:** The primary objective of the project is to develop a smart parking system using IoT and ML that automates the parking management process, optimizes space utilization, and enhances user convenience. The system aims to reduce parking search time, minimize traffic congestion, and improve overall parking efficiency.
2. **Project Scope:** The project's scope encompasses designing the system architecture, selecting appropriate IoT devices such as sensors and actuators, collecting real-time parking data, pre-processing the data, analysing the data using machine learning algorithms, generating parking recommendations, integrating the system with existing urban infrastructure, and conducting testing and evaluation.
3. **Project Deliverables:** The project will deliver a functional agent-based smart parking system that utilizes IoT. The system will provide real-time parking space availability information, optimize parking allocation decisions, and enhance the overall parking experience for drivers.
4. **Project Timeline:** The project timeline will be determined based on the project scope and deliverables. The timeline will include key milestones such as system design, IoT device deployment, data collection and pre-processing, machine learning model development, integration with urban infrastructure, testing, and evaluation. The timeline will be structured to ensure efficient project execution.
5. **Project Budget:** The project budget will encompass the costs associated with designing the system architecture, procuring and deploying IoT devices, data collection and pre-processing, developing machine learning algorithms, integrating the system with urban infrastructure, conducting testing and evaluation, and project management expenses. The budget will be carefully planned to optimize resource allocation and ensure the successful implementation of the smart parking system.
6. **6.Project Team:** The project team will consist of individuals with expertise in IoT, software development, and project management. The team will work together to ensure the project's success and timely completion.

By successfully implementing the agent-based smart parking system using IoT, the project aims to revolutionize parking management, optimize space utilization, alleviate traffic congestion, and enhance the overall parking experience for drivers in urban areas.

Hardware Components:

1. **IoT Sensors:** IoT sensors are utilized to detect the availability of parking spaces in real-time. Different types of sensors, such as ultrasonic sensors or magnetic sensors, can be deployed to accurately detect the presence or absence of vehicles in parking spots.
2. **Microcontrollers:** Microcontrollers like Raspberry Pi are employed to collect data from IoT sensors, process it, and make decisions based on the information received. They facilitate communication between sensors and the central control unit.
3. **Gateways:** Gateways serve as the bridge between the IoT sensors and the cloud infrastructure. They aggregate the data collected from sensors and transmit it to the cloud for further analysis and storage.
4. **Cloud Infrastructure:** The cloud infrastructure, such as AWS IoT or Azure IoT, is used to store and process the data collected from the sensors. It provides scalable storage and computing capabilities for efficient data management and analysis.
5. **Networking Devices:** Networking devices like routers and switches are necessary for establishing connectivity between the sensors, gateways, and the cloud infrastructure. They ensure seamless data transmission and communication within the smart parking system.

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6. **Power Supply:** Power supplies such as batteries or power adapters are used to power the hardware components.

Software Components:

1. **Embedded Software:** Embedded software is used to program the microcontrollers that control the IoT sensors and gateways. It enables data collection, pre-processing, and communication with the cloud infrastructure.
2. **Cloud Platform Software:** Cloud platform software, such as AWS IoT Core or Azure IoT Hub, is employed to manage and process the data received from the gateways. It provides storage, data analysis, and machine learning capabilities to derive valuable insights from the collected parking data.
3. **User Interface**: A user interface can be developed, such as a web-based dashboard to provide real-time parking information to users. It enables users to view parking availability, reserve parking spaces, and receive notifications about parking status.
4. **Database Management Software:** Database management software, such as MySQL is used to store and manage the parking data collected by the system. It allows for efficient data retrieval and ensures data integrity and security.

Overall, the implementation of an agent-based smart parking system using IoT involves the integration of various hardware components such as IoT sensors, microcontrollers, gateways, networking devices, and cloud infrastructure. These components work in conjunction with software components including embedded software, cloud platform software, machine learning algorithms, user interfaces, and database management software to create an efficient and automated parking management system.

VIII. CONCLUSION

This project aims to streamline the vehicle parking process by implementing a payment system and capturing customer and vehicle details for data storage. The primary focus is to ensure the safety and security of parked vehicles. The project planning phase has been conducted with great efficiency.

In conclusion, we have completed the project planning stage and will now gradually proceed with the development phase. The developed application will undergo testing using sample inputs to ensure it meets the specified requirements.

The system is expected to exhibit high levels of reliability, accuracy, and efficiency, resulting in reduced processing time and minimal errors. Additionally, the project is designed to be cost-effective and robust.

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