IOT Based Car Parking Using Edge Computing

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Abstract: The promise of autonomous driving is that edge computing can deliver real time services. Using a variety of sensors and communication modules, autonomous cars may function both indoors including in parking lots and outdoors. But because the interior station's ability to communicate with the outer world is limited globe, and the present underpowered autos don't really work; they could have to handle all the data. Autonomously, hence a control mechanism must be put in place. Completely self-sufficient car in the surroundings. In this research, we suggest an edge computing based smart parking system for self driving cars. Smart parking has resolved Boundaries and traffic, and parking spaces are managed using a grid. To assess the effectiveness of the smart parking system, In the current parking system, we contrasted the journey time with the parking time. Furthermore, the resource to make sure that the service quality margin number is offered and maintained; expenses and transaction data are examined.
Keywords: autonoums, edge computing, carparking, Iot-based car parking, smart car parking.

I. INTRODUCTION

The practice of doing tasks including data processing, event detection, and storage at the edge of the Internet of Things (IoT) network is known as edge computing. Without transferring data to a central place like the cloud, the edge in edge computing can work with neighbouring edges or process data locally. The cloud may improve quality of service (QoS) by offering end users real-time services while conserving bandwidth through edge services that serve as interfaces between the cloud and end users. Autonomous vehicles can be used both on the road and in closed spaces such as parking garages or underground. However, as we mentioned before, it is quite difficult to achieve this time due to limited traffic resources. Therefore, there must be a way to control the parking lot. Roadside units (RSUs), cameras, and vehicle-mounted global positioning systems (GPS) are being used in the study of several outdoor parking techniques. Research on parking in spaces like underground parking garages or other locations where contact with the outside world is challenging is still lacking, nevertheless. Automobile cluster computing. The moveable edge must travel till it finds an empty place in a general parking setting where there aren't many, and the moving distance grows as the parking lot gets bigger. However, in a smart parking lot, a mobile edge is connected to the system at the point of entrance, allowing it to locate a spot on its own. In order to evaluate the moving distance and parking duration of a mobile edge in a smart parking lot with those in a conventional parking lot setting, we ran trials in this study. By comparing the energy consumption of the deployed edge terminals for interaction with the number of data transmissions based on the number of data transmissions, we were able to establish the number of effective edge terminals for the smart parking lot service.

A set parking spot in the lot and a completely controlled vehicle that follows a cell phone make up the smart parking idea. An actual Raspberry Pi edge terminal model. Grid maps are used by the edge terminals and mobile edges positioned in parking lots to manage parking spaces, locate routes, and estimate locations. When a mobile phone enters the station, the edge terminal controls the grid map and sends it to the edge. To enter the station, the edge terminals link to the paper edge groups and exchange information with the mobile edges.

II. LITERATURE REVIEW

W. Shi, J. Cao, Q. Zhang, Y. Li and L. Xu [6] says that, the autonomous driving is one exciting field that edge computing can support in real time. Using a variety of sensors and communication modules, fully autonomous cars can drive on public roadways as well as inside structures like parking lots. However, a control scheme for fully self-driving cars in indoor environments must be developed because there is limited communication between indoor parking lots and the outside world, and autonomous cars do not yet have the real-time performance capabilities required to process all information independently. In this paper, we suggest an edge cluster computing-based smart parking lot for autonomous cars. A smart parking lot use grid maps for parking lot management and has both stationary and movable edge vehicles. FRahul Sakore [1] says that, the reservation-based smart parking system (SPSR) allows users to reserve an empty parking space. When the scheduled parking time is about to expire, the administrator will send a notification to the user through the network service. The disadvantage of this system is that other users are in the specific parking space, but this can be prevented by using a QR code scanner to identify the user. Aditya Basu [2] says that, Smart parking systems use low-cost sensors, instant data collection and mobile payment systems to provide information about parking spaces and allow parking spaces to be reserved in advance. This reduces the need for drivers to find parking spaces, which can reduce vehicle emissions and improve parking management. M2M technology increases safety and convenience through three modules: the monitoring module detects empty parking spaces and sends information to the control room via ZigBee, and the control system data to a central system and a display unit. The central system manages parking information and sends relevant information to mobile phone users, including parking allocation, parking time, fees and instructions. Ahteshamul huq Osmani [3] says that, our system provides an Android application that displays a map of parking lots where infrared sensors play an important role in detecting parked vehicles. The visual display of the application is updated according to the parking status detected by the infrared sensor. Registered users who frequently visit the parking lot can benefit from the electronic parking lot using the RFID tags we provide. After entering the station, the RFID card is heard and the administrator checks whether the user is authorized. When the vehicle arrives and the RFID tag is detected, the entry time is recorded, and when the vehicle leaves the parking lot, the exit time is calculated. The electronic valet account will be charged accordingly. Abhirup Khanna [4] says that, Smart parking systems based on the Internet of Things, which use sensors to collect and access information from remote locations via the cloud, thus increase the concept of Cloud of Things (COT). With this technology, parking lots can be monitored and controlled from anywhere. Our planning system provides real-time information about available parking spaces via a mobile application, allowing users to reserve parking spaces remotely. Anusha [5] says that, this study introduces a smart parking system using Arduino devices and mobile applications. The system includes a parking area that monitors and reports the availability of each parking space in real time. A mobile application is also provided for end users to check parking availability and make reservations. Smart parking like this can support economic development by reducing fuel consumption and urban pollution.

III. METHODOLOGY

A. GRID-MAPINPARKING-LOT:

[15] One method for making better use of available space is grid mapping. It is possible to designate a certain area with several barriers or routes. The grid map's benefit is that it makes it simple to represent interior and outdoor spaces without making any distinctions, which is especially useful for basic indoor object movement or robot control. Even in an unfamiliar location, a robot or mobile device can estimate its position using sensors that display its position in the grid. Additionally, a grid may be made beforehand to predict the placements of things while moving them or relocating them someplace if the user is already familiar with the building's structure. The entry, exit, driving, and parking are all predetermined, thus the underground or indoor parking lot is made to produce a plan. Additionally, the mobile phone may utilize the grid to determine its location and navigate to it because its edge is packed with several sensors and communication components.

B. RASPBERRYPI ANDEDGE-CLUSTER:

[12] One of the most popular add-ons for several projects is the Raspberry Pi. It has a WiFi module, Bluetooth, and GB of RAM. Additionally, it offers a Raspberry Pi operating system based on Linux that is compatible with Ubuntu or Windows. Additionally, a number of Raspberry Pi software modules have been made available. A collection of edges, such as Raspberry Pi, is called an edge cluster. In general, reduced power consumption is the goal of the edge. To make up for this flaw, Edge divides the data and forms groups along the edges. Fast data processing is made possible by this technique, which lowers the cost of data processing at each edge. Combining Raspberry Pi with edge clusters offers a scalable and reasonably priced edge computing solution. Due to their affordability and versatility, Raspberry Pi devices can serve as standalone nodes inside an edge cluster. This setup reduces latency and reliance on cloud infrastructure by enabling distributed processing, which analyzes data locally. Examples of applications include AI inference, IoT, and real-time analytics. Edge clusters enable parallel processing and fault tolerance while increasing performance by pooling the resources of several Raspberry Pi devices.

C. EXISTING SMART-PARKING LOT:

[1]Smart-parking has acquired a variety of techniques. Based on WSN, the smart station gathers and transmits data in bulk from sensor nodes that are deployed within the station. IoT-based smart stations may accomplish numerous scenarios by altering the connection structure, responsibilities, and data, even if their fundamental structure is identical to that of WSN. processing techniques. Register and manage many parking spots. Studies on using artificial intelligence for vehicle detection Intelligence is also continuous. Current studies on wireless sensor networks and the Internet of Things are presented in this area. and image processing, the majority of which look at different facets of smart parking. Processing data is feasible. [13] The most popular type of smart parking lot right now is image processing-based, which uses a single camera and requires fewer equipment than WSNs or the Internet of Things to record and examine several parking spots. Additionally, investigation into artificial intelligence-based vehicle detection is underway as well. This chapter outlines previous research. Pertaining to image processing, IoT, and WSNs, several of which examine several strategies pertaining to the smart parking lot.

IV. APPLICATION

1) WSN-based Smart Parking Lot:

[11] To assist cars in finding free parking, users can make use of web servers, wireless sensor networks, and a variety of smartphone applications. Through an application that is updated by sensors placed across the parking lot, drivers may monitor the condition of the lot. There are two types of web servers: central web servers and WSN internal web servers. Through the driver program, the internal network server and the central network server are updated concurrently. [14] The motorist was notified in of the quantity and location of parking spots that were available. Additionally, the technology in question makes it easier to manage and keep an eye on cars parked in spots. WSN, RFID, and ZigBee are used in the implementation of this technology, and either a distributed or centralized approach is used to handle the data gathered from each node. [10] The data is collected by the sensor nodes of WSN and then sent to the user through the sink to control the position of the station. In this study, ultrasonic sensors, Arduino and LCD are used for data collection, processing and monitoring purposes.

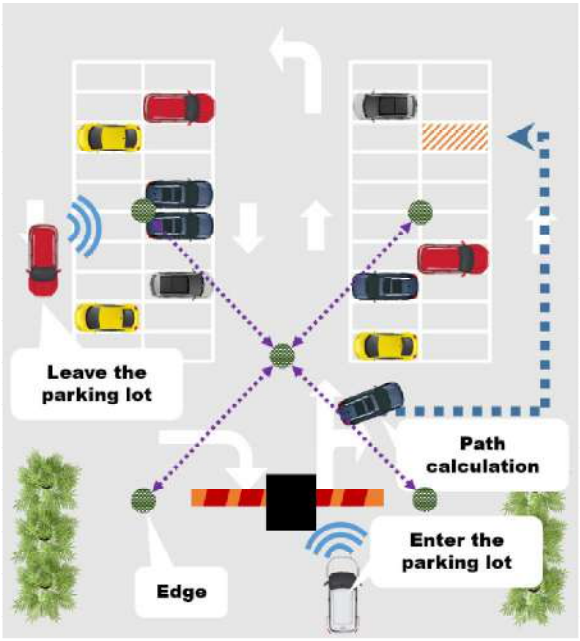

Figure1. Smart parking lot overview

2) IoT-based Smart Parking Lot:

[1] A detector module named SPIN-V, which includes a Jeer Pi, ultrasonic detector, camera, LED, buzzer, and battery, was used to determine if a car was in a parking spot or not. In this research, the parking lot owner used a monitoring center to oversee the entire lot, while the driver was able to book and manage a spot using a smartphone app. Similarly, three scripts ('Reserve and locate a parking place, Park someone differently in the reserved parking space, and the driver doesn't have an app and premises in an unreserved space') are used in the study to demonstrate the efficacy of a smart parking system. [6]Infrared and ultrasonic sensors were used to identify the presence of a car in the parking area. The LED lighting was then adjusted according on the detection outcome. Through a software model made up of sensor, network, cognitive, and application layers, the system then sent the observed data to the edge and cloud servers to update the parking lot status, lowering parking time and management expenses.Send the current station to the LoRa receiver using an ultrasonic sensor and a transmitter module based on a remote (LoRa). Through Wi-Fi, the recipient will transmit the data to the user's smartphone app and IBM Watson cloud. The LoRa receiver or the cloud may be used by users to view the station data.

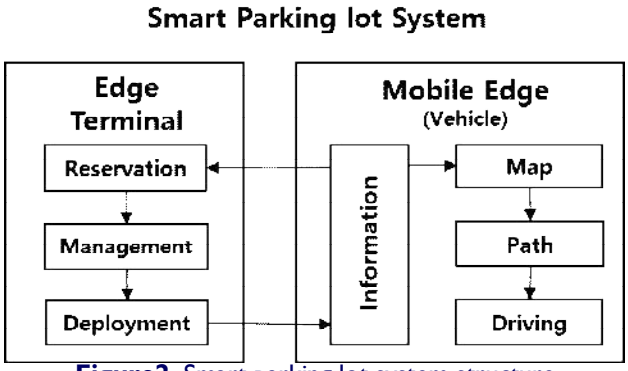

Figure2. Smart parking lot system structure

3) Image Processing-based Smart Parking Lot:

[7] The ARM9 microcontroller is used in the development of intelligent parking advice and information. To recognize and detect parking spaces, a camera is coupled to a microcontroller. Red boxes show the locations of stations in acquired photos. By choosing one of the available spots, the user can book a parking spot. While taking a picture of the parking lot, explain how to tell the difference between occupied and vacant spaces in an occupied parking lot and show it on the LCD. [10] In order to evaluate the station's nature, every image in this research was converted to grayscale. The modified picture did not include the area outside the parking lot. Station and no station were then shown on the LCD once the station's state was ascertained by binarization. [1] explains a technique for identifying occupied and vacant spots inside a parking lot and displaying them on an LCD while the lot is being captured on camera in real time. In order to evaluate the condition of each parking spot, each picture frame used in this study was converted to grayscale. The modified picture no longer included the area outside the parking spot. The occupied and vacant parking spots were then output to the LCD after the parking space's state was ascertained by binarization. [8] A Raspberry Pi 3 camera, image processing, and Firebase were used to evaluate the parking space status. The parking lot was photographed using the camera, and the Raspberry Pi's Haar cascade technique was used to process the pictures. The Haar cascade technique was used to choose a number of characteristics from each image as it was processed. AdaBoost was then used to train these features, and a classifier was used to identify items. The parking lot's current state was then uploaded to Firebase, which allowed for remote parking lot status checks. [1] A smart parking lot that uses image processing is a cutting-edge approach to urban parking issues that provides sustainability, convenience, and efficiency. It can direct cars, automate spot detection, and expedite payments by using cameras and sophisticated computer vision algorithms. This system decreases traffic congestion in parking lots, maximizes space use, and requires less human interaction. Better parking management is also made possible by using data analytics, which offers insightful information about utilization patterns. Such solutions are a major step toward smarter, more connected urban infrastructure, guaranteeing better user experiences and long-term operational efficiency as cities expand and the need for effective parking grows.

V. FUTURE DIRECTION

[13]IoT-based parking and edge computing are revolutionizing urban transportation. By combining real-time information from sensors with device operation, the technology provides a number of benefits, including instant parking, seamless navigation, dynamic pricing, and advanced traffic management. Edge computing processes sensitive data locally, improving privacy and security while reducing latency for faster response times. This new approach has the potential to reduce traffic, reduce emissions, and provide drivers with more convenient and efficient parking. [9] The future of edge computing-based IoT-based parking systems rests in improving scalability, efficiency, and compatibility with new technologies. Parking systems can now handle data closer to the source thanks to developments in edge computing, which allows for real-time analytics and latency-free decision-making. AI-powered algorithms will probably be included into future systems to increase car identification accuracy, optimize space allocation, and forecast parking demand using both historical and current data. Furthermore, the addition of cutting-edge edge devices like Raspberry Pi-based clusters and NVIDIA Jetson will improve computing power even more, strengthening these systems and enabling larger-scale deployments. [11] Connecting IoT parking systems to smart city infrastructures is another exciting avenue. To provide a smooth urban mobility experience, edge-enabled parking solutions can cooperate with EV charging networks, traffic control systems, and public transportation hubs. Additionally, blockchain technology could be essential for decentralized transaction automation and data interchange security. The performance of IoT sensors and edge devices will also be boosted by 5G connectivity developments, guaranteeing quicker communication and more dependability. [8] Future systems may potentially include augmented reality (AR) for drivers, which would allow them to use heads-up displays or smartphones to navigate in real time to open parking spaces. These systems will become more energy-efficient and sustainable by utilizing edge computing, which will help to lower emissions and traffic in metropolitan areas.

VI. CONCLUSION

An [14] innovative method of handling parking issues in cities is the use of edge computing in IoT-based vehicle parking systems. Edge computing guarantees real-time responsiveness, lower latency, and less reliance on cloud infrastructure by processing data locally. By using predictive analytics, optimum space usage, and precise vehicle identification, these systems improve parking management efficiency.

Their scalability and performance are further enhanced by the integration of AI algorithms with cutting-edge edge devices like the Raspberry Pi and NVIDIA Jetson, which makes them perfect for smart city deployments. The [15] future of these systems depends on their capacity to smoothly integrate with larger urban infrastructures as cities expand and transportation needs rise. They help to build a cohesive smart city environment by integrating with public transportation, EV charging stations, and traffic control systems. In order to improve connection, security, and user experience, emerging technologies like 5G, blockchain, and augmented reality will be essential. Additionally, by lowering pollutants and traffic, these technologies support sustainability and support international initiatives for greener urban development. In conclusion, edge computing-based IoT-based parking solutions have enormous potential to transform urban transportation and parking. As they develop further, smarter, more connected cities will be created, enhancing urban dwellers' quality of life and stimulating technological advancement.

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