**SMART PARKING USING A SPACE DETECTION SYSTEM**

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**PROBLEM STATEMENT:**

Implementing a smart parking system via the help of GPS by connecting all parked vehicles in a network, to induce proper traffic practices and reduce road blockades.

**ABSTRACT**

* Parking sensors in each parking spot detect vehicle presence and send data to a microcontroller, which communicates with a router via Wi-Fi or Ethernet. The router transmits this data over the internet to a central server, where it is processed and stored. Users access real-time parking availability through a web or mobile application, displayed on mapping apps like Google Maps. This system enhances convenience by showing available parking spots before users arrive, saving time and reducing hassle.
* The communication process involves several OSI model layers, including physical for data transmission, network for data transfer via the router, and application for server data processing and user access. Scalability challenges include increased data volume, network traffic, server load, network reliability, maintenance complexity, security concerns, interoperability issues, and costs, requiring robust infrastructure and efficient solutions to address.

**INTRODUCTION:**

As time goes by, cities undergo different levels of modernization, with the aim to make the lives of its residents more comfortable and peaceful. SDG 11, short for “Sustainable Development Goals 11”, are a set of guidelines meant to depict the different aspects of change required, to make any residential area a “smart city”. Out of these categories, this paper aims to provide a solution for “Smart Parking”, a method by which users are able to not only discover available parking spaces in parking lots using their maps, but also aims to provide a method to “book” those parking spaces for a limited time, effectively guaranteeing that the user gets an assured parking spot.

Smart parking comes under SD11.2, which states that: “

“Emerging technological advancements have paved the way for innovative solutions in the realm of parking management, particularly in the form of smart parking sensors, technologies, and applications. While considerable attention has been directed towards closed parking environments, where these systems have showcased notable efficacy, there remains a distinct gap in research pertaining to their applicability in open parking lots”

The architecture of intelligent parking solutions generally consists of a hardware component involving decides such as sensors, cameras…, and a software component including communication protocols and software solutions.

Some tools that may be used for implementing an effective smart parking system are:

* Parking sensors: Sensors are positioned in parking spaces to identify the presence of vehicles. These sensors provide real-time data to a centralized system, so that users can locate available spaces without delay. There are several types of sensors that can be used, such as magnetic sensors, ultrasonic sensors and infrared sensors.
* Guidance Systems: Guidace systems use dynamic display panels or mobile applications to direct drivers to available parking spaces. Real-time information on space occupancy is used to guide drivers to areas with the greatteset number of free spaces.
* Cameras: Capture imaaes or videos of the parking spaces, and this data is then analyzed using advanced techniques such as image analysis to track the status of a parking space, as to determine whether the space is vacant or not.
* Automated Payment System: Smart parking systems can include cashless payment systems that allow drivers to pay for parking electronically. This can be done through mobile apps, payment kiosks, or vehicle-mounted devices, reducing the need for physical payment transactions.
* Smart Parking Meters: Advanced parking meters enable drivers to pay for parking using payment methods, such as credit cards, mobile wallets, or prepaid parking cards. These meters often integrate with back-end systems to provide teal-time payment verification and enforcement.

**Limitations:**

The few limitations of smart parking, which hinders its implementation and usability are:

Cost: With other projects of SDG11 already underway, implementation of a space detection system will undoubtedly increase the monetary requirement for not just the implementation of the system, but for the implementation of SDG 11 altogether.

Maintenance: Implementation of smart parking in multiple parking lots, especially ones that are exposed to the environment, would require regular maintenance to ensure the system functions properly.

Disruption: Underlining the requirement of proper maintenance, any sort of malfunction in the sensor will cause the wrong data to be relayed to the customer, thus causing confusion and disrupting the coordinated chain of events.

Sensors: Magnetic sensors have a rapidly decreasing battery life as accuracy requirements increase. Modern electric vehicles may also not have ferromagnetic parts, which can impact detection accuracy.

**Design:**

A simple smart parking system consists of three ultrasonic sensors, conveniently placed on 3 separate locations that would be connected to an ESP 32 microcontroller, which is in turn wirelessly connected to another ESP32, and would transmit real-time signals between each other. This eps32 acts as a medium between the server and the esp32 system, hence relaying data that would be displayed in map applications for customers to see.

A circuit board with wires and wires

Description automatically generated

A step further from this plan would be to implement a “Booking “ system, such that the customer would be able to book their parking spaces well ahead of their arrival. The booking system is structured in such a way that the slots would be based on a 30-minute interval. Where if the vehicle does not arrive in that timeframe, the booking gets canceled, and the customer gets refunded.

The code used for the ultrasonic sensor is as follows:

const int trigPin1 = 14;

const int led=27;

const int echoPin1 = 12;

//define sound speed in cm/uS

#define SOUND\_SPEED 0.034

long duration1;

double distance1;

void setup() {

**Serial**.begin(115200); // Starts the serial communication

  pinMode(trigPin1, OUTPUT); // Sets the trigPin as an Output

  pinMode(led,OUTPUT);//sets led as an Output

  pinMode(echoPin1, INPUT); // Sets the echoPin as an Input

}

void loop() {

  // Clears the trigPin

  digitalWrite(trigPin1, LOW);

  delayMicroseconds(2);

  // Sets the trigPin on HIGH state for 10 micro seconds

  digitalWrite(trigPin1, HIGH);

  delayMicroseconds(10);

  digitalWrite(trigPin1, LOW);

  // Reads the echoPin, returns the sound wave travel time in microseconds

  duration1 = pulseIn(echoPin1, HIGH);

  // Calculate the distance

  distance1 = duration1 \* SOUND\_SPEED/2;

  // Convert to inches

  // Prints the distance in the Serial Monitor

**Serial**.print("Distance1 (cm): ");

**Serial**.println(distance1);

  if(distance1<30){

    digitalWrite(led, HIGH);

  }

  else{

    digitalWrite(led, LOW);

  }

  delay(1000);

}

**Conclusion:**

Smart parking is one of the pillars of SDG 11, specifically SDG 11.2, and its implementation is relatively simple, yet effective.

The model designed in the paper would be one of the ways in which a smart parking system can be implemented, given that the microcontrollers are near prevent signal disruption or unnecessary communication delay. The presented model

Even though smart parking has its own role to play in building a smart city, it does not come without its own drawbacks, such as maintenance, cost, and device malfunction.

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