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IoT based Smart Parking System Using Bluetooth

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Abstract:

This paper presents an IoT-based smart parking system utilizing Bluetooth technology to efficiently manage parking spaces in urban environments. The system integrates Bluetooth Low Energy (BLE) sensors installed in parking spots with a central server and a mobile application. BLE sensors detect the presence of vehicles and transmit this information to the server, which updates the availability status in real-time. Users can access the availability status via a mobile app, allowing them to locate and reserve parking spaces conveniently. The system improves parking efficiency, reduces congestion, and enhances the overall urban mobility experience.

Keywords:

1.Arduino IDE program software.

2.Development board ESP8266.

3.Communication devices.

4.Sensors.

I. INTRODUCTION

In today's rapidly urbanizing world, the challenge of finding parking spaces in crowded cities has become increasingly daunting. Traffic congestion, wasted time, and environmental pollution are just a few of the consequences of inefficient parking management systems. To address these issues, there is a growing need for innovative solutions that leverage cutting-edge technologies. In this context, the Internet of Things (IoT) has emerged as a transformative force, offering unprecedented opportunities for optimizing various aspects of urban infrastructure, including parking management.

This paper introduces an IoT-based smart parking system that utilizes Bluetooth technology to revolutionize parking management in urban environments. Traditional parking systems often rely on outdated methods, such as manual monitoring or static signage, leading to inefficiencies and frustration among drivers. In contrast, IoT-enabled solutions leverage interconnected sensors, real-time data processing, and

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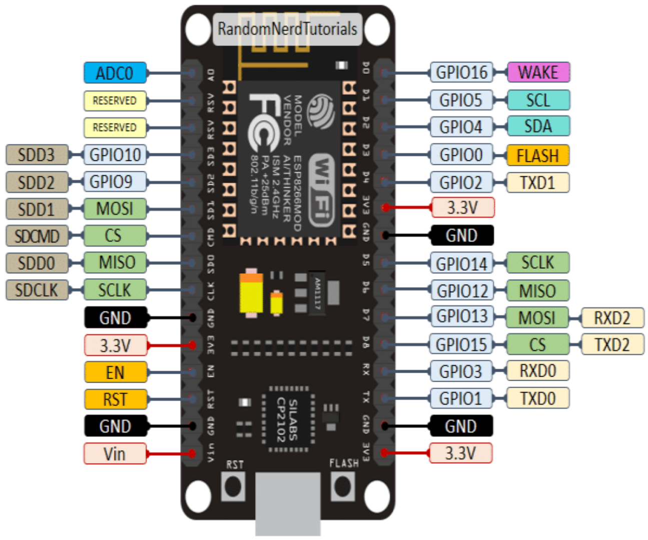
user-friendly interfaces to streamline the parking experience for both drivers and parking operators.

The proposed smart parking system utilizes Bluetooth Low Energy (BLE) sensors installed in individual parking spaces to detect the presence of vehicles. These sensors communicate wirelessly with a central server, providing real-time data on parking space availability. A dedicated mobile application serves as the interface for users, allowing them to access this information conveniently and reserve parking spaces remotely.

By harnessing the power of IoT and Bluetooth technology, the smart parking system offers several key advantages. It enables real-time monitoring and optimization of parking spaces, leading to improved efficiency in space utilization and reduced congestion on city streets. Furthermore, the system enhances the overall user experience by providing drivers with accurate information on parking availability, reducing the time and frustration associated with searching for parking.

Development board ESP8266:



Connectivity: The ESP8266 can connect to Wi-Fi networks and GSM, enabling the parking system to access the internet. This connectivity can be used for remote monitoring, control, and data exchange.

1.Magnetic sensor:

The magnetic sensor in a smart parking system using Bluetooth is typically placed in parking spots to detect the presence or absence of vehicles. When a vehicle parks or leaves, the sensor detects the change in the magnetic field and sends this information wirelessly via Bluetooth to a central system. This data is then used to update parking availability information in real-time, allowing drivers to find and reserve parking spots efficiently using a mobile app or other interface.

2. Infrared sensors:

These sensors detect the presence of vehicles by measuring infrared radiation emitted by objects in their field of view. They are often used in conjunction with a central control system to monitor parking spaces.

2.Communication devices:

1.Bluetooth Beacons or Sensors: These are installed in individual parking spaces or at strategic locations within a parking facility. They continuously broadcast Bluetooth signals to detect nearby devices and communicate with them.

2. Central System: This could be a server or cloud-based platform that collects data from the Bluetooth beacons/sensors. It processes the information received and manages the overall operation of the smart parking system.

3.Smartphones: Users' smartphones act as receivers in the system. They detect Bluetooth signals from the beacons/sensors and communicate with the central system through dedicated mobile applications. Users can view parking availability and other relevant information on their smartphones.

4. Parking Management Software: This software is part of the central system and includes algorithms for analyzing data collected from the Bluetooth devices. It determines parking availability, updates parking status in real-time, and manages user interactions through the mobile app.

5. User Interface (Mobile App): The mobile app provides a user-friendly interface for drivers to interact with the smart parking system. It displays parking availability, allows users to reserve parking spaces, navigates users to available spots, and provides other relevant information such as pricing and time limits.

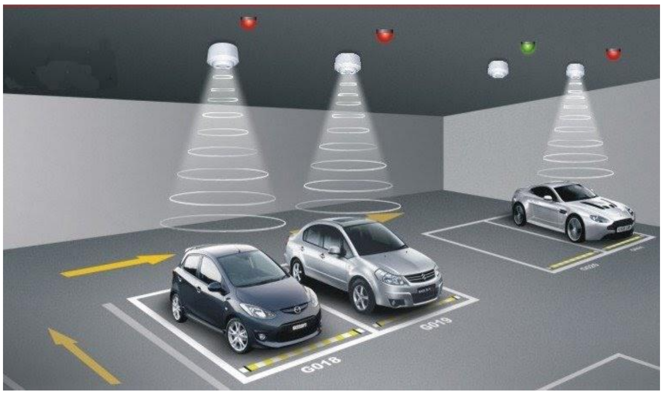
3.SENSORS:

1. Infrared sensors:

These sensors detect the presence of vehicles by measuring infrared radiation emitted by objects in their field of view. They are often used in conjunction with a central control system to monitor parking spaces.

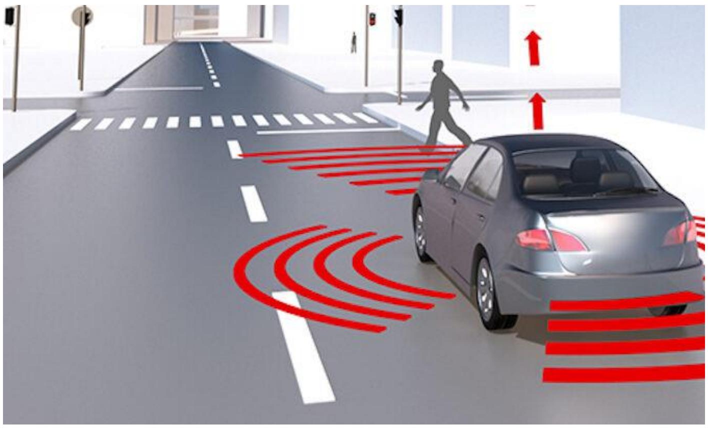
2.Ultrasonic sensor:

A smart parking system using ultrasonic sensors is a system that can monitor empty parking spaces and identify the locations where individual users have parked their vehicles. The system uses ultrasonic sensors to detect either car park occupancy or improper parking actions. The system is designed to assist drivers to find vacant spaces in a car park in a shorter time.

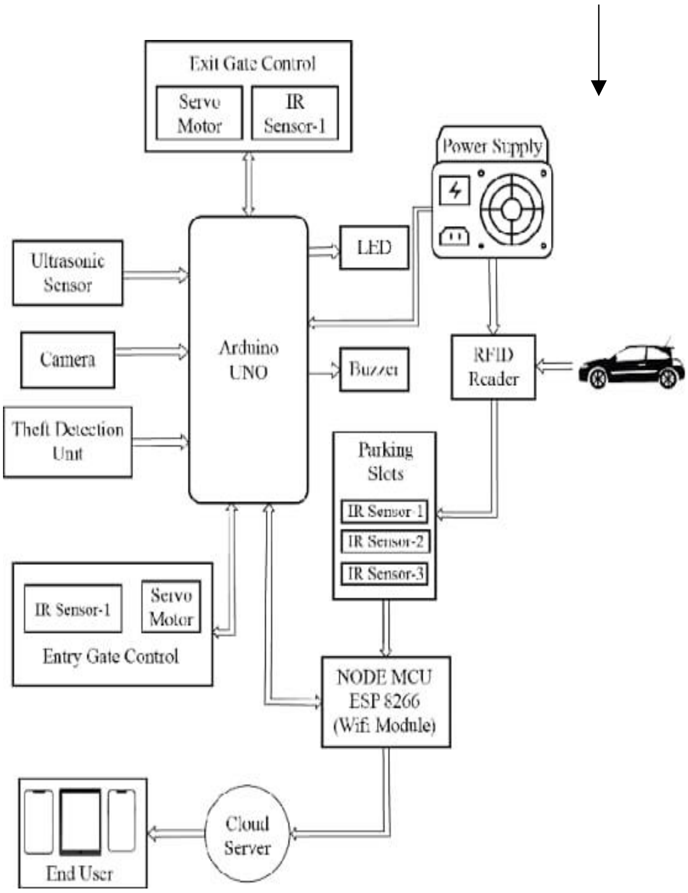


3.Proximity sensor:

In a smart parking system using Bluetooth, proximity sensors can be utilized to detect the presence of vehicles in parking spaces. These sensors would be equipped with Bluetooth technology to communicate with nearby smartphones or other devices. When a vehicle enters the vicinity of a parking space, the proximity sensor detects it and sends a signal to the corresponding app on the user's smartphone, indicating the availability of that parking spot. This allows drivers to easily find and reserve parking spaces without the need for physical tickets or manual searching.



CIRCUIT DIAGRAM



Program:

```
#include <ESP8266WiFi.h>
#include <BLEDevice.h>
#include <BLEUtils.h>
#include <BLEScan.h>

#define SCAN_TIME 5 // Scan time in seconds
#define PARKING_SERVICE_UUID "0000180d-0000-1000-8000-00805f9b34fb"
#define PARKING_STATUS_CHAR_UUID "00002a37-0000-1000-8000-00805f9b34fb"

// WiFi settings
const char* ssid = "YourWiFiSSID";
const char* password = "YourWiFiPassword";
```

```
BLEScan* pBLEScan;

void setup() {
 Serial.begin(115200);

 // Connect to WiFi
 WiFi.begin(ssid, password);
 while (WiFi.status() != WL_CONNECTED) {
  delay(1000);
  Serial.println("Connecting to WiFi...");
 }
 Serial.println("Connected to WiFi");

 // Initialize BLE
 BLEDevice::init("");
 pBLEScan = BLEDevice::getScan();
 pBLEScan->setAdvertisedDeviceCallbacks(new
MyAdvertisedDeviceCallbacks());
 pBLEScan->setActiveScan(true);

 // Start BLE scan
 pBLEScan->start(SCAN_TIME);
}

void loop() {
 // Do nothing in the loop, scanning is handled
asynchronously
}
class MyAdvertisedDeviceCallbacks: public
BLEAdvertisedDeviceCallbacks {
 void onResult(BLEAdvertisedDevice
advertisedDevice) {
  Serial.printf("BLE Device found: %s\n",
advertisedDevice.toString().c_str());

  // Check if the device advertises the parking service
UUID
  if (advertisedDevice.haveServiceUUID() &&
advertisedDevice.isAdvertisingService(BLEUUID(PA
RKING_SERVICE_UUID))) {
   Serial.println("Parking service found");

   // Check if the parking status characteristic is
available
   if (advertisedDevice.haveServiceData() &&
advertisedDevice.getServiceDataUUID().equals(BLEU
UID(PARKING_STATUS_CHAR_UUID))) {
    Serial.println("Parking status characteristic
found");

    // Get the parking status data
    std::string statusData =
advertisedDevice.getServiceData();
    // Assuming the status data is a single byte
indicating occupancy
    bool isOccupied = statusData[0] != 0x00;

    // Process parking status
    if (isOccupied) {
     Serial.println("Parking spot is occupied");
    } else {
     Serial.println("Parking spot is vacant");
    }
   }
  }
 }
}
```

Connections:

1.Conceptualize the System: Define the scope of the project, including the number of parking spaces to monitor, the target audience, and the desired features.

2.Hardware Selection: Choose appropriate hardware components such as Bluetooth modules, microcontrollers (like Arduino or Raspberry Pi), sensors (to detect car presence), and actuators (to indicate parking space availability).

3.Bluetooth Communication Setup: Implement Bluetooth communication between the parking sensors and a central device (such as a Raspberry Pi or a smartphone). Ensure compatibility and reliability.

4.Sensor Installation: Install sensors in parking spaces to detect the presence of vehicles. These sensors could be ultrasonic sensors, infrared sensors, or magnetic sensors.

5.Data Processing and Storage: Develop software to process data received from the sensors. This may involve writing code to interpret sensor readings, determine parking space occupancy, and store this information in a database.

6.User Interface Development: Create a user-friendly interface for both parking lot attendants/managers and end-users. This interface could be a mobile app or a web application, allowing users to view parking availability in real-time.

7.Integration and Testing: Integrate all components together and thoroughly test the system to ensure reliability and accuracy. Test various scenarios such as different weather conditions, varying vehicle sizes, and high traffic volumes.

8.Deployment and Maintenance: Once testing is successful, deploy the system in the target parking lot(s). Provide ongoing maintenance and support to address any issues and to keep the system up-to-date.

Advantages:

Advantages of a smart parking system using Bluetooth listed in points:

1. Real-time parking availability updates.
2. Enhanced efficiency in finding parking spots.
3. Convenience through smartphone integration for reservation and navigation.
4. Cost-effectiveness compared to other sensor technologies.
5. Seamless integration with navigation apps.
6. Valuable data collection for parking management optimization.
7.Scalabilityand easy implementation.

Disadvantages:

1. Limited Accuracy: Bluetooth signals can sometimes be affected by interference or signal blockage, leading to inaccuracies in detecting available parking spaces.
2. **Dependency on Smartphone Usage**: The system relies on users having Bluetooth-enabled smartphones and actively using them, which may not be universal or consistent across all users.

3. Privacy Concerns: Bluetooth tracking raises privacy issues as it can potentially track individuals' movements within parking --7areas, leading to concerns about data privacy and surveillance.

4. Initial Setup Complexity: Implementing a Bluetooth-based system requires installing and configuring sensors, which can be complex and time-consuming, especially in larger parking facilities.

5. Maintenance Requirements: Bluetooth sensors require regular maintenance, including battery replacements and software updates, which can add to the overall operational costs.

6. Compatibility Issues: Compatibility issues may arise with older smartphones or devices that do not support Bluetooth technology, limiting the accessibility of the system to certain users.

Conclusion:

The conclusion of an IoT-based smart parking system using Bluetooth could highlight the system's effectiveness in optimizing parking space utilization, reducing traffic congestion, and improving user experience. It may also discuss challenges faced during implementation, such as Bluetooth range limitations, and propose potential solutions or future enhancements, like integrating with other IoT technologies for broader coverage and functionality. Overall, it emphasizes the system's contribution to smarter and more efficient urban environments.

Reference:

One reference for an IoT-based smart parking system using Bluetooth is the paper titled "Design and Implementation of Smart Parking System Based on IoT Technology" by Xiaoming Jiang, Junyang Li, and Ming Xu. This paper discusses the development and implementation of a smart parking system that utilizes Bluetooth technology to detect and manage parking spaces in real-time. You can find this paper in academic databases or online repositories for further details.