SMART CAR PARKING MANAGEMENT SYSTEM

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Abstract: *This paper discusses an Internet of Things project that will be implemented, and whose aim is to make it easier to manage every limited and private car parking area and description of hardware components for implementing this system. Is proposed a smart system for making the parking process easier and more secure. The Intelligent Car Parking Management System allows parking only those cars whose plate number is in the database and does not allow access to the parking area vehicles that are not registered. Moreover, this system is having such a great feature so that users can book through the user interface the parking slots in time and can see what slots are available.*

Keywords*: parking, sensor, IoT, car, plate number, detection, camera, intelligent system.*

Introduction

Nowadays a lot of people have vehicles because it is a basic need. This need comes with the development of corporate offices, shopping centers, educational institutes, that generates a problem of organization a parking space where people can park their vehicles safely, quickly and easily.

Everything is under the process of urbanization. And unfortunately, a big problem on a global scale is traffic congestion caused by vehicles. Car parking problems are a major problem with confined parking spaces in urban cities. Searching for a parking space isn't such a pleasant activity for many people in cities around the world.

This is a problem for drivers, parking guards. It is very difficult to find a parking space where is a crowd of cars. A lot of time is wasted for entering the parking slot and finding a vacant place, or if there is no vacant space - this means a waste of time. Moreover, for parking guards, it isn't so easy to have records of vehicle details in a handle registry. This is a problem that unauthorized people can enter on the parking of an organization.

Solution

For solving the problems related above is proposed an intelligent car parking management system, which is an automatic system. There will be developed a system that will overcome the difficulties encountered while using the existing system. [1-2] Moreover, there will be no parking guard that will register every car and can be eliminated the manpower. Our system will consist of a camera that will scan the number of cars, and if this car is in the database, then the bar will open, otherwise, it will remain closed.

Also, the driver will know if there are any available slots or no, for saving time. In the coming future, there will be an excessive need for a Car parking management system.

The role of IoT is to provide wireless access to the system, where the user can keep track of available parking spaces via internet connection.

Network communication

The network communication between the device and the server is performed either using a SIM card module and GPRS/3G internet connection, or a Wi-Fi module connected to a WLAN.

The *advantage* of using the GPRS/3G internet connection is that the system will be totally standalone and will be able to work regardless of different network issues with the local Building that is sharing this internet connection. On the other hand, this implies that the account that is linked to this SIM card, must also be managed, like a separate entity.

Cloud

The embedded system that is being built, will be splitter into modules, like are shown in Figure 1:

- the module which is responsible only for the entrance and exit of the parking area
- the module that analyzes the number plate of the car that just came to the entrance
- the cloud system (server/database) that stores all the data related to cars that have access to the parking area.
- the end-user interface that will mainly be responsible for the 2SV (two-step verification) of the access to the parking area. The steps that the user must perform are the following: When the user is close enough to the camera, and the camera can detect the plate number, having the account information which is linked with this plate number, the application will show a message, asking the user to confirm his presence at the barrier.
- the end-user interface for managing / administering all this data mentioned before.
- the server will have an API (rest endpoints) that tells the parking management system either it should open the gate, or deny the access of the car to the parking area.

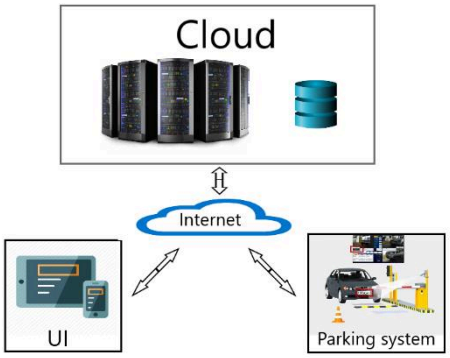

Figure 1. System Architecture

The database contains the data related to:

- car numbers which has access to the parking area (some of them might be in a black list)
- the information related to the car holder
- the accounts of the people who will have to confirm their presence at the parking area entrance (2SV)
- the accounts of the people responsible for managing all this data
- full logs related to the cars that entered and left the parking area.

Security

The security of the system is ensured using the following techniques:

- 2SV - To avoid the possibility of hacking the camera with a fake number plate, it is required to confirm the presence of the car in front of the camera from a user interface, mobile number, gear, tablet, and other devices which support the application.
- Account login - the authentication to the user-interface will also require 2FA. Even if the password of the account becomes known to the unauthorized people, they wouldn't not be able to use it thanks to the 2FA. The authentication to the system will be confirmed either using an SMS code confirmation or an email code confirmation.

- The security of the user-interface will also be ensured using such tokes as CSRF, which will exclude the possibility of user session theft

It might also store a local copy of the allowed car numbers and ensure the availability of the system in bad weather conditions, or technical maintenance of the cloud environment, or other force majeure circumstances.

Hardware

For implementing this system, we will use the following hardware components for:

- measuring distance between obstacle and object - **ultrasonic sensor,** that are more suited for this project that require shorter range sensing, where it is very much still capable. [3]
- detecting / recognizing license plate number - **raspberry pi camera module**, because it provides a best resolution and we can control zoom and quality of video. So, PiCAM is a good way to recognize the plate number of the car that was booked or want to entry to the park area. [4]
- displaying information about available slots - **LCD display**, because it is easy to use, it is enough to display the number of free parking slots, or show a message that the parking area is full. [5]
- controlling the position of the boom barrier - **servo motor**, because we need a high precision of motion control and excellent torque, not only at low speed and at high speed. The servo motor rotates within a 180 degrees range. It has physical stops built into the gear mechanism to prevent turning beyond these limits to protect the rotational sensor. [6]

  Raspberry Pi is used as MCU for controlling all the components of the system and making the network connection with the cloud. [7]

Jumper wires are used for making connections between items (sensors/actuators) to the microcontroller' s header pins (Raspberry Pi). We use them to wire up all our circuits.

Implementation

Below is a basic scheme of how all our project must work (Figure 2). Firstly, you need an app to access the parking lot (1). Let us assume that we reserved a space in the parking lot through the app. Secondly, we approach the boom barrier and a camera scans our plate number to see if it exists in DB (2). The MCU finds that we have a reserved spot and our plate numbers are in DB and it opens the barrier. We parked our car.

Mobile application

Our mobile application scope is to give access to the parking lot for specific users. There are 2 user types. First one is the **user** and the second one is an **admin.**

Each user has an account that he gets from the admin, so only specific users determined by the admin can gain access to the parking lot. After the login page, the user can see the number of empty parking spots, a list with car plates associated with his account (a user can have multiple cars) and he can reserve a parking spot. The functionality in the reservation page is quite simple. You can select the car plate number you are in and the number of minutes you are away from the parking lot. Based on this information the boom barrier will not give access to other cars for the spaces reserved during 10 min period.

An admin must register a new user, also add plate numbers for him and add technical information. Technical information means Info from Technical Passport of the car and some drive license info. An admin can do all the *CRUD (CREATE/READ/UPDATE/DELETE)* functionality for the plates and for accounts.

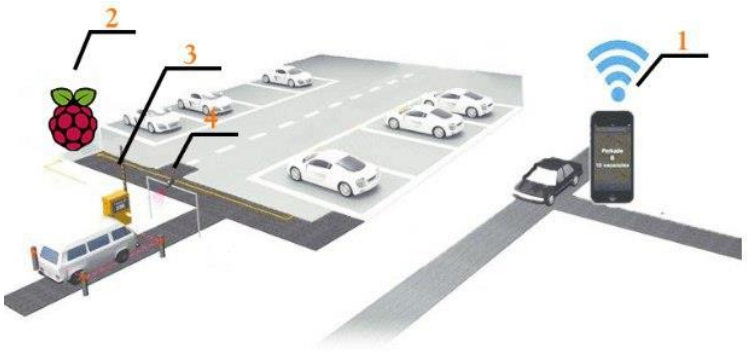

Figure 2. Basic scheme of an intelligent car management system

1. **Mobile Application** - used for reservation of a parking lot, confirmation if you are in front of the camera.
2. **Microcontroller** - raspberry pi microcontroller that does synchronization between sensors, actuator with the cloud.
3. **Boom barrier** - used for access restriction for unknown users.
4. **Camera** - used for car plates detection and comparing with authorized car plates.

Conclusions

This paper analyzes the role of IoT project based on the implementation of a smart car parking management system. There were described all the steps from the problem analysis to the detailed description of the architecture. Also, it describes the hardware component for further implementation of the system. For a better understanding of how this system will work is presented the system architecture.

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