Authenticated IoT Based Online Smart Parking System with Cloud

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Abstract

The day to day urbanization of the developing countries has led to the increase in the need for vehicles. This has in turn resulted in the emerging of new vehicles into the market. There is increase in number of vehicles but no proportional increase in the parking space. Lot of time is wasted in search of the parking place. This leads to the parking problem in busy areas. In order to solve the problem the need of automated parking system, online parking slot booking, multi-story parking garage etc., are increased. The objective of this project is to build an online parking slot booking. And also secure it with various security algorithms to protect it from intruders. In the present work a prototype of online parking system is developed and a mobile App is developed which will allow the user to check the vacant parking slots at their hands.

Keywords: *smart parking, IoT, Authentication, Android App*

1. Introduction

1.1 Online parking slot booking

Due to the rapid growth of the vehicles on the road, parking has become a tough job for the people to find a parking spot. Online parking slot booking is one of the ways to solve this problem. Online parking slot booking is a technique where the user is able to access the available slot and given a feasibility to reserve the slot for his vehicle.

In the present work the technology IoT (Internet of Things) is used to make the parking system more intelligent and choice based system. Hardware components Node MCU, IR sensors and software components Cloud access, Cryptographic techniques are used in the present work

1.2 Internet of Things

IOT is the network of physical devices embedded with electronics, software, sensors and actuators. It enables, then to connect and exchange data for computerizing the physical world resulting in reduced human exertions.

2. Hardware configuration

The project is implemented by using Node MCU. The top view and side view are shown in figure 1. And for this we need IR sensors because with that we can identify whether the car has arrived to the parking area. This can also be accessed with the cloud to store the data. In this we will use multiple security algorithms to protect it from intruders. If we use only one security algorithm, then hacker can easily decrypt it. So here we use multiple security algorithms which make it difficult to decrypt.

NODE MCU:

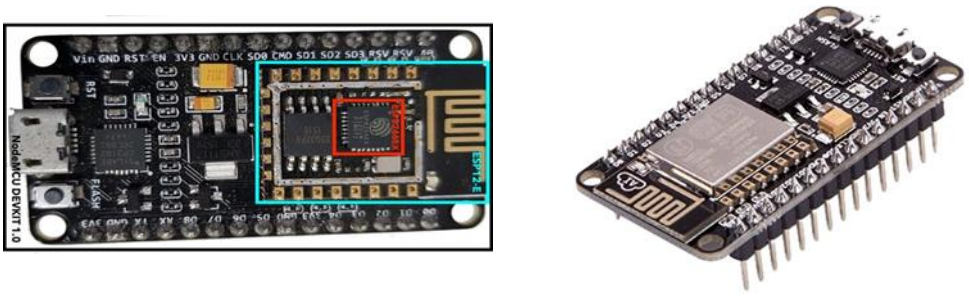

Figure 1 snapshot of NodeMCU used in this project

2.1 Architecture

The NodeMCU called as Devkit has developed with onboard WiFi module (ESP-8266). It facilitates the user to use WiFi module without going for external device. Indirectly it saves the power consumption and also the space occupied by the hardware circuit. NodeMCU can be easily interfaced with any compatible USB port. The layout of NodeMCU is shown in figure 2.

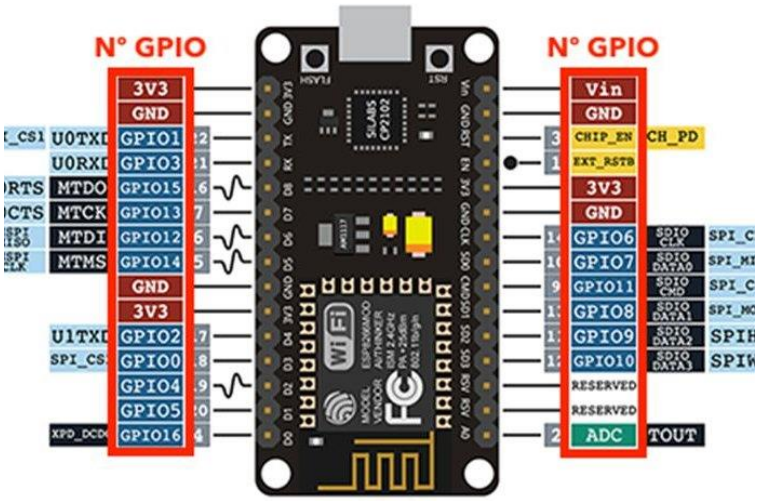

Figure 2 Layout of NodeMCU

2.2 WiFi module

The NodeMCU contain onboard WiFi Module ESP8266 with autonomous TCP/IP protocol as shown in figure 3. This enables any processor to access the WiFi network. The WiFi module can be used to host an application or for importing network functions from other applications. This module supports AT commands which will function similar to Arduino Wi-Fi module. The current NodeMCU module has advantage of low economic, with more features, and hence mostly used device in IoT applications.

This was made by Espressif. It has integrated WiFi and low-power consumption. This processor supports features of reduced Instruction Set of Computer Processor and functions with maximum clock frequency upto 160 MHz.

Figure 3 WiFi Module

2.3 Digital I/O Pins

Just like Arduino, the ESP8266 has digital input/output pins (I/O or GPIO, General Purpose Input/output pins). They can be used as digital inputs to read a digital voltage, or as digital outputs to output either 0V (sink current) or 3.3V (source current).

Voltage and Current Restrictions: Since the ESP8266 is a 3.3V microcontroller, its I/O operates at 3.3V as well. Applying more than 3.6V on any pin will kill the chip because the pins are not 5V tolerant. 12mA is the maximum current can be drawn from one GPIO (General Purpose Input/Output) pin.

Usable pins: Although ESP8266 has 17 GPIO pins (0-16), we can only use 11 of them, because 6 pins (GPIO 6 - 11) are used to connect the flash memory chip, small 8-legged chip right next to the ESP8266. If we try to use one of these pins, you might crash over your program. GPIO 1 and 3 are used as TX and RX of the hardware Serial port (UART), simultaneously, so in most cases, we can't use them as normal I/O while sending/receiving serial data.

Table 1 Mapping of D pins with GPIO pins

Pin name	GPIO Pin number
D0	**16**
D1	**5**
D2	**4**
D3	**0**
D4	**2**
D5	**14**
D6	**12**
D7	**13**
D8	**15**
D9/RX	**03**
D10/TX	**01**
D11/SD2	**09**
D12/SD3	**10**

Input/Output Pins:

- **digitalWrite** do NOT work with GPIOs 6, 7, 8, 11, and ADC (A0)
- **digitalRead** do NOT work with GPIOs 1, 3, 6, 7, 8, 11, and the ADC (A0)
- **analogWrite** do NOT work with GPIOs 6, 7, 8, 11, and ADC (A0) (GPIOs 4, 12, 14, 15 have hardware PWM, and the others are by software)
- **analogRead** works only with the ADC (A0)
- **6, 7, 8, 11** do NOT work for the above four commands

This is the one that provides access to the GPIO (General Purpose Input/Output) subsystem. Access is based on the I/O index number on the NodeMCU dev kits but not the internal GPIO pin. For example, the D1 pin on the dev kit is mapped to the internal GPIO pin 5. The table 1 refers to the GPIO pin maps for the index↔GPIO mapping. The functionalities and limitations are shown in table 2.

Table 2 Functions of GPIO pins

GPIO	Function	State	Restrictions
0	Boot mode select	3.3V	No Hi-Z
1	TX0	-	Not usable during Serial transmission
2	Boot mode select TX1	3.3V (boot only)	Don't connect to ground at boot time Sends debug data at boot time
3	RX0	-	Not usable during Serial transmission
4	SDA (I^2C)	-	-
5	SCL (I^2C)	-	-
6 - 11	Flash connection	x	Not usable, and not broken out
12	MISO (SPI)	-	-
13	MOSI (SPI)	-	-
14	SCK (SPI)	-	-
15	SS (SPI)	0V	Pull-up resistor not usable
16	Wake up from sleep	-	No pull-up resistor, but pull-down instead Should be connected to RST to wake up

2.3 **IR sensor**

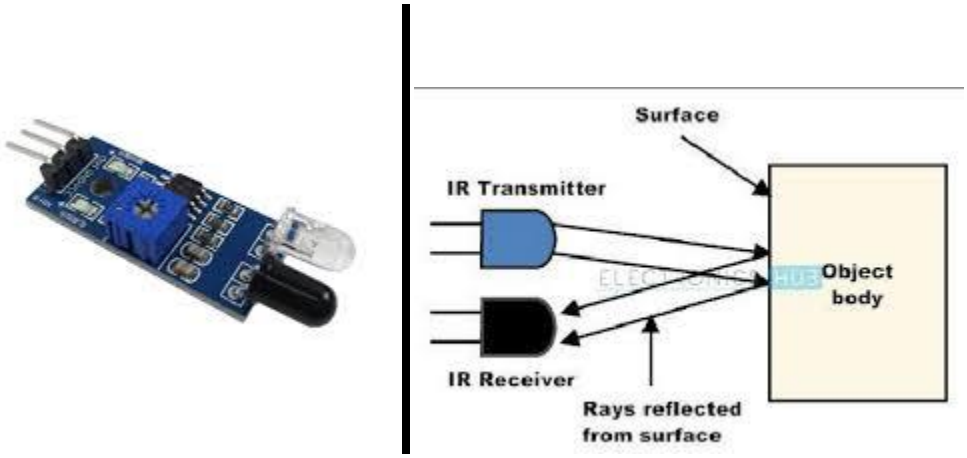

Figure 4 Working principle of IR module

An infrared_sensor is an electronic device, which emits IR rays in order to sense some aspects of the surroundings. An IR sensor can measure the heat of an object and also detects the motion. This type of sensor measures only infrared radiation emitted by object. Generally these types of thermal radiations are invisible to normal eye but can be detected by infrared sensor. The basic working principle is, when an IR LED emits light the photodiode senses the IR light as shown in figure 4. The voltage across photodiode proportionally changes with respect to IR light intensity. The voltage variations are depends on the resistance across photo diode. The resistance of photodiode is sensitive to the light falls on photodiode. In the present work the IR sensor module used is as shown in figure 5.

Figure 5 IR module in the present work

3. Accessing cloud

The cloud is a technology through which we are free to access computer, information technology (IT), software applications and data centers through a wide area network or an internet connectivity. Almost all IT resources, a software program or application, a service, or an entire infrastructure can live in the cloud. For example, if a business wants to build an IT infrastructure, typically it needs to install the servers, software, and networking resources but nearly all of those services and resources are now accessible by going to third party servers that offer them in the cloud.

Advantages: Cloud computing has many advantages like it is faster in providing the service, and in many cases, you can gain access to it instantly. Remote users can access cloud resources from wherever they have a connection, rather than being limited by geographical location. According to the permissions given to grant access the services provided by the cloud the cloud is classified into three standard categories. They are named as public, private, and hybrid services. As the name implies the public cloud offers services to every-one on the internet. The private cloud built for autonomous bodies and utilized only by the local network of the same organization.

The hybrid cloud provides services for the above two types of owners.

Cloud technology: The cloud service providers, provides the services to the client are categorized into three types. They are Software-as-a-Service (SaaS), Platform-as-a-Service (PaaS), and Infrastructure-as-a-Service (IaaS). The SaaS, as the name represents it provides softwares for developers. The PaaS provides platforms to host applications. The IaaS provides infrastructure such as computing systems, networking etc., as service. Virtualization technology is the key for cloud computing because it allows physical servers, storage, and networking services to be partitioned on demand, using software and to be provisioned for customers.

There are three methods to connect the cloud.

- ✓ Using Wi-Fi module
- ✓ Using excel sheet

✓ Android app

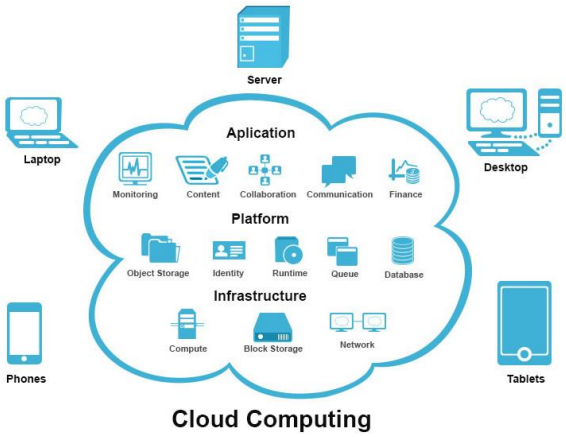

Figure 6 Applications of Cloud Computing

4. Implementation

Wi-Fi Module: If Arduino is used, it has to be installed Wi-Fi Module separately. Since Node MCU is used in the present project, and it has an in-built Wi-Fi module, there is no need of installing it separately.

Excel sheets: Excel Sheets acts as an intermediate between Node MCU and cloud. The data can be stored/retrieved from the cloud.

Android app: Certain apps provide a platform to control Arduino, Raspberry pi, Node MCU etc. over the Internet.

Blynk App: In the present work Blynk App is selected in this project .It is a digital dashboard where it can be used to build a graphic interface by dragging and dropping widgets. The blynk App will get this application online immediately when Node MCU is connected with internet.

Cryptographic algorithms: Cryptography is the study of techniques for securing data .Encryption is important because it secures data from unauthorized access and maintains confidentiality.
Cryptography is classified into two categories one is Symmetric key cryptography and second one is Asymmetric key cryptography.

Symmetric key cryptography: It is an encryption system in which a common key is shared in between sender and receiver of a message. The key is used to encrypt the message on sender side and the same key is used on the receiver side to decrypt it.

Asymmetric key cryptography: In this, different key is used on the sender and receiver side for encrypting and decrypting the data. The keys are different but are mathematically related.
Since Blynk App is used in the project , there is no need to use cryptographic algorithms . The app provides required security for the project. It generates an authentication code, which has to be entered in the source code, is known only to the user.

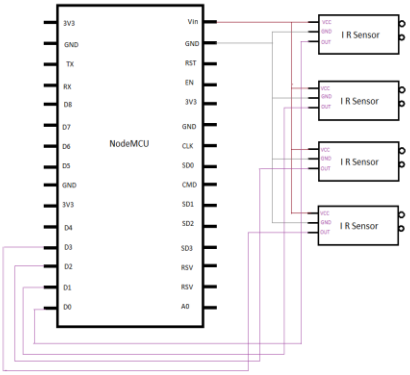

Figure 7 Circuit diagram of system

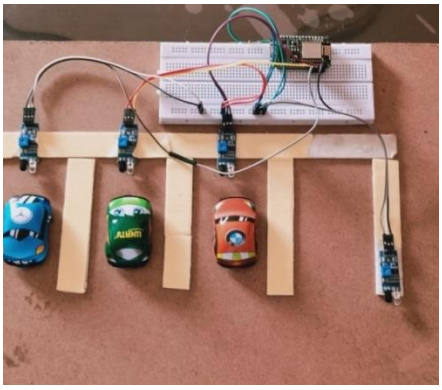

Figure 8 Prototype of parking System

5. Results and discussion

The Figure 9 to 11shows the project design on the left, and snapshots of the mobile App on the right. The figure 9 depicting that all parking slots are vacant. Figure 10 is showing when all slots are filled. Figure 11 is showing that only slot is vacant for parking.

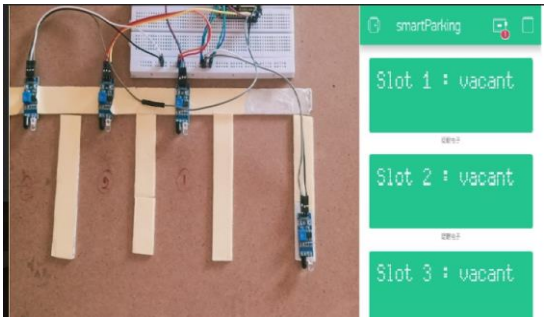

Figure 9 Three parking slots are empty and are available for parking

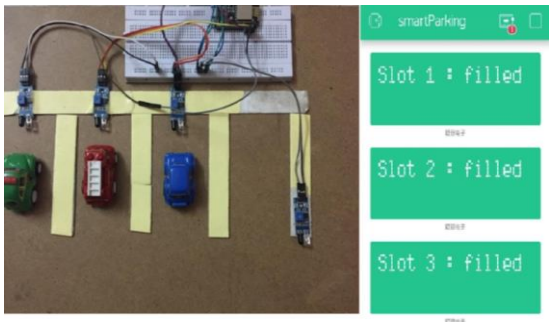

Figure 10 None of the parking slots are available for parking and are full

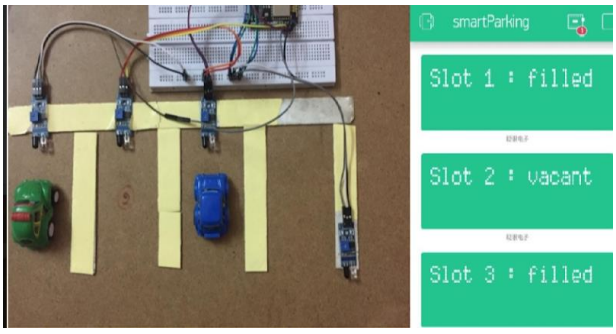

Figure 11 First and third slots are filled and second one is available

6. Conclusion

Technology has been progressed exponentially. It enables us to increase our comfort and to achieve efficiency in all sectors. It reduces the human efforts making our life easier. The current project smart parking system is one of them. Smart Parking system provides the availability of slots in busy area and thus reduces the time to search for an empty parking slot in rush hours. The current project provides cloud access and also required security to protect it from intruders.

In this project a mobile App is developed to check the vehicle empty slots. This will provide flexible service to the clients for checking of slots in parking arena.

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