

IoT Enabled Smart Parking System

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Abstract - Nowadays, an increase in population and as its direct result an increase in pollution is one of the major concerns of modern society. One such inevitable aspect of population explosion is that of increased vehicular traffic. As more and more people acquire vehicles, the need for available parking spaces increases drastically as well. Due to this, in urban areas, people end up burning a huge amount of unrenewable fossil fuels in search of parking spaces in designated parking lots (i.e. for malls, expos, carnivals, fairs, etc.) sometimes even driving around a parking lot for a while until they find a vacant parking spot. Using IoT we can easily target and tackle this issue. Using a combination of obstruction detecting IR sensors and Distance measuring Ultrasonic sensors (SONAR), we can design a Smart Parking System that lets users know about vacant spots in parking lots and display a visually represented data of the same for instant monitoring.

Key Words: NodeMCU, ESP8266, Ultrasonic Sensor, IR Transceiver, WiFi Module.

1. INTRODUCTION

The existing manual method of vehicle parking requires an assigned individual who monitors the parking lot frequently and reverts back the status to the gatekeeper who then keeps a tab of vacant and occupied spaces and allows a specific number of vehicles (corresponding to the number of vacant parking spaces available) into the parking lot. Not only is this process lengthy and tedious but it even leaves a huge possibility of human errors at almost every step. For example: A mistake made by the patrolling officer in counting the number of vacant spaces may lead to either vacant spaces not being occupied by agitated vehicle owners waiting for vacancy or having all the spaces occupied and having the vehicle owner wait even after being allowed into the lot. Another flaw in the current system involves assigning incompetent individuals for patrolling duties, as such individuals won't work properly and according to the rules and create chaos making their presence as good as their absence.

However, information exchange has now been made fast, reliable and secure due to the recent advancements in the field of information transfer and communication. Such advancement coupled with reduced cost of electronic and telecommunication devices has subsequently given rise to low cost communication and computing devices like NodeMCU and ESP8266 WiFi connection module. Computing

devices like NodeMCU are now available readily throughout the world.

We aim to create an automated Smart Parking System using NodeMCU which enables a gatekeeper to keep a track of the status of all parking spaces in a lot and provide a visual representation of the real time data acquired. If there are any vacant spaces the gatekeeper gets alerted of the exact location of the vacant space so he/she can guide the vehicle to the vacant location without any hassle.

1.1 COMPONENTS USED:

(**Note:** The components mentioned below are for designing and running a prototype and not the final system. The final system will use more advanced and powerful sensors and components.)

NodeMCU: The NodeMCU is an open source firmware development board designed to incorporate the ESP8266 WiFi chip. It consists of:

1. 16 General Purpose input/output pins (of which 4 can be used as PWM outputs).
2. 1 analog input.
3. USB connection (USB A to micro-B).
4. A FLASH button.
5. And a RESET button.

It can be powered with a USB cable directly connected to a device or a battery pack. It can accept 7V-12V of input voltage and can operate on a maximum voltage of 3.3V. It is a cheap, WiFi enabled and education-oriented board which can be implemented for prototype IoT systems and/or projects.

ESP8266: The Espressif ESP8266 chip is a highly integrated WiFi chip with a highly compact design, reliable performance and overall efficient power usage. It supports Wifi Protocols at 802.11 b/n/e/i bands clocked at 2.4 GHz. It features an on-chip SRAM and a Tensilica L106 Diamond series 32-bit processor. It functions at a supply voltage of 2.5V to 3.6V.

Ultrasonic Sensor (HC-SR04): The Ultrasonic Sensor is a sensor that measures distances from a point using ultrasonic waves. Here the trigger head of the sensor emits ultrasonic waves that travel a path and get reflected when they hit a target. The distance between the sensor and the object is then calculated by measuring the time difference between emission and reception of the waves. It functions on an

operating voltage of +5V and can measure a practical distance of 2cm to 80cm.

IR Transciever (FC-51): The IR Transciever is an Infrared based proximity sensor; it is mainly used to detect and avoid obstacles and for line following bots. It consists of an infrared transmitter and a receiver soldered onto a compact PCB design along with two indicator LEDs and a regulator to control distance measurement of the module. The transmitter emits infrared beam and the receiver (i.e. photo-transistor) receives that IR beam post reflection. The module can be used to identify an obstacle.

-One onboard LED indicates if the module is connected properly.

-Another onboard LED indicates detection of an obstacle.

2. RELATED WORK

The proposed system aims to operate as an automated Smart Parking System which enables a gatekeeper to keep a track of the status of all parking spaces in a lot and provide a visual representation of the real time data acquired. If there are any vacant spaces, the gatekeeper gets alerted of the exact location of it so he/she can guide the vehicle to the vacant location without any hassle. If there happen to be no more vacant parking spaces left, the system alerts the gatekeeper to not let any more vehicles into the lot until a vacancy is reported/detected.

2.1 Problem Formulation

The proposed system, although convenient and advanced, gives rise to a few problems and challenges such as:

- Cost of implementation of such a system for usage over a short duration of time (such as for fairs or a temporary outdoor exhibition) will be comparatively higher than hiring a manual labor since the system will require a power supply and a constant wireless connectivity along with cost of installation and maintenance.
- Training individuals to utilize such a system will become a necessity since any aspect of the functioning of the system left unexplained to the operator will lead to a great deal of confusion and might cause chaos or irritability to the end receiver (i.e. the vehicle driver). This in turn will make employment of eligible individuals for the post of operator tedious and time consuming.

3. Proposed System

Figure-1 shows the block diagram of the proposed system. The components used are A NodeMCU board, the FC-51 IR Transceiver Module, HC-SR04 Ultrasonic Sensor, and a Central Server. The programming language used for

NodeMCU is C and the IDE used is Arduino IDE. The Server is programmed using MySQL.

The proposed method uses IoT system to automate the current parking system. In this method the two HC-SR04 Ultrasonic sensors detect if the entire parking space is occupied or not, while two FC-51 IR Transceiver sensors installed on either edges of the space verify if the vehicle is parked properly or not and if at all the incorrectly parked vehicle is obstructing the space of another vehicle. If yes, then the system will alert the gatekeeper and the vehicle owner about the same so that immediate action can be taken.

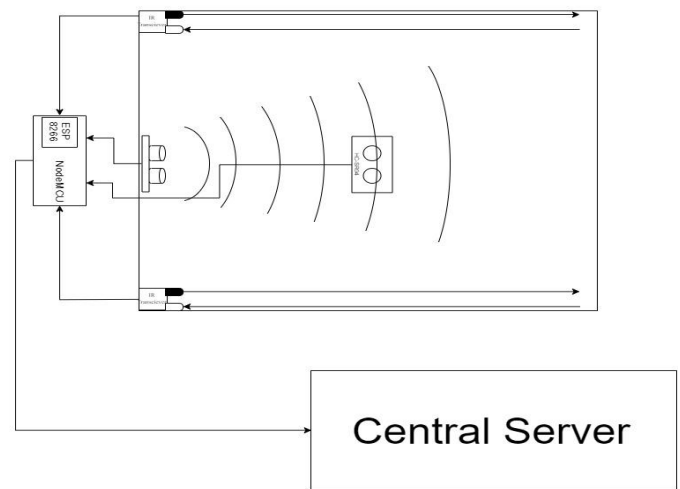
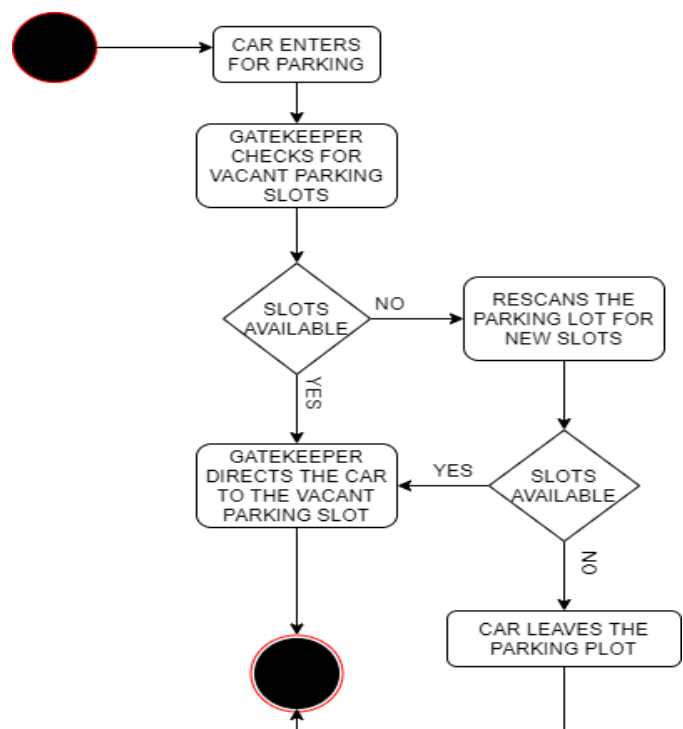


Figure 1

The NodeMCU sends the parking space status (i.e. vacant or occupied) to the central server via WiFi internet connectivity.



There are three scenarios that can occur for the current system:

- **Spot Vacant:** The spot in consideration is vacant i.e. there are no vehicles parked in that spot. In this case the system will display that the space as vacant and ready for accommodation.
- **Spot Occupied:** In this case the spot in consideration is occupied so the system will display the space as occupied and hence not available for accommodation until vacated.
- **Spot Obstructed:** In this case either the parking space is obstructed by an incorrectly parked vehicle or by an individual who knowingly or unknowingly is obstructing a vacant parking space. In such cases the system detects the parking space as obstructed and alerts the gatekeeper or concerned person about the situation and advises to take immediate action as necessary.

3.1. Advantages of our Proposed System:

- **Live Monitoring:** Since the system utilizes sensors and online data transfer, the situation can be monitored in real time by the gatekeeper or any concerned individual. This helps in reducing time and effort by automating the system rather than manually inspecting the situation or status.
- **Reduced chances of errors:** This system makes use of electronically generated values and sensor data. This reduces the chances of user error and misinformation from individuals.
- **Reduced Fuel Wastage:** Since the system detects vacant spaces and informs the end user of the same, they don't have to keep driving through the entire parking lot in search of a parking space. This not only reduces time and effort but also saves precious fossil fuels.

4. Future Scope:

- **Online Payment Portal:** We can include an online payment system using QR Code, NFC or RFID to let users pay parking fares at pay and park sites. This eliminates the issue of excess fare being charged by corrupt individuals by making the process transparent and foolproof.
- **Online Pre-booking:** A provision can be made to book a parking space online, i.e. reserve a parking space online for a particular time slot. The concerned person has to arrive at/occupy the parking space by the speculated time or the space will be allotted to whoever is present and seeking it.

- **Alerts and Assistance using AI:** We can completely eliminate the need for human involvement in this system by programming an AI that functions as a gatekeeper and directs vehicle owners to the vacant parking spaces if available and to other parking lots if the current parking lot is filled. Furthermore, it can also alert the vehicle owner in case of an incorrect parking.

5. CONCLUSIONS

Multiple steps have been taken to curb the nuisance of pollution and our system is one of them. Using this system, we can help reduce pollution by eradicating the need for roaming around a parking lot in search of an empty parking space.

This system makes use of IoT technology for real-time parking space monitoring. This system can greatly increase end user satisfaction and contribute to reduction in wastage in fossil fuels and time. This system is highly efficient and scalable. Since efficient sensors and a low powered NodeMCU are used, it uses less energy. This system can automate the current manual Parking System.

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