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IOT Based Vehicle Parking Manager

Rakshana R[1], Rohith S[1], Santhosh Bala S[1], Santhosh Kumar S[1], Dr. Senthil Kumar K[2]

[1]UG Student, Department of Electronics and Communication Engineering, Rajalakshmi Engineering College, Chennai, Tamil Nadu, India

[2]Associate Professor, Department of Electronics and Communication Engineering, Rajalakshmi Engineering College, Chennai, Tamil Nadu, India

ABSTRACT

In today's fast-paced world, time is of the essence. With the growing number of vehicles in urban and semi-urban towns and cities the time wasted in traffic is alarmingly high. Too much dismay, the time wasted in finding a parking spot is equally high and can be easily prevented. When properly planned, parking vehicles can be a swift process. An Automated Parking Manager with Cameras and wireless sensor networks is proposed in this paper. Several versions of cameras exist and there are no parking lots today without a camera. Video Surveillance over wireless sensor networks has been widely adopted in various cyber-physical systems including border security, traffic analysis, healthcare systems in hospitals, public safety (bus, mall etc.), wildlife tracking and environment/weather monitoring etc. However, this paper aims to solve a rather interesting scenario that is not much discussed in reality. Instead of using the cameras only for security and surveillance purposes, cameras can also be used to monitor the parking lot for empty spaces with the help of Wireless Sensor Networks. The usage of Wireless Sensor Networks improves reliability and acts as a fool-proof technique to detect the presence or absence of a vehicle in a particular spot. All these camera systems available in the market run 24x7 and have enormous junk data stored in the form of videos. So the proposed system in this paper does not store any video information. Media data is always the heavier data to store. Instead, very little information in the form of text is stored about the vehicles and their designated spots, thereby reducing huge storage issues. This solution does not require any major modifications to the pre-existing architecture of the surveillance infrastructure in any parking arena. It only requires an extension and some amount of processing to choose and store the required information on a cloud-based storage so that it can be viewed by users from an Android Application from anywhere. This allows the users to make well-informed decisions about the parking situation in the complex they want to visit. The proposed solution can be applied to shopping complexes, theatre's, drive-ins and pretty much any area with a parking lot.

Keywords: IoT, NodeMCU, Sensor Node, Modem.

I. INTRODUCTION

Moving towards the development of smart city, various smart applications like smart home, smart healthcare, smart irrigation, Smart street lighting, smart parking system, Smart waste management system, etc., are part of it. Out of these applications, a smart parking system is an important part of a so-called smart city. Smart parking system allows reserving the parking spot in advance, which helps in reduction of time in searching the parking spot, reduction in traffic congestion, reduction in pollution, reduction in frustration of drivers etc. Use of automobiles is increasing day by day which leads to various parking issues. Vehicular population is shooting out the roof and no amount of space is sufficient to accommodate stationary vehicles. Management of parking has grown to a large extent. The main problem is to manage parking in congested areas. Nowadays trying to find a vacant parking space is difficult in large public places such as metropolitan cities, malls, multiplexes, shopping complexes etc. especially on weekends and public holidays. This process also creates traffic congestion as well as accidents in cities. Due to this time and fuel are also wasted. These issues could be solved by proper management of available parking spaces. Enabling sustainable mobility is one of the most challenging goals of a smart city, and within it, the efficient management of parking areas and the development of intelligent parking systems represents a fundamental aspect. It is estimated that 30% of the daily traffic congestion in an urban downtown area is caused by vehicles searching for parking spaces. Furthermore, some drivers, frustrated by the lack of parking spaces, often use the parking spots reserved for people with special needs, such as disabled. This not only causes waste of time and fuel for drivers looking for parking, but also increases air pollution and driver's frustration. Vehicles searching for a parking stall waste a large amount of fuel and produce a large amount of CO2 emissions. The endless searching for a parking stall in a crowded city thus causes driver frustration. The main objective is to develop a low-cost parking manager system. This system needs to be reliable and robust. For this purpose, the system is built based on the implementation of cameras and sensors connected to the internet (IoT). In this paper, a parking lot is assumed to be the base of operations. The user has an Android App to view the empty spots in the b. The entire scenario is similar to booking tickets online for a movie, except this is more complicated because the user has to get real time data and it has to be updated at irregular time intervals as and when the spot gets occupied or freed. The paper is divided into 3 phases. Number plate recognition of each vehicle, display availability of parking slots in Android App and dedicated hardware to detect the presence or absence of vehicles are the three phases

II. PROPOSED METHODOLOGY

The parking lot is assumed to be constructed in the following manner as shown in Fig. 2. Two parking spots share a single ESP8266 - SR04 combination. The parking spots are then connected to the Internet by the MODEM present in the parking lot. Each ESP8266 Module is connected to the Internet via the MODEM.

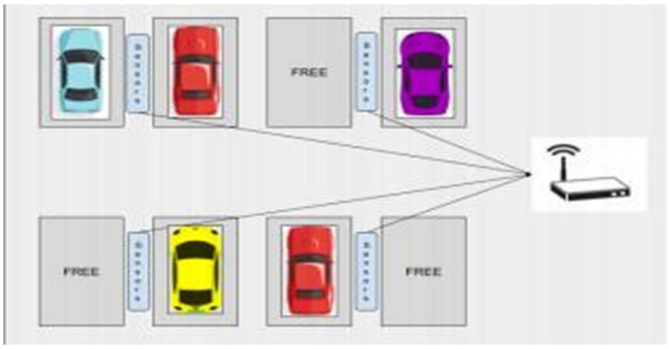


Figure 2 Parking area outline

The SR04 modules detect the presence or absence of cars and send this information to the Firebase cloud [1]. From the firebase cloud, the information can be read by the Android App. The Entry and Exit gates usually have a camera. The video footage from this camera is taken and processed at the Processing

Unit[16]-[20]. The information from the camera is broken down to machine readable information and then processed to obtain the number plate [2]. For this number plate detection, the following algorithms were used.

1) Canny with contour detection.
2) Using Haar-cascade features.
3) Sobel and morphology technique.

CANNY WITH CONTOUR DETECTION

Canny edge detection [5] is a technique to extract useful structural information from different vision objects and dramatically reduce the amount of data to be processed. It has been widely applied in various computer vision systems. Canny has found that the requirements for the application of edge detection on diverse vision systems are relatively similar. Thus, an edge detection [6] solution addresses these requirements can be implemented in a wide range of situations.

The general criteria for edge detection include:

1. Detection of edge with low error rate, which means that the detection should accurately catch as many edges shown in the image as possible [13].
2. The edge point detected from the operator should accurately localize on the centre of the edge [14].
3. A given edge in the image should only be marked once, and where possible, image noise should not create false edges.

Figure. 3 Canny with Contour Detection

HAAR CASCADE FEATURES

1. Haar-like features[8] are digital image features used in object recognition.
2. They owe their name to their intuitive similarity with Haar wavelets and were used in the first real-time face detector.
3. A simple rectangular Haar-like feature can be defined as the difference of the sum of pixels of areas inside the rectangle, which can be at any position and scale within the original image[16]. Figure 4 is example for Haar-Cascade detection

Figure 4 Haar-Cascade detection

SOBEL AND MORPHOLOGY TECHNIQUES

1. The Sobel operator, sometimes called the Sobel–Feldman operator or Sobel filter,is used in image processing and computer vision, particularly within edge detection algorithms where it creates an image.
2. At each point in the image, the result of the Sobel–Feldman operator is either the corresponding gradient vector or the norm of this vector [9].
3. The Sobel–Feldman operator is based on convolving the image with a small, separable, and integer-valued filter in the horizontal and vertical directions. Figure 5 shows the edge detection using sobel technique.

Figure 5 Sobel Technique

HARDWARE DESIGN

1. The hardware components in Fig 6 have been assembled, programmed and tested to create an end-to-end system that works without any manual interruptions.
2. The entire system is robust and adaptive to changes.
3. 3.The system can be deployed in any parking lot with a MODEM available

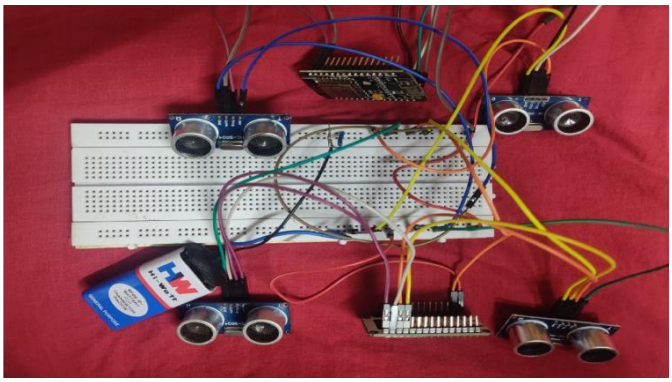


Figure 6 Hardware Design

III. RESULTS & DISCUSSIONS

The best-suited number plate recognition algorithms were run and compared. The algorithm yielding the highest accuracy was determined. This algorithm was selected and incorporated into the system. The performance comparison of the other algorithms have been presented in the following subsection.

COMPARISON OF NUMBER PLATE RECOGNITION

The results presented in Table 1 show a clear indication of the algorithm that is best suited for this application. This also coincides with general intuitive knowledge about these algorithms. The first method has lower accuracy but comparatively faster processing time [11]. Though faster processing time is a desirable attribute, in this scenario, accuracy is a major concern. In case of a wrong assessment of the number plate, the billing procedure at the backend will be severely affected causing unnecessary confusion and reliability issues.

Haar cascade has decent accuracy. It can work as a reliable alternative for the best algorithm but it still has its flaws and not recommended in this case. To solve the accuracy issue, the Sobel operator is used. From the table above, it is clear that Sobel operator has the best numbers to support its claim as the most suitable algorithm. Admittedly, this algorithm adds more computational complexity thereby increasing the computational time of the number plate recognition process. However, the time taken to retrieve the number is not a bottleneck in this scenario.

There is an evident trade-off between computational complexity, time and accuracy of recognition. Since the time factor is not drastically deteriorated by using the Sobel operator this is the preferred algorithm. The rest of the system has been built based on this algorithm.

Table 1 Comparison of Results

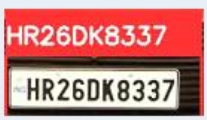
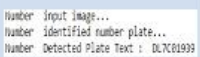
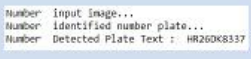
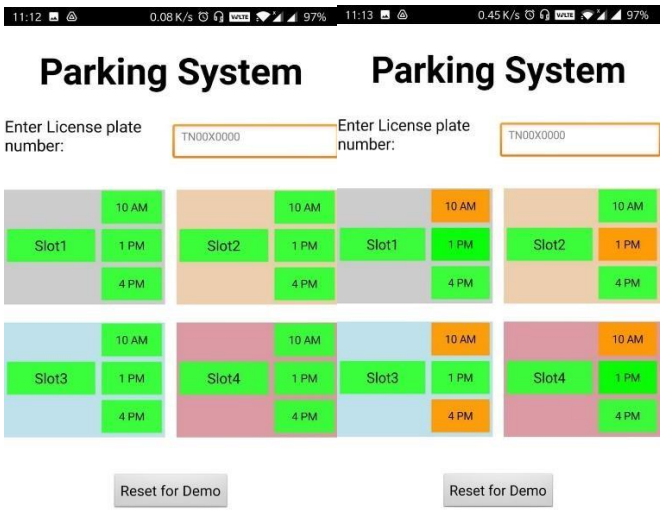
ALGORITHM	OUTPUT TEST 1	OUTPUT TEST 2
Canny with Contour	No contours detected	
Haar-cascade		
Sobel and morphology		

Figure 7 shows the screenshot of android application for the users who can book the slot previously



IV. CONCLUSION

The parking manager system contains the necessary low-cost hardware as well as secure software operations.

The hardware implementation involves the camera, processing unit, Wireless Microcontroller nodes and sensors.

The software implementation involves the program that allows number plate detection, uploading values to the cloud-based storage and retrieving those values on an Android App.

The following points are the key advantages of the system.

1. Saves a lot of Time and Manpower.
2. Easy to get parking slot.
3. Parking becomes cheaper when considered on a long run.
4. Parking Management can become automated.

V. FUTURE SCOPE

The system can also be extended to be used at the following scenarios

1. In theatres for empty seats
2. In auditoriums and seminar halls for empty seats
3. In any crowded place like hospitals or multiplexes

Thus a smart, compact, cost effective parking manager system capable of automation has been proposed and built. It is most important to have reliability, privacy and security on both ends, which is achieved in this paper.

Other modifications such as the following can be made to make the system even more robust

1. Camera angle control to view in 360 degree and rotate the camera along the Z axis as well.
2. Using digital image processing to speed up the number plate recognition process with full accuracy
3. Convert it to online payment transactions by linking with PayTM, Gpay, etc., so as to minimise the human interaction and make it fully automatic.
4. A distributed database to control parking slots throughout a larger democracy
5. A parking search suggestion based on the user's location.
6. Automated payment per hour service

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Dr.K. Senthil Kumar received his bachelor's degree in Engineering from Madurai Kamaraj University, master's degree and doctorate from Anna University, Chennai. He has 19 years of academic experience. He has presented 27 papers in various national and international conferences and published 20 papers in reputed journals. He has been the co-coordinator of the paper "Green Communication – A Low Power
Implementation of MIMO-OFDM System for EMI Mitigation" of worth Rs. 8 lakhs funded by AICTE. He is recognized as a research supervisor by Anna University and guiding 8 scholars at present. He has guided 8 PG students so far. He is serving as an editorial board member and reviewer for several reputed journals including IEEE Communication Letters. He is a member of professional societies such as IFERP, IRED and ICSES. At present, he is working as an associate professor in the department of ECE, Rajalakshmi Engineering College, Chennai. His research interests include wireless communications, information & coding theory and MIMO-OFDM.