VISION BASED PARKING OCCUPATION DETECTION USING EMBEDDED AI PROCESSOR

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Abstract

The basic objective of this project is to create a smart parking system, which is much needed to save money, time, and even environment. This work aims at developing an IOT based smart parking system in a metropolitan city, which automatically finds the nearest available parking slot. This smart parking feature enables a user in finding a parking location and a free slot in that parking space inside a city or outside of shopping malls. This project focuses on reducing time wasted on finding parking space nearby and ongoing through the filled parking slots. This in turn reduces the fuel consumption and standard of living. This system can also, be used to recognize a user entry and exit and it will be uploaded to cloud server. This system uses RFID Reader, it which identifies the vehicle number when it is there at parking slot and again it will send vehicle number when it is leaving.

Keywords: *Internet of things, RFID, Smart parking system, IR sensors.*

1. INTRODUCTION

A vehicle leaving framework assists drivers with tracking down an empty spot. Involving sensors in each parking spot that recognize the presence or non appearance of a vehicle, signs direct approaching drivers to accessible areas. This quick urbanization has prompted an expansion in autos on street, which thus has spiked interest for parking spot. In any case, most metropolitan urban areas have restricted space they can designate for stopping. The answer for this issue is a shrewd vehicular stopping framework which effectively oversees stopping and furnish clients with data in regards to closest parking spaces. These frameworks consolidate advancements for example, Wireless Sensor Networks (WSN), Webserver, Internet of Things (IOT) couples [1, 2]. An implanted framework is one sort of a PC framework for the most part intended to play out a few assignments like to access, interaction, and store and furthermore control the information in different hardware based frameworks. Installed frameworks are a mix of equipment and programming where programming is generally known as firmware that is inserted into the equipment. One of its most significant attributes of these frameworks gives the o/p inside as far as possible. Installed frameworks backing to make the work more awesome and advantageous. Thus, we habitually utilize implanted frameworks in straightforward and complex gadgets as well. The uses of inserted frameworks mostly include in our genuine for a considerable length of time like microwave, adding machines, TV controller, home security and neighborhood traffic signal frameworks [3, 4].

Internet of Things (IoT) can be defined as anything which could be connected to internet results into “Internet of Things” The key elements in Internet of Things are sensors, actuators, RFID tags. The things could be tracked, controlled or monitored using remote computers connected through Internet. IoT extends the use of the Internet, providing the communication, thus inter-network of the devices and physical objects, or Things IoT, in general it consist finter - network of the devices and physical objects, number of objects can gather the data at remote locations and communicate to units managing, acquiring, organizing and analyzing the data in the processes and services. It provides a vision where things (wearable, watch, alarm clock, home devices, surrounding objects with) become smart and behave alive through sense computing and communicating with embedded small devices which interact with remote objects or persons through connectivity [5, 6]. Due to high scalability in the cloud any number of nodes could be added or removed from the IoT system on a real time basis and IoT is well

known to reduce human effort storage at extent. The ideal of creating a Smart City is now becoming possible with the emergence of the Internet of Things. The IoT has created a revolution in many ways in life as well as in Smart Parking System (SPS) technology. As parking becomes a very essential need of our day to day life. Therefore, this system looks forward to plan and acquire a smart parking system before heading out towards our destination in order to reduce the hassle of driving around looking for a parking spot during peak hours [7, 8].

In present day cities, finding an available parking spot is always difficult for drivers, and it tends to become harder with ever increasing number of private car users. This situation can be seen as an opportunity for smart cities to undertake actions in order enhance the efficiency their parking resources, thus leading to reduction in searching times, traffic congestion and road accidents. Recent advances in creating low-cost; low- power embedded systems are helping developers to build new applications for the IoT. As the number of population increased in the metropolitan cities, the need of vehicles also got increased. Ultimately, it causes problems in parking which leads to traffic congestion, driver frustration, and air pollution. When we visit the different public places like Shopping malls, multiplex cinema hall & hotels during the festival time or weekends it creates a lot of the parking problem. According to the recent research found that a driver takes nearly 8 minutes to park his vehicle because he spend more time in searching he parking slot. This searching leads to 30 to 40% of traffic congestion. This work aims to reduce the parking problem and to do secured parking using the smart parking system [9-12].

2. RELATED WORKS

There have been several research studies and implementations of vision-based parking occupation detection systems using embedded AI processors. A detailed explanation about these methods is as follows.

Harmeet Singh et.al., [13] "Automated Parking System with Bluetooth access". Applied Bluetooth technology implemented in mobile phones enables the user to perform the identification and the state of presence while entering/exiting the parking space without stopping the vehicle.

Zhou et.al., [14] "Evaluation of a vision-based parking assistance system". In this work, they developed an system which is used to Searches for detection of parking space using laser line scanners. In this supervised learning technique is used to identify vehicle bumpers from laser range scans that the topological graph is created and then the parking space is identified.

Alois Knoll et.al., [15] "Automatic Parking Based on a Bird's Eye View Vision" – they implemented an parking space based on LIDAR Sensors. In this work RANSAC algorithm and kalman filter allows localization and tracking. LIDAR sensor is mounted on the moving object for tracking and detection of relevant object.

Renuka R. and S. Dhanalakshmi et.al., [16] "Android Based Smart Parking System Using slot Allocation reservations". They developed a Intelligent parking system aims to manage the parking area by capturing the number plates of each vehicle for unique identification of vehicle. This information is then used for payment calculation of each user.

These existing methodologies have a few drawbacks such as the proposed solutions rely on expensive hardware components like LIDAR sensors, Bluetooth modules, RFID tags, or dedicated cameras, which can increase the overall cost of the system and limit its scalability. Some of the proposed systems require significant modifications to the existing infrastructure, which can be challenging to implement in real-world scenarios. Many of the solutions lack flexibility and adaptability, as they are tailored to specific parking scenarios and may not be easily applicable to other parking lots or environments.

3. MATERIALS AND METHODS

3.1. Requirements

The proposed system requires the following hardware:

Raspberry Pi(3 model B), Power supply(5V Battery), LCD Display, RFID Reader, RFID Tags, PHP Server, IR Sensors and Web Camera.

The Raspberry Pi 3 Model B is a small computer that can fit in the palm of your hand. It is designed to be an affordable and versatile computing platform that can be used for a variety of projects. The board is powered by a quad-core ARM Cortex-A53 CPU and has 1GB of RAM, which is plenty of processing power for most applications. It also has built-in wireless connectivity and supports both Bluetooth and Wi-Fi. The Raspberry Pi 3 Model B has a range of ports, including USB, HDMI, and a microSD card slot, which allows you to connect peripherals and expand the storage. It can run various operating systems, including the Raspberry Pi OS, making it an excellent choice for hobbyists, students, and professionals alike.

The specifications of the required hardware are presented in table 1:

Table 1: Hardware Specifications

S. No.	Hardware Name	Specification
1.	RFID Tags	1. Frequency range: RFID tags operate at different frequencies (LF, HF, UHF) that impact their performance and compatibility with readers. 2. Data storage capacity: RFID tags have varying data storage capabilities based on their type and usage, from unique identifiers to product information. 3. Cost: RFID tags vary in cost depending on their features, volume, and application, with some low-cost tags designed for disposable use.
2	RFID Reader	1. Communication protocol: ISO/IEC 18000-6C. 2. Communication frequency: 860 – 960 MHz. 3. Communication range: 6 to 8 m approx. 4. Size of outline: 210(W) x 210(D) x 130(H) mm.
3	Web Camera	1. Frame rate: The camera should be capable of capturing images at a high frame rate to ensure smooth and accurate detection of parking occupation. A frame rate of at least 30 frames per second (fps) is recommended. 2. Connectivity: The camera should be compatible with the embedded AI processor and capable of connecting to it using a suitable interface such as USB, MIPI CSI, or Ethernet.
4	LCD 16X2	1. This 16 × 2 LCD packs 32 characters into an outline smaller than that of most two-line displays. 2. An LED backlight enables optimal viewing in all lighting conditions.
5	PHP Server	1. Operating System: Linux, preferably Ubuntu, CentOS, or Debian. 2. Web server software: Apache, Nginx, or LightSpeed.
6	Raspberry Pi 3 Model B	1. Processor: 64-bit quad-core 2. frequency: 1000 MHz 3. Clock frequency: 1200 MHz 4. RAM: 1024 MB 5. Wi-Fi : Yes 6. Operating Voltage : 5V

The algorithm of the proposed model is developed in software by python language, OpenCV libraries and Tensor Flow.

3.2 Proposed model

The proposed system has the Raspberry Pi 3B model (Fig. 1), to detect and monitor the occupancy status of multiple parking slots. The system uses a Raspberry Pi camera module to capture images of the parking slots, which are processed using a pretrained TensorFlow object detection model. IR sensors are installed for each parking slot to detect the presence of a car. When a car enters a slot, the IR sensor for that slot is triggered, and the system updates the

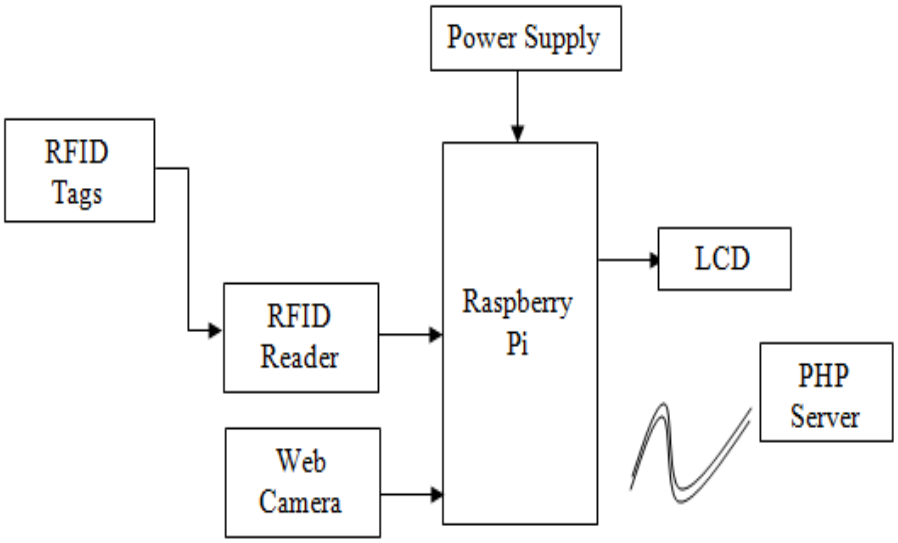


Figure 1 : Block diagram of the Proposed System

occupancy status of that slot. When a car leaves a slot, the IR sensor is no longer triggered, and the system updates the occupancy status again.

The system will use the OpenCV library for image processing, allowing the system to extract necessary data for occupancy detection. The occupancy status of each parking slot will be

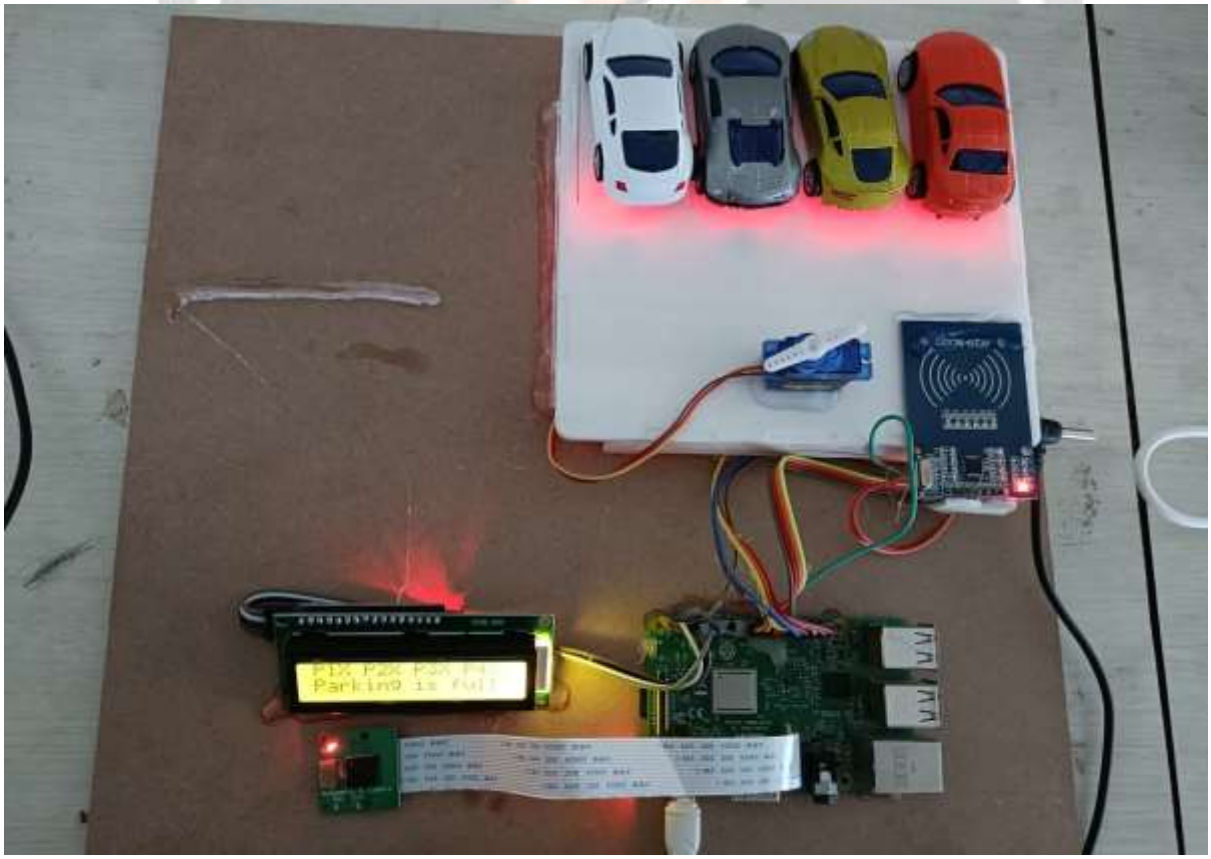


Figure 2 : Working of the Proposed System

displayed in real-time on a monitor using text and color-coded indicators (Fig. 2). A green color indicator will be used to denote a vacant parking slot, while a red color indicator will be used to denote an occupied parking slot. Additionally, LEDs attached to the Raspberry Pi will be used to provide a visual indication of the occupancy status of each slot. Each parking slot will have an LED attached to it. If the slot is vacant, the LED will be on. If the slot is occupied, the LED will be off.

The system will be programmed in Python, and the Raspberry Pi GPIO library will be used to interface with the IR sensors and LEDs. The system will continuously monitor the occupancy status of each parking slot and update the display in real-time. The proposed system provides an efficient and effective way to monitor the occupancy status of multiple parking slots in realtime, making it useful in various settings, such as parking lots, garages, and other areas where parking spaces are limited. With the system, drivers will be able to quickly and easily find vacant parking slots, reducing the time and frustration associated with finding a parking space. Additionally, the system can be used by parking lot operators to monitor the occupancy status of their lots, allowing them to optimize parking space usage and increase revenue

4. EXPERIMENTAL RESULTS

The project is designed to detect the occupancy status of parking slots using an embedded AI processor and IR sensors. The system uses a Raspberry Pi 3B model and a Raspberry Pi camera module to capture images of the parking slots. The images are processed using a pre-trained object detection model created with TensorFlow and the results are displayed in real-time on a monitor. The system uses IR sensors to detect the presence of a car in each parking slot. When a car enters a slot, the IR sensor for that slot is triggered and the system updates the occupancy status of that slot. When a car leaves a slot, the IR sensor is no longer triggered and the system updates the occupancy status again. The occupancy status is displayed on the monitor using text and colours. Each parking slot is labelled with a name.
In addition to the display on the monitor, LEDs attached to the Raspberry Pi are used to provide a visual indication of the occupancy status. Each parking slot has an LED attached to it. If the slot is vacant, the LED will be on. If the slot is occupied, the LED will be off. Overall, the system provides an efficient and effective way to monitor the occupancy status of multiple parking slots in real-time. It can be used in a variety of settings, such as parking lots, garages, and other areas where parking spaces are limited.

Figure 3 : LCD Display Before Parking

In figure 3 LCD display is showed before parking the vehicles where P1,P2,P3 and P4 are the parking slots are empty.

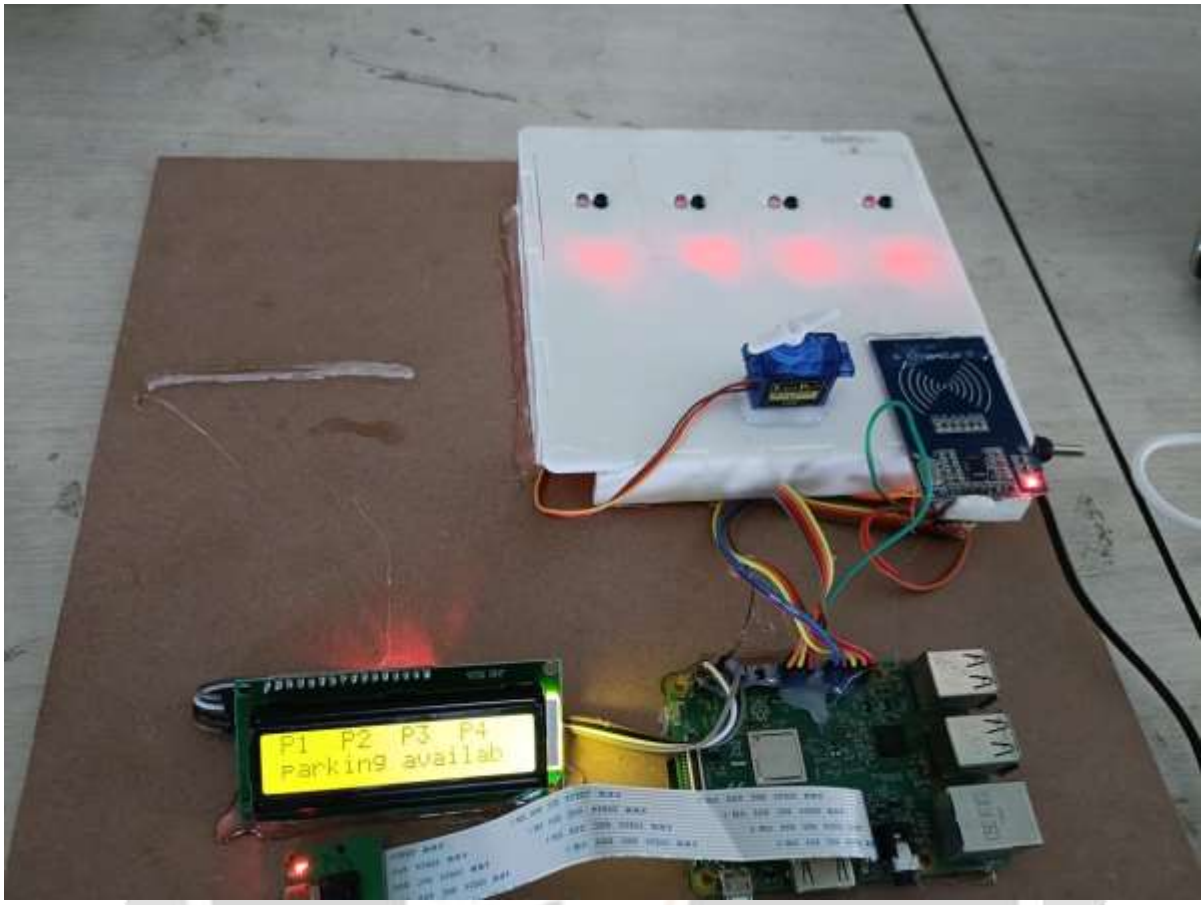
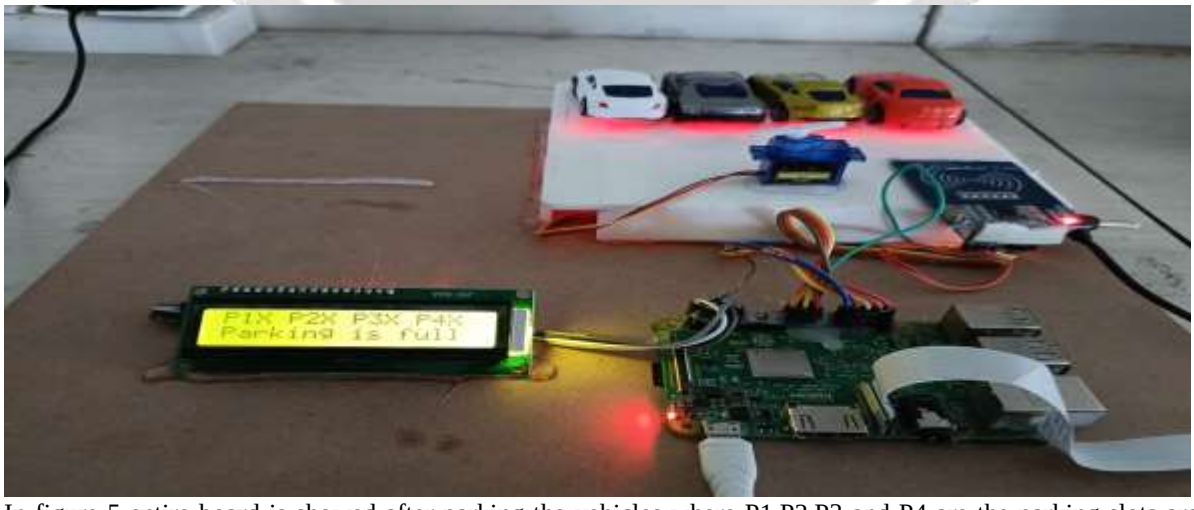


Figure 4 : Board Before Parking

In figure 4 entire board is showed before parking the vehicles where P1,P2,P3 and P4 are the parking slots are empty.

Figure 5 : Board After Parking



In figure 5 entire board is showed after parking the vehicles where P1,P2,P3 and P4 are the parking slots are filled.

5. CONCLUSIONS & FUTURE SCOPE

This new framework is an additional worth to the metropolitan way of life. In the ongoing scene, where Google vehicles are presented and an improvement of extraordinary size. Computerized vehicles can do the leaving all alone in the event that this vehicle leaving application is a piece of their underlying framework. Consequently, We trust that this basic idea, when delivered into the world, will be one of those progressive changes in ordinary exercises. In future, we will think about the security parts of our framework as well as execute our proposed framework in enormous scopes in reality.

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