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IR Sensor based Smart Parking System

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Abstract: **Nowadays congestion of traffic level increased with the increase in population. As the population increases, the utilization of vehicles also increases. It's becoming a difficult task to find a slot to park the vehicle. To overcome this problem, a smart parking system is introduced. Previously, there were some approaches to this system where Bluetooth and GPS tracker were used to find the empty slots, and different sensors were used for indoor and outdoor parking. In some approaches there was no security for the user's details. Whereas in the proposed system, every slot has a number which makes it easier for the user to find out the empty slot. IR sensors are used to detect the vehicle and the empty slot is displayed on LCD as well as cloud server where the user's details are secured. Smart parking system is an IoT based system which includes Raspberry pi, LED display, Cloud Server, Monitor and IR Sensors that are available in each parking slot. The proposed system leverages the advantages of IR sensor technology to accurately detect the presence of vehicles in parking spaces, provides real-time information to the users, and improves overall parking efficiency. The paper discusses the system architecture, sensor deployment strategies, and implementation, thereby showcasing the potential benefits of IR sensor-based smart parking systems.**

Index Terms: **camera, cloud, parking, Raspberry Pi, sensors, vehicles**

I. Introduction

Parking is one of the most common human activities on our planet, and it has become more important in recent years as car ownership has increased. It is found that approximately by 2050 most of the cities would be accommodating two thirds of the world's population. Due to rapid urbanization, there is increasing concern over traffic congestion in many parts of the world. In dense urban areas, many drivers have difficulty finding a parking space when they need one. A parking system that can be used to help drivers find parking spaces could solve this problem, allowing them to park their cars more easily and avoid wasting time. A smart parking system could also help save parking facilities from overcrowding. This would be useful in city centers and other large urban areas where many cars must be parked to prevent them from blocking roads and creating traffic bottlenecks. Once a space is available, the car can be parked and removed from the system, making the available space available for other cars to use. This would reduce traffic congestion and allow for a more streamlined parking process.

II. Related Work

There are previous works on this topic where they had different approaches to locate the available parking lot. In paper [1], authors have worked with the same principle, but ultrasonic sensors are used to detect vehicles. Though both ultrasonic and IR sensors are used for detecting objects, IR sensors give the sensed information faster than ultrasonic sensors to locate the available area.

In paper [2], authors have used some simulation models. The work is based on an RFID reader for each vehicle entering the parking area. The proposed system is designed to detect and find a parking location for the user's vehicle. This system creates a wireless sensor network, and the user must wait for confirmation of parking slot through notification from server, it is a little time-consuming process.

In paper [3], authors have used ultrasonic sensors and GPS using MQTT protocol for simulation of the work. The work is not implemented in real time and since it uses ultrasonic sensors, the overall performance of the system is low compared to the proposed system.

Paper [4] provides an idea about smart parking systems using IoT and cloud, but the user must pay the toll fee to use the service. Thus, the proposed method of smart parking system using IR sensors overcomes all the problems discussed above.

Paper [5] uses convolutional neural network tool to train the algorithm deeply. It uses image processing and segmentation for capturing the real time images of the parking slot and displaying the information of its occupancy. It uses MATLAB for validating the approach.

In paper [6], the authors have created a mobile application enabling the users to verify parking space availability and make reservations accordingly. The app also provides real-time 'parking service payment' based on the duration of parking. Moreover, it detects the arrivals of vehicles at the entrance for automated gate opening. This feature empowers the users to conveniently check parking availability online from any location, ensuring hassle-free parking experience.

Paper [7], provides a comprehensive review and analysis on multi-approach-based Smart Parking Systems (SPS) which will emerge as dominant in future smart cities, with IoT serving as the backbone. The user interface is anticipated to be smartphone application-based, offering features such as parking supervision, online payment, parking reservation, and vehicle guidance. Sensor selection in SPS will be contingent upon various indoor and outdoor conditions, with installation ease (easy installation), privacy, sensing method, and sensor coverage area emerging as

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primary considerations. Data communication protocol security will also be a significant concern in future SPS systems, prompting increased emphasis on wireless communication protocols to ensure data security.

Paper [8], introduces an efficient method for detecting vacant spaces and managing vehicle movement within complex multistoried parking structures. It utilizes IR sensors to detect vehicles and provides real-time feedback. The fully automated smart car parking system is simple and does not necessitate extensive lines of code or expensive equipment. It's a straightforward circuit designed precisely for its intended purpose.

This automated system efficiently identifies available parking spaces and guides drivers to their desired spots using visual cues, thereby reducing search time. It proves beneficial for malls, multi-storey parking facilities, IT hubs, and other parking areas, significantly reducing the need for manual labor.

The authors have done extensive research work in [9] and a technical analysis of smart parking solutions, focusing on the systems and sensors documented in existing literature is discussed. The review aims to offer comprehensive insights into the development of smart parking solutions with a thorough examination of the current landscape of smart parking systems including categorizing these systems based on advanced vehicular detection technologies. The work also presents clear explanations of communication modules involved in these solutions.

Authors in paper [10] introduce a Smart Parking Energy Management solution designed for structured environments like multi-storied office parking areas. The system proposes the integration of cutting-edge Internet of Things technology with advanced Honeywell sensors and controllers to establish a systematic parking management system for users. Empty parking spaces are indicated using lamps, guiding users to available spots and eliminating the need for extensive search. Occupied parking spaces are digitally stored in the cloud, accessible to the central system to direct incoming vehicles to vacant spots. Automatically controlled light brightness helps in reducing energy consumption while providing adequate illumination to the users within the parking area. The fully automated system reduces the need for manual intervention, enhancing the aesthetic appeal of the parking area.

Paper [11] introduces a smart parking system aimed at addressing current parking challenges at an affordable cost. The system integrates the latest advancements in Information and Communication Technologies and comprises four layers: Application, Middleware, Networking, and Sensor layer. It promotes environmental sustainability by reducing harmful emissions during parking and operates as a computerized system pre-programmed without requiring human intervention. The paper also emphasizes the comparison between traditional parking systems and smart parking systems utilizing IoT. Furthermore, it presents a framework for the implementation of a smart parking system.

The paper is organized as follows: Section III describing the proposed methodology followed with implementation of the work in section IV, results and conclusions in V and VI respectively.

III. Proposed Method

The proposed architecture is partitioned into three sections. The first section consists of the parking area where we have IR sensors placed in their respective slots along with the Raspberry Pi module. The sensors give us the information about the availability of the parking slot. In the parking area, cameras are placed for live view of the available slot, an LED display is also employed at certain height at the entrance so that the user will have a view of the slot status from a far distance. The monitor is placed at the entrance of the parking lot. The second section comprises the cloud server. One xyz online cloud server is used to store the data that is being transmitted by the sensors. The third section is meant for the users. The user is given access to the server, he/she can login to the server and check for the available parking slots. There is an LCD display that shows all the slots. If they are occupied, it shows ‘1’ otherwise, it displays’0’ (Example: s1-0 s2-1 s3-1 s4-0 s5-1). It is placed in the parking area alongside the monitor so that the users can have easy access to the free slots. Relays are also used in each slot that glows ‘On’ and ‘OFF’ based on slot occupancy. Figure 1 gives the proposed system architecture.

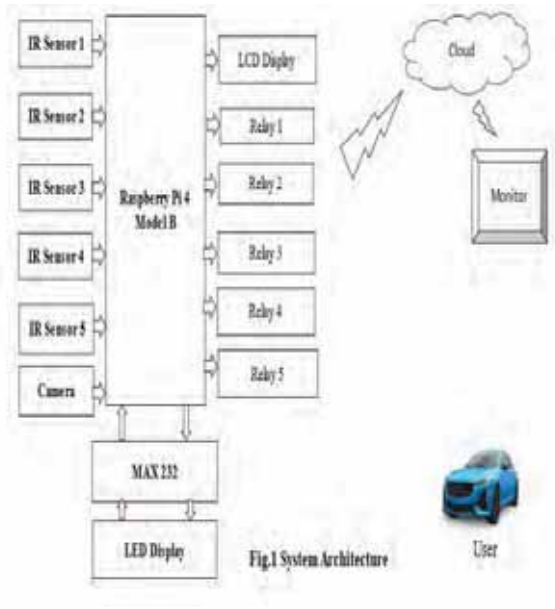

Figure 1. System Architecture.

The module includes:

A. *Raspberry Pi*

The Raspberry Pi as shown in figure 2 is an affordable, credit-card-sized computer that can be plugged in to any computer. It possesses the capability of performing various tasks akin to a desktop computer, including internet browsing, playing high-definition videos, word processing, and gaming. It is widely used to make gaming devices, fitness gadgets, weather stations, and much more.

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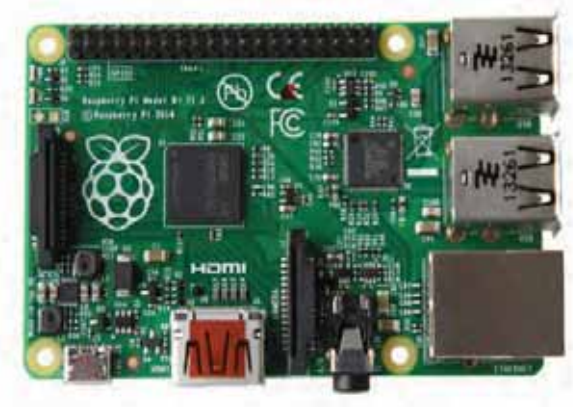

Figure 2. Raspberry Pi.

B. IR Sensor

An Infrared (IR) sensor (shown in figure3) is an electronic device designed to detect and measure IR radiation emitted by objects. Objects with temperatures higher than 5° emit IR radiation. IR sensors are primarily employed for motion detection and temperature measurement. They can be classified into two types: Active Infrared Sensors and Passive Infrared Sensors.

Figure 3. IR Sensor.

C. LCD Display

An LCD serves as a display mechanism for showcasing information on various devices such as machines, clocks, railway departure indicators, and more. A dot matrix controller translates processor instructions into signals, activating or deactivating lights within the matrix to generate the desired display. This display comprises a dot matrix of lights organized in a rectangular pattern, allowing for the presentation of text or graphics by selectively turning on or off specific lights. LCD display is shown in figure 4.

Figure 4. LCD Display.

D. IoT-AWS Software

IOT represents the prominent technology of our time, where devices interconnect via the internet, enabling data transfer without direct human-to-human or human-to-computer interaction. The internet connectivity among sensors, computational devices, and storage units can be established through either wired or wireless connections. AWS, an acronym for Amazon Web Services, stands as the foremost cloud provider in the market, offering developers access to over 170 AWS services from any location, as needed.

IV. Implementation

This section of the paper demonstrates the flow of implementation of this project in real life.

A. Section I: Parking Area

With the help of daughter board, the IR sensors are connected to the power supply. The sensors are then placed in their respective slots based on their numbers. The range of these sensors can be altered for future use. Whenever there is a vehicle in the slot the sensors sense it and send a message saying there is an object present. This is further updated in the cloud server.

B. Section II: Cloud Server

Amazon AWS cloud server is used in the work. The server takes the message from the sensor and displays the information accordingly. It displays “1” if the slot is occupied else “0”.

C.Section III: User Interface

The user is given the login credentials to the website, and he/she can access the site whenever he wishes. The user can see whether the slot is occupied or not and can park according to his will.

In addition to the server, there is an LED display at the entrance of the parking lot at a certain height which gives the same information of the slots from afar. The sensors are vulnerable to detect any object in addition to the vehicles, thus, to avoid any error, a camera is placed in the parking area which gives the live streaming and is displayed on the monitor at the entrance gate.

V. Results

Results are shown in the form of pictures taken at different times as per the slot occupancy.

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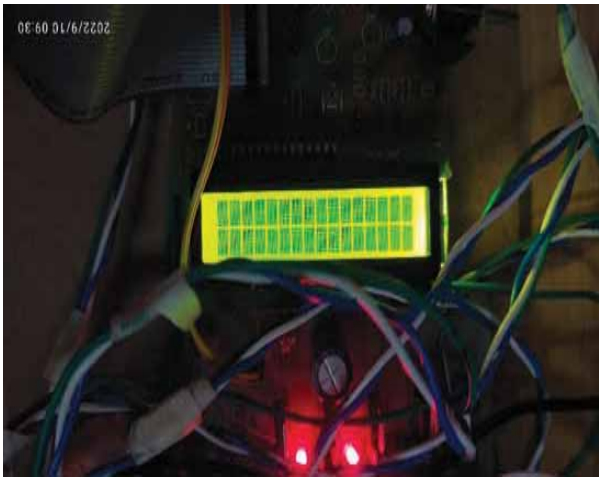

Figure 5. LCD Display.

Figure 5 shows the LCD display, showing the slot occupancy at a particular time. If a slot is occupied, it is represented as F otherwise E.

Figure 6. LED Display.

Figure 6 displays the slot occupancy as 1 or 0 for being occupied or empty.

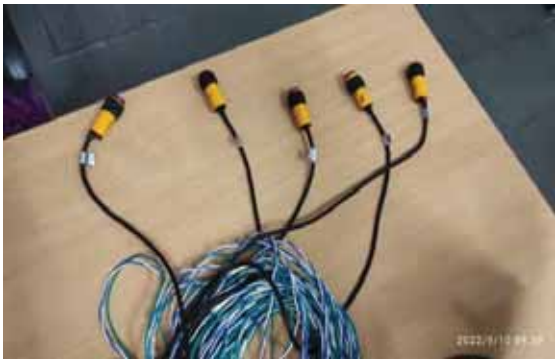

Figure 7. LED Display.

Figure 7 shows the five IR sensors used in the work. These sensors can cover ten meters in detecting an object.

Figure 8. Raspberry Pi.

Figure 8 shows the Raspberry Pi used in the work for receiving the inputs from the sensors, processing it, and transmitting the data to the cloud.

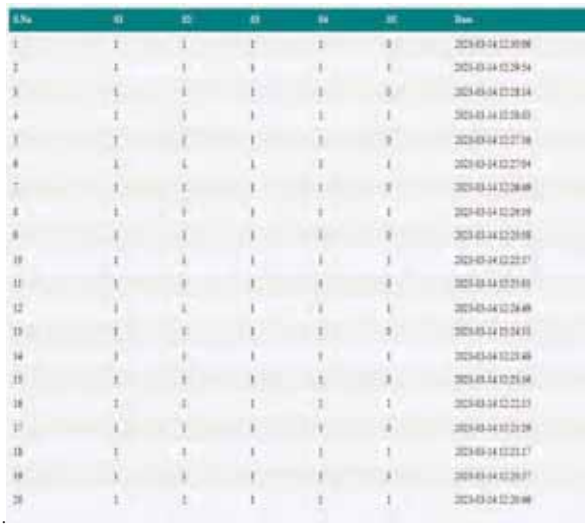

Figure 9. IoT Server data on Monitor with timestamp

Figure 10. IoT server data on Monitor with Timestamp.

Figures 9 and 10 give the data received in the cloud at different time instances regarding the occupancy of the slots with time stamps (date and time).

VI. Conclusions

In conclusion, this smart parking system allows the users to easily access the parking lot irrespective of the place they are in. This paper aims to provide an in-depth understanding of the design, implementation, and optimization of a smart parking system using IR sensors. By leveraging the capabilities of IR sensor technology, this system offers accurate and real-time vehicle detection, enhancing parking space utilization and improving the overall parking experience.

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