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Parking Management System for Smart Cities Using IoT

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ABSTRACT
The internet of things is the network of physical objects embedded with electronics, software, sensors and network connectivity, which enables the other objects to collect and exchange data. In this new era of urbanization, and interconnectedness, IoT applications are getting considerable attention because of their capabilities to integrate the latest technologies into one big system. Here, we are trying to create a project to automate the conventional commercial parking system with some well-known new technologies. We will be integrating technologies like phpMyAdmin database management, optical character recognition and image processing to facilitate vehicle number plate detection, billing and QR code generation of bill using Python, displaying the bill on web application and finally using raspberry pi with different sensors to take readings.
Keywords – Automation, Database Management, Image Processing, IoT, OCR, Web Application

I. INTRODUCTION

IoT applications utilize the advanced communication technologies between devices for granting a better gamut of accessibility features to the end users who live in connected areas. Nowadays, as the population in the cities is increasing rapidly, more and more people are buying vehicles for personal use and with the land in these cities being limited, the need for optimized parking has increased significantly and management of such spaces is becoming difficult by using old management practices.

The increase in city traffic is one of the major effects of population growth especially in urban areas. Due to this, searching for a vacant parking area during peak hours is not only time-consuming but also results in wastage of fuel. The drivers keep searching for a suitable parking lot which leads to increase in traffic. Increasing volume of vehicular exhaust creates a negative impact on the environment. Hence smart parking has become the need of the day.

This Project focuses on implementation of vehicle parking place detection using internet of things. The benefit of smart parking systems goes well beyond avoiding time wasting and minimizes the costs of moving to the parking space. Developing smart parking solutions with in a city also solves the pollution problem.

The following Technologies will be used in this project:

1.1 Database Management

PhpMyAdmin is a free and open source administration tool used for MySQL. It is used to perform web hosting services. Users can create, modify, edit and even delete tables using SQL queries.

1.2 OpenCV in Image Processing

OpenCV is a free open source library used in real time image processing. In OpenCV, images are converted to multidimensional arrays which greatly simplify their manipulation. It is also used in Optical Character Recognition.

1.3 Raspberry Pi 4 (2GB)

Raspberry Pi is a desktop board which acts as a computer. It helps in the tasks like integration of sensors for reading/writing data, it helps in running and developing softwares and also we can create a local host database in it.

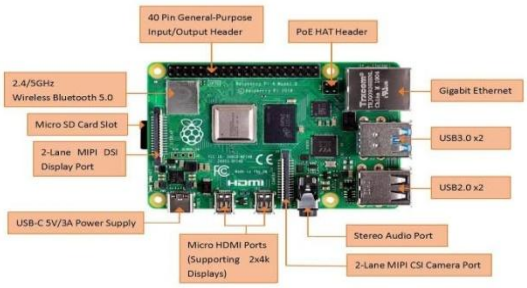

Fig.1 Raspberry Pi

1.4 Web Application

Web application is software which runs on a web browser with an active internet connection unlike the computer applications which run locally using an open source operating system. It performs its tasks over the internet without any requirement of a local array.

II. BLOCK DIAGRAM

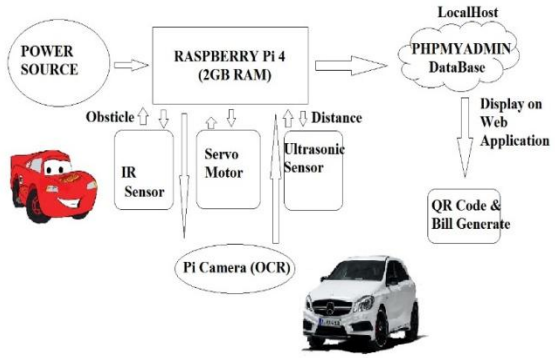

Fig.2 Block Diagram Representation

Fig.2 explains the interconnection of different sensors with one another. There are mainly four sensors which we are using in this project and they are:

2.1 Ultrasonic Sensor

An ultrasonic sensor is an electronic device that measures the distance of a target object by emitting ultrasonic sound wave and converting the reflected sound to electrical signal. To calculate the distance of the object the equation which is used is as follows:

$$D = (\text{Time Taken} * \text{Speed of Sound})/2 \quad (1)$$

Fig.3 Ultrasonic Sensor

2.2 IR Sensor

IR Sensor is an electronic device, which emits light in order to sense an obstacle in front of it. It can measure the heat of an object as well as can detect motion of that object.

Fig.4 IR Sensor

2.3 Servo Motor

A servomotor is a device that allows angular rotation. It is a rotary actuator. It consists of a suitable motor coupled to a sensor for position feedback.

Fig.5 Servomotor SG90

2.4 Pi Camera V2 (8MP)

The Raspberry Pi Camera Module v2 has a Sony IMX219 8-megapixel sensor. The Camera Module can be used to take high-definition video, as well as stills photographs.

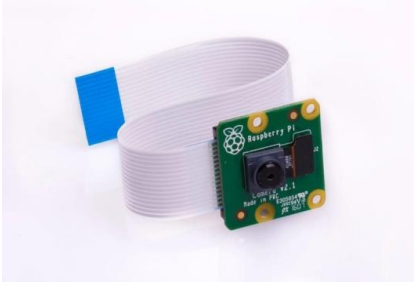

Fig.6 Pi Camera

III. PROJECT EXECUTION PLAN

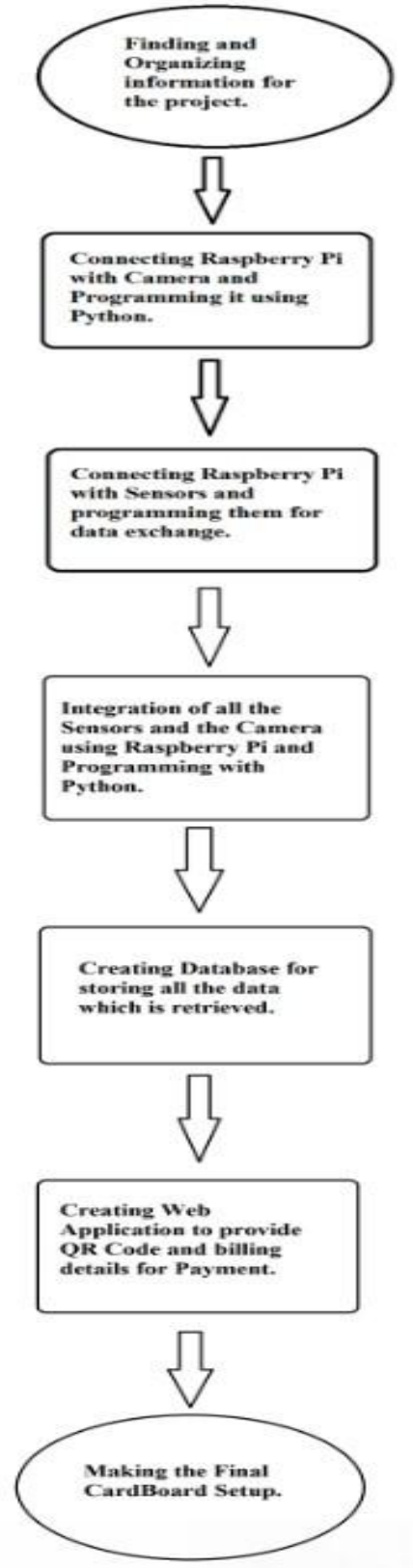

Fig.2 Project Execution Plan Diagram

Initially, information was gathered and research was undertaken using various research papers which were available on the internet related to smart parking. Then a choice had to be made pertaining to the selection of technologies to be chosen to implement the project in a cost-effective manner. There were many technologies available on the internet but the most cost effective trends were considered by our team.

A raspberry pi was then used, as it already has a port for camera and it can also connect different sensors which are necessary for the project. After the board was finalized, it was connected to the pi camera and was programmed using python. A lot of libraries were installed, and eventually a program was created which can capture real time image of vehicle, and then using optical character recognition we were able to extract the vehicle number plate in text form.

After completion of the camera part the next task was to select different sensors to read the objects in nearby surrounding. To this effect, ultrasonic sensors and infrared sensors were used. They were programmed in such a way that they became the deciding factor for taking the picture using camera. The servo motor was also used as a gate to block/allow the vehicle into the parking space, its function was also decided with the help of the sensors. All the small programs which were generated were thereby integrated into one big program using functions.

Now after collecting all the data, a storage solution was to be sought that could provide easy and fast access to the data at any point. For this purpose, phpMyAdmin database was used to create tables with columns such as vehicle number plate, entry time, exit time, slot number allotted.

To retrieve all the data from the database and to display it to the user a web application was created, with the help of website templates which were available on the internet. Through the web application we were able to provide all the billing details as well as the usage of python programming enabled us to generate a QR code of the amount payable which can be paid after scanning the code.

Finally, after completing all the required steps our model was optimized and made to a more presentable state by creating a cardboard setup. All the wiring was hidden away and a coat of paint helped with the presentation of the setup. With the help of a breadboard a lesser number of GPIO pins were used, considering that one of the issues we faced was the limited number of GPIO pins on the raspberry pi.

IV. CIRCUIT DIAGRAM

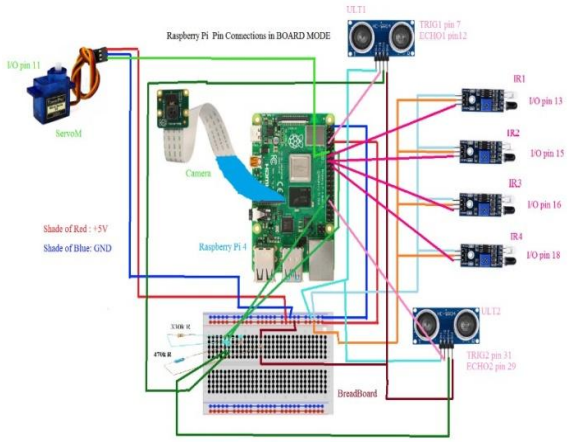

Fig.3 Circuit Diagram Representation

Fig.3 represents the circuit diagram which is created during the project. As there are limited GPIO pins on the raspberry pi we took the 5V vcc and GND pin common on the breadboard. The pin 2 of GPIO is taken as 5V and pin 6 as GND.

All the vcc and GND of all the different sensors to the breadboard were connected with common GPIO pins for power. All the reading/writing connections of different sensors are connected individually to the GPIO pins.

Two ultrasonic sensors were used for entry and exit points in the parking space and the servomotor was used as a gate.

In this project four IR sensors are used, which will be placed in front of parking slots to assign a name to each slot and also to check the availability of parking space.

Only depending upon the available parking space, the gate will be triggered otherwise if all the IR sensors are blocked then the gate will remain closed i.e. the servomotor will not rotate.

The Pi camera is also connected for taking real time images when the gate opens and when ultrasonic sensor detects the vehicle. The image taken will be used to ascertain the number plate of the vehicle and therefore recognition of the same will happen in real time to log the in time and out time of that particular vehicle to generate a bill and QR code for payment of our services.

A BOARD configuration has been used to program the project using Python. The OUT pins of the IR sensors are connected to Pin 13,15,16,18 of the Raspberry pi GPIO set. The servomotor pin is connected to 11 pin of GPIO set. Ultrasonic sensor one and two has trig and echo pins respectively and they are connected to 12, 7, 29, 31 GPIO pins. Resistors are also used to provide stable connection to the ultrasonic sensors and to increase reliability.

V. CONCLUSION

The purpose of parking management system for smart cities is to reduce traffic, pollution and time taken for searching the right parking spot. This project also helps in providing security to the vehicles parked.

In this project, the issues related to parking are presented and solution is given by using IoT technology which is integrated with web application and database management. The project provides real time information regarding availability of parking slots in a particular parking area and it also helps in optimizing the limited parking space available in cities.

The main aim accomplished is to enhance the performance of locating available spaces, storing information in database, providing billing details, improve security and finally automating the system.

Some issues present themselves in the process of optical recognition, i.e. when correct characters are not detected on the number plate, and that leads to issues in generation bill at the end of the process. This issue can be resolved by creating a program which works on machine learning so that text/character recognition becomes much more efficient.

The application of the project includes but is not limited to metro station parking lots, bus depots, shopping centers, colleges, schools and hospitals and anywhere else ere quick and efficient solutions to parking are required to save time and fuel.

FUTURE SCOPE

This Project can be integrated with machine learning, artificial intelligence and it can also use upcoming autonomous vehicle technologies and can be a very good business model which uses automation to create a hassle free environment in the smart cities.

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