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An IoT-Enabled Smart Parking System

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Abstract:
Today Internet of things (IoT) has made it possible to connect various physical objects to a network and communicate via internet. Automation is the new result of this approach where these connected objects can be managed and controlled remotely. The technology of IoT can be made useful in various fields. One such a field is the current parking system. A tremendous increase in the number of vehicles has resulted in poor traffic management systems for the past couple of years. It is really a hectic job to park efficiently a car in a parking area. The reason is nothing but the lack of notification of slot availability or vacancy. The system proposed here is designed in order to tackle this problem. The proposed system will notify the drivers by providing slot availability in prior before entering the parking area. Thus it saves our time and helps in conserving energy by avoiding unnecessary burning of fuels.

Keywords: Internet of Things (IoT), Pi-camera, Raspberry pi, Raspbian OS, Smart City, Smart Parking System.

I. INTRODUCTION

Urbanization has resulted in the emergence of more cities .Today a majority of the world's population is in the cities. The popular mode of transportation used in cities is vehicles which includes people possessing their own vehicles for comfort and convenience. This has caused in large scale increase in the total number of vehicles. Consequences are increased traffic and congestion, along with various problems related to vehicle management. One among such problems is the parking of these vehicles. Finding an empty parking slot has become a difficult job that sometimes causes people to take several rounds across parking area searching for the same. This not only results in more traffic but also causes unnecessary burning of fuels eventually resulting in wastage of time and energy. Now this is where the evolution of IoT is considered as a boon. The idea of smart city is made realize by IoT. To be precise, IoT refers to two words, Internet and Things. Internet is the global computer network that enables exchange of information through communication among the connected computers based on standardized communication protocols. Things on the other hand can refer to any kind of material object, as per the dictionary. Combining both, IoT is a technology that helps a wide variety of physical objects to be integrated to computer networks over internet, enabling the objects to be remotely controlled and managed. This not only reduces human interventions in various fields but also helps in making many solutions automatic. It is studied that nearly millions of devices are made accessible online every year by manipulating the technology of IoT. This implies the emergence of immense opportunities in the coming years. Employing IoT in a field not only helps to bring in automation, but it also helps to establish a cost effective and a more productive methodology. This can benefit almost all product and solution based industries. Cloud is a word that defines a variety of possibilities when used with IoT. The technology constraints of IoT such as storage can be tackled by making use of cloud. Remote access of stored data can be made easier when cloud is incorporated with IoT. Since the connected devices can use cloud to access and store their data, it makes communication simpler and more efficient.

Various microcontrollers that support IoT are available today in the market, such as Raspberry Pi, Auridino etc. The Smart Parking System that we introduce in this paper is using Raspberry Pi. As far as power and performance are considered, RaspberryPi is a really useful device to implement with.

II. LIMITATIONS OF EXISTING PARKING SYSTEM

There are currently different kinds of parking methods in use. RFID is one such a technology employed in the current parking systems. Some systems also assist parking with the help of a map provided. The various limitations of such systems are the following.

- None of these technologies provides vehicle information or vehicle number which can be useful for the security of the respective parking zone or complex.
- The user is also not notified in advance which causes him/her to wander around the parking area for an empty slot.
- Some of the system does not synchronize the free parking slots on vacation of vehicles. This further complicates parking.
- Most of the existing systems does not provide a choice of the all possible vacant slots, disabling the user to choose the nearest accessible slot and park in there without further time wastage.

III. SMART PARKING SYSTEM

The IoT enabled smart parking system is setup so that the ultra sonic distance sensor implanted on each slot of parking area can sense the presence of the vehicle in the parking slot through distance calculations. This information is then communicated to the cloud through the internet enabled raspberry pi .Also the Pi-camera implanted in a similar way will capture the image of the vehicles' number plate. This is

initiated by Raspberry Pi only if a presence of the vehicle is identified in the corresponding slot. The captured image is then processed in order to extract the vehicle number. This information is also sent to the cloud and stored. Both the sensor and Pi-camera are connected to the Raspberry pi via GPIO pins The information collected and processed regarding the vehicle as well as the slot availability is made available through a website for all the people who can easily visit and get notified about the slot availability in prior, thereby overriding parking hazards. It is a very economic implementation due to the low priced devices and sensors usage

IV. PROPOSED ARCHITECTURE

The proposed architecture of the solution system can be explained as shown below.

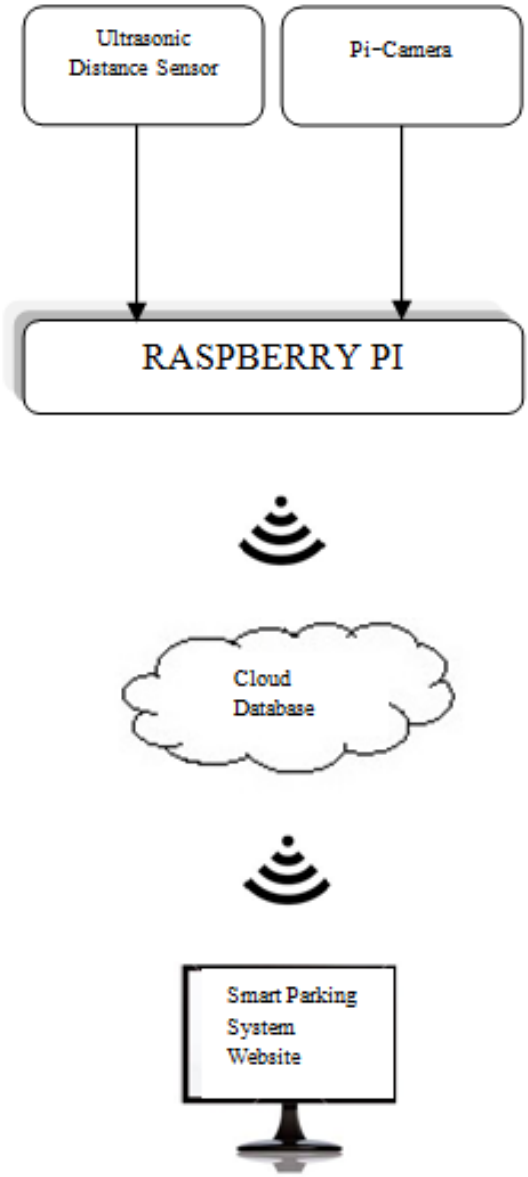


Figure.1. Solution architecture

V. IMPLEMENTATION

Assume that each slot is monitored by a Pi-camera and a distance sensor which are connected to the raspberry pi using GPIO pins. The raspberry pi is internet enabled.

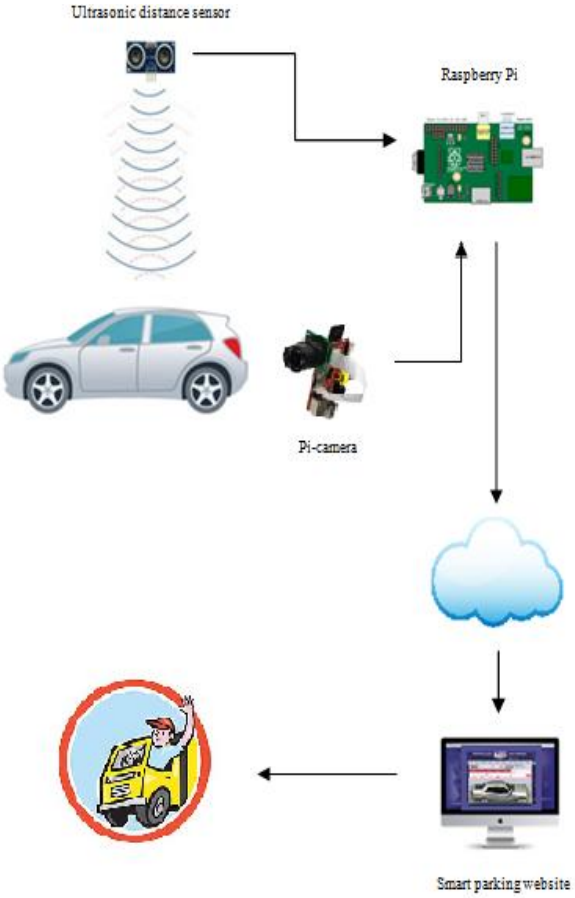


Figure .2. Proposed system design

The system implementation can be explained by the following steps.

1. When a vehicle enters a parking slot, the distance sensor will sense the distance variation occurred and will notify the Raspberry Pi, which will in turn update the slot value in the cloud by running a python script.
2. Once a slot is occupied, Raspberry pi will invoke Pi-camera to capture image of the vehicles' number plate.
3. The image is then processed by the python program running in pi to extract the vehicle number and is also updated in the cloud
4. The results are instantaneously reflected in parking website
5. The driver can just visit the page using their phone and get the vacant slots.

It is also possible that a mediator to retrieve the info of slot vacancy and update a common LCD screen that can possibly be kept at the entry of each parking area.

VI. SOFTWARE AND HARDWARE COMPONENTS EMPLOYED

- **Raspberry Pi:** A credit card sized computing machine with a Broadcom BCM2835 system on a chip. This relatively cheap tiny computer can be employed in electronics or embedded projects as it is capable of connecting digital devices and sensors .A single raspberry pi unit comprises of 26 GPIO pins indicating 26 different devices can be connected to it to receive and send signals.

- **Ultrasonic Distance Sensor:** A device for calculating the distance between two objects by the transmission of ultrasonic waves. It includes a transmitter, receiver and a control circuit. The ultra sonic waves transmitted by the transmitter will get hit on the target object and is reflected back. This reflected wave is received at the receiver of the sensor. The time duration taken by the transmitted wave to get received back is noted and the distance in between is measured using it in the equation below:

  Distance (cm) = (Travel Time /2)*Speed of Sound

- **Raspberry Pi Camera:** The Pi Camera module of Raspberry Pi can be manipulated for taking photographs and videos. It provides facility to take high definition videos as well. Fortunately it can be controlled programmatically and Pi-camera Python library is one among various libraries developed in order to access it. We will be using the same to realize our solution. It can be attached to the Raspberry Pi via a CSI port.

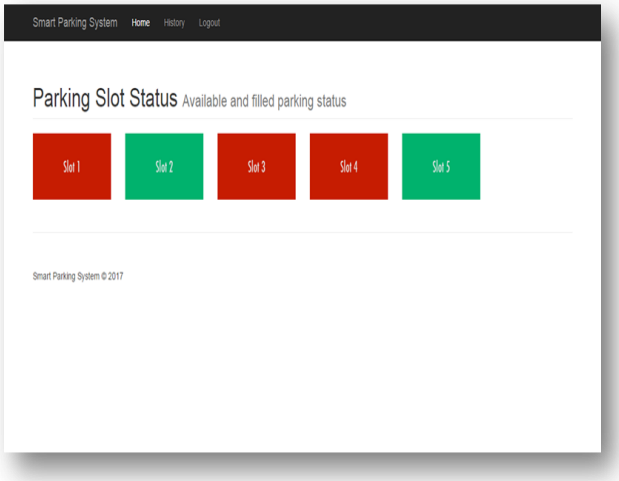
- **RPI.GPIO:** The GPIO pins of Raspberry Pi can be managed and controlled by using this python module. The class can be included in the python script to control the pins programmatically. This set of Python files and source is included with Raspbian by default, the operating system we use in Raspberry Pi.

- **Pytesseract:** Python provided optical character recognition. It can recognize the text that is embedded in images which will be captured using Pi-camera in our scenario. Python-tesseract acts as a wrapper for Google's Tesseract-OCR Engine which can read all image types including jpeg, png, gif, bmp, tiff and others.

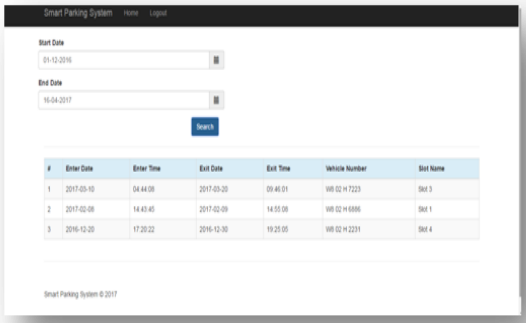
VII. RESULT AND DISCUSSION

The smart parking system was implemented as described and the resultant website looks like as shown below.

The website will indicate the status of all the slots in the current parking area. For implementation convenience only five slot statuses have been shown in the website. As you can see it is indicated with two colors. That is a vacant slot is identified using green color where as an occupied slot with red color. A new vehicle can park in any of the vacant slots. Suppose the driver opts slot 1 and parks the car in there. Then the resultant website would look like as shown below.



Hence slot1 is indicated as occupied by changing color from green to red. Beyond this, the vehicle number is also updated in the website along with the entry and exit information of the same vehicle under a history tab as shown.



VIII. CONCLUSION

It is possible to say that IoT has succeeded in realizing the concept of smart city to a great extent. It proposes an ideology where human intrusions can be reduced in almost every field and thereby uplifting comfort and saving labor through automations. The system we have discussed in this paper is also an IoT application. It works towards reducing the hurdles of the parking vehicles in parking areas. It allows people to get informed about the vacancy in prior entering the parking area and thereby allowing parking in the vacant slot without much hustle. This is a very economical approach as the participating hardwares are cheap and require less power. The future enhancement of the system includes providing a login for separately for drivers and an admin side where as the vehicle information is made available only for the admin side. Developing a dedicated smart parking app for mobile users is also one of other enhancements. Billing for the parking can also be linked with each user account so that automatic billing can be realized on exit.

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X. ADDITIONAL RESOURCES

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