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Smart Parking System Using Image Processing and Open Source Computer Vision Library

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ABSTRACT

In this structured approach, the empty parking slot to park the vehicles can be identified using the image processing technique. In the existing system, certain specific number can be marked in the respective parking slots and a sensor will be kept near each of the parking slot and with the help of these sensors we can identify whether a parking slot is full or not and the empty parking slots can be identified to park the vehicle. In this method, there is a CCTV(which is a USB cam) connected with the Raspberry pi which monitors and captures the image and gets the free slots. The image is processed in Open CV, a library of programming functions mainly aimed at real-time computer vision. The CCTV which has a USB cam integrated with it present in the parking slot will sense whether a car is present or not by image processing using open cv. In addition, the RFID tag is also provided to each user which is used to find the duration and the bill amount which is later sent to the respected user. The available slots can also be viewed by the local host before the vehicles arrive.

Keywords: Image processing; CCTV Camera; Open CV; RFID; Internet of things; Raspberry pi

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INTRODUCTION

The idea of smart cities has attained popularity. Due to this rise, the parking system has also been considered to play a vital and efficient role. We present an image processing using Open CV based smart parking system [1]. People face a lot of daily problems with automobiles and one of the main problems is car parking. Car Parking is a time-consuming and tiring task for human effort. It is difficult for people to comprehend as it happens on a very large scale. In this paper, weproposed to save lot of time and reduce human time and effort by looking at the available free slots for parking via the IoT platform. The proposed system can be implemented in busy apartments, convention Centre, and malls and will reduce fuel emission [2].

PROPOSED SYSTEM

When a vehicle enters the parking area, the driver or the owner of the car checks the corresponding link (using localhost communication) for free slots [3]. The CCTV present in the parking slot will sense whether a car is present or not by image processing using an open cv. In this case, the CCTV is the USB cam [4]. The message is sent to the user which contains the time duration and the bill details. This is done by fast2SMS, which is a SMS service provider. Each car is given an RFID tag which has a unique identification in it. If there is a car, then the parking slot will not display in the local host platform because the USB cam detects the car via edge detection using Open CV and the localhost link displays “filled slot”. The local host platform will display the filled and the available slots where the car is not present. When the maximum number of cars enters the parking area, the servo motor will not open. The car parking system is monitored through the USB camera using image processing technique [5].

The USB camera is used instead of CCTV camera. CCTV’s are connected in respective areas. In this scenario, we’ll be using a raspberry pi as a microcontroller. These CCTV’s are connected to the raspberry pi to detect and capture images later sent to open cv which will detect the presence of the vehicles. On a larger scale, the image saved by the CCTV will preserve a database of empty slots at any given point of time in cloud [6]. The localhost communication which provides a link is updated with that and after which it suggests a parking slot, after reviewing various factors like which slot is the shortest and easier to reach which can be an optimum solution. spent in the car parking slot and the bill amount for that time is sent to the user via fast2sms. A short path algorithm is also used to find the shortest and the intelligent way of approaching space. The slots can also be booked before a person arrives at the parking area [7].

METHODOLOGY

When a vehicle enters the parking area, the driver or the owner of the car checks the corresponding local host link for free slots. The CCTV present in the parking slot will sense whether a car is present or not by image processing using OpenCV. Each slot has the coverage of USB camera's which is processedwhether it is filled or not. We use a grayscale image which is a faster rate to be processed. The captured image has to be converted to a grayscale format so that each pixel can be simply compared with the threshold.The equation which converts RGB to Grayscale is- Gray = (0.299*r + 0.587*g + 0.114*b). Another image processing method is edge detection which helps in finding the boundaries of objects within images. The process works by acquiring interrupted brightness [8].

The disturbances or noise in the image captured needs to be erased after obtaining the segments for the objects used. This can be achieved through dilation and erosion. Dilation increases the boundary or the edge of the objects in the picture or the given image. But this is good to fill up holes in objects. On the other hand, erosion decreases the boundary or edge of the objects or a picture so that they can be easily distinguished from each other. We dilate the image and then we fill the particular image so that it will become easy for extraction. This process is explained in figure 1.

If there is a car, then the parking slot will not display in the IoT platform. The IoT platform will only display the available slots. When the maximum number of cars enters the parking area, the servo motor will not open. The display will show that the parking lot is "Filled". CCTV's are connected in respective areas. In this scenario, we'll be using a raspberry pi as a microcontroller. These CCTV's are connected to the raspberry pi to detect and capture images later sent to open cv which will detect the presence of the vehicles. The mobile application or the local host is updated with that. An RFID tag is given to each user while entering the parking area which will be scanned while entering and stores the data of any vehicle which enters the parking slot. Once they decide to leave the RFID is once again scanned while leaving and the details of the timespent in the car parking slot and the bill amount for that time is sent to the user via fast2sms.

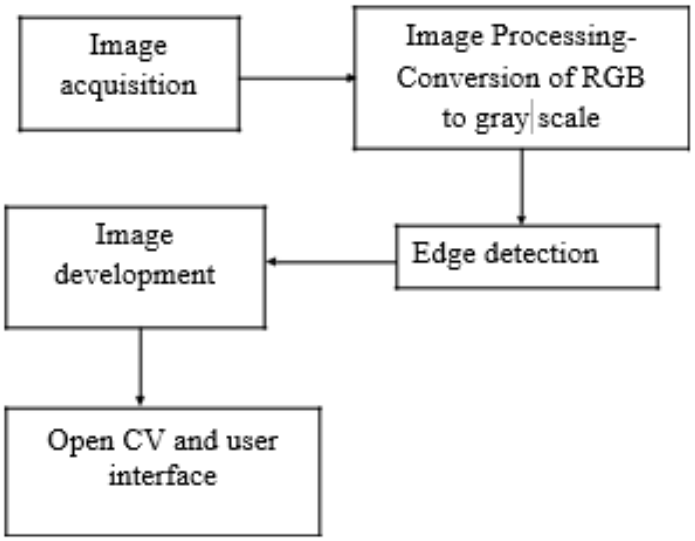

Fig 1. Flowchart of processing of image in Open CV

BLOCK DIAGRAM AND EXPLANATION

The block diagram for the process of the car parking system using image processing is shown in fig 2(a), 2(b). Fig 2(a) is a normal block diagram and fig 2(b) is the pictorial representation of the block diagram. The microcontroller used here is Raspberry Pi 2. In the Raspberry Pi, we connect the following modules such as RFID reader, LCD display, USB camera for image processing, servo motor as a toll gate for entering and an IR sensor for detecting the vehicle [9].

Raspberry pi process information and controls all devices connected to it according to the program. Camera are used for detecting the presence of vehicle in a slot based on OCR. A one-time manual drawing of slot numbers is done in the parking area. In order to identify the location of each parking space a unique number is assigned to each and every parking slot. A camera is set up in a position to capture the entire slot numbers in a single frame. Unlike the earlier systems, there is no need to give extra care for fixing the camera. The only one thing here we need to ensure is that the captured image should contain all the slot numbers clearly. When cars are parked in the lots the corresponding slot number will be hidden in the image. Now the only one thing we need to do is to identify the available slot numbers. This can be done by using Optical Character Recognition (OCR) techniques of digital image processing. A typical OCR based number recognition model.So when the vehicle enters the car parking area, the IR sensor at the entrance detects the car and lifts the servo motor which acts as a toll gate if there is empty slots which are available in the

parking area. While entering, the vehicle is given a unique RFID tag which is scanned while entering the parking area. For example, if car A and car B enters the slot simultaneously, car A is given a unique RFID tag and car B is given another unique RFID tag which separates the identity of two cars present in the parking slot. After entering the parking slot, for example slot 1 is filled by car A and slot 2 is filled by car B. The USB camera which is connected with the raspberry pi, detects the two cars present in the car parking area. The USB camera detects the car present in the parking space by using image processing which is carried out by Open CV.

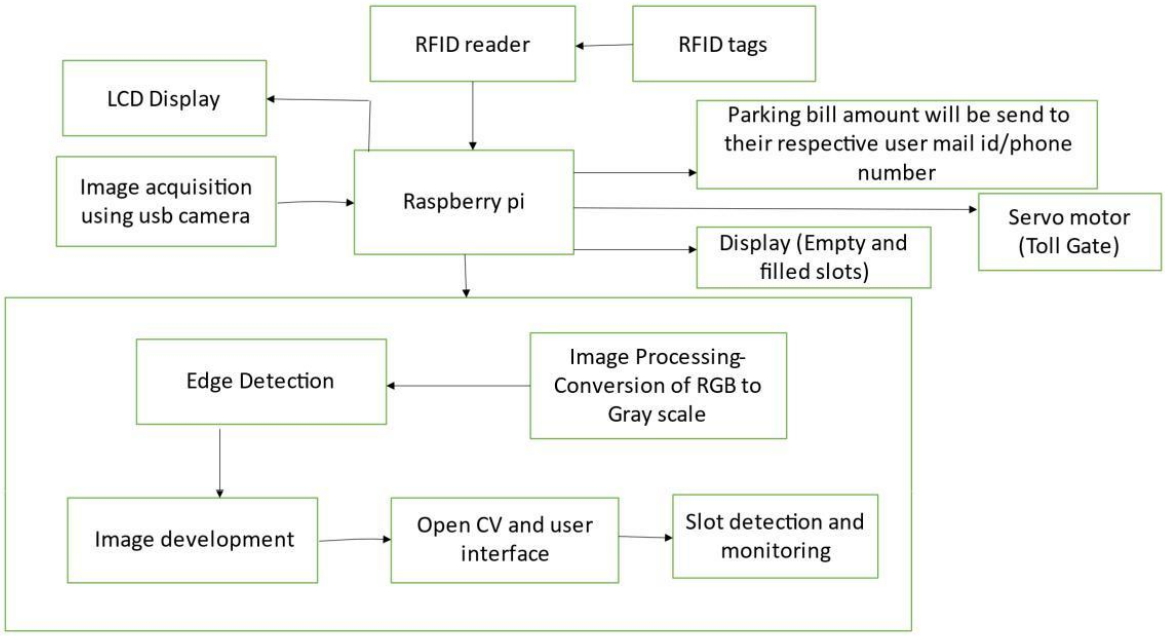

Fig 2(a). Block diagram of the process

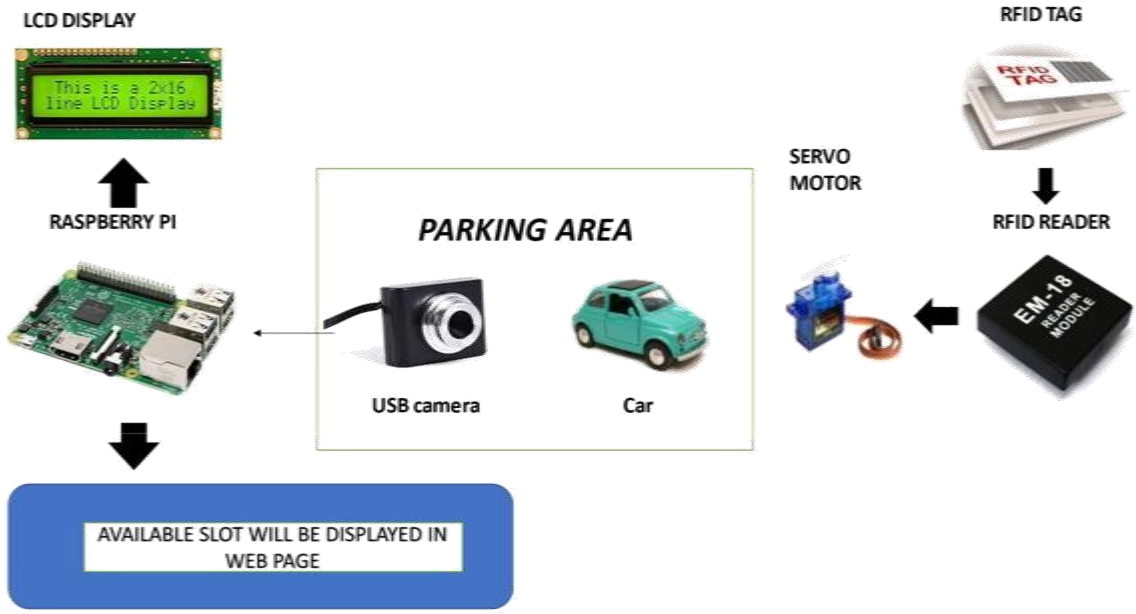

Fig 2(b). Block diagram is pictorial representation

The OpenCV's objective is to capture the coordinates of the object and highlight that object in the video. Firstly, the image undergoes conversion of RGB to Gray scale. Secondly, the image undergoes edge detection in that process for detecting the car. In this step, the edges of the car is being detected and we can able to see the car getting detected live through the video of the camera. Then it undergoes image development and lastly through the user interface in the OpenCV, the slot detection and monitoring can be done.After the detection of the vehicle in the car parking space, then a webpage is given through the local host communication through a link where the empty and the filled slots can be viewed. Later this can be developed into a mobile application and we can view in it(10). The link can be viewed and the vehicle can be parked in the parking are if it is empty. Simultaneously, the empty and free slots in the parking area is

updated and shown in the LCD display which is present in the parking space. It is also updated time to time through image processing. The webpage loads and updates the empty and free slots in the parking lot. For example, when car A decides to leave the parking slot 1, the USB camera detects the empty slot via the same process in OpenCV and updates in the webpage and the LCD display. So when car A exits the parking space the unique RFID given to car A's owner is again scanned and the bill amount and the time duration of the vehicle parked in slot 1 is sent to the respective car owner through fast2SMS. The exiting route is not the same as the entering route. The exit route does not contain any servo motor which acts as a toll gate. After leaving the parking space the updated information is sent to the webpage and another car can access the webpage and see if they could park their vehicles if the slots are empty.In the block diagram shown in fig 2(a), there is the implementation of image processing technique using OpenCV through USB camera which is connected to Raspberry Pi

FLOWCHART

The process of the smart parking systems is explained using a flowchart in figure 3. The step by step process gives us a clear view on the functionality of parking a vehicle in the parking space from the entry to the exit. At the entrance the vehicle enters the car parking space. While entering the parking space, the IR sensor kept in the entrance detects the car and allows the vehicle if the slots in the parking space is empty. If there is no empty parking slots available in the parking slot, the car leaves the parking space. This is done by keeping a servo motor as a toll gate to allow the vehicles. If the maximum number of cars enters the parking space, the status in the LCD and the webpage through local host communication shows "filled". So the servo motor doesn't lift the toll gate. If there are empty slots in the parking space, the vehicle is given a unique RFID tag and while entering the tag is read by the RFID reader module. The information regarding the vehicle is sent to the system and it is monitored. The USB camera present in the parking space monitors the vehicles present in the parking space and detects if the slots are free through image processing technique. So if any slot is free, the LCD and the webpage shows that the slot is empty. If it if filled it shows filled. After that, when the vehicle decides to leave the parking area the RFID tag is once again scanned while exiting. The RFID reader present in the exit route reads and sends the bill information to the respective owner. Calculation of bill amount based on entry time and exit time is sent through SMS via Fast2SMS. And finally after payment the car is leaves the parking space.

This whole process of car parking system is hassle free and less complex than the usual car parking and monitoring system present in the current lifestyle[10]. Most importantly, there is no need of human presence in the parking system. There is no need for people to be present for monitoring the parking area because of the presence of CCTV camera. Without human intervention, people avoid more contact with strange people and it is a solution for having no contact with other people during any pandemic. With less complex way of parking the vehicle people don't waste more time in searching the parking slots .

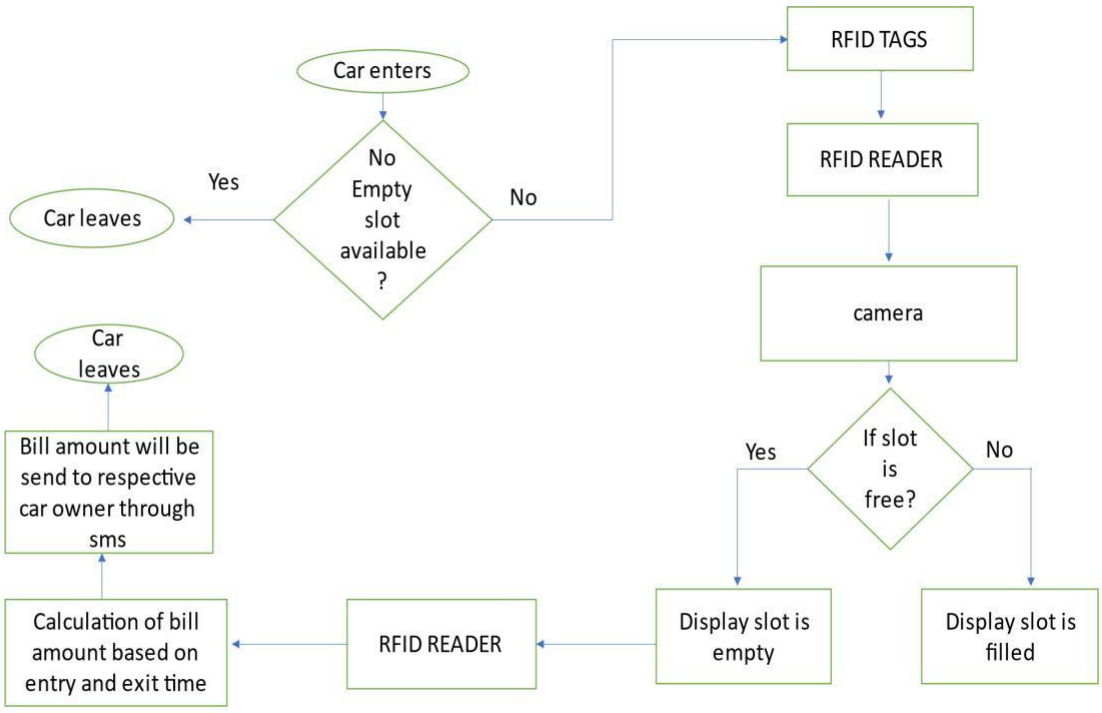

Fig 3. Flowchart

RESULT

So many researches on traffic congestion analysis reveal that an estimated 70 per cent of all drivers currently on the road are searching for effective parking. This will intensify traffic congestion as the vehicles spend more time on the road. Drivers may also tend to drive at low speed when they are searching for a parking space. Researches in this area have found out that vehicles spend an average of 15 minutes.

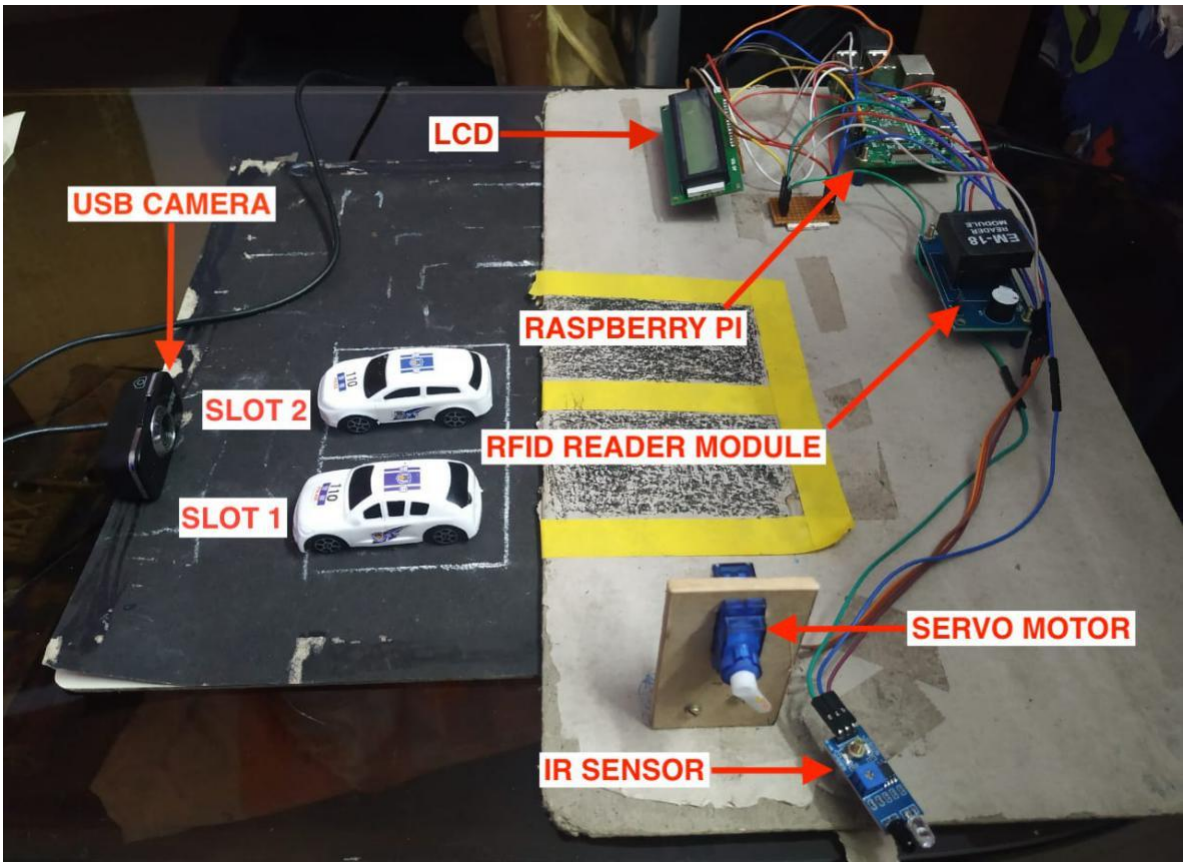

Fig 4. Car parking system setup

The motive to use a USB camera is because of the ability to capture the presence of many vehicles with an image. Also, the camera can be effortlessly moved to determine different car parking slots and can be kept in various positions. By capturing the various image, the specific car parking lot which is vacant can be recognized and then the processed information will be a guidance for a driver to an empty or available car park rather than wasting time to find the vacant slot one by one.looking for a parking space, travelling at an average of 10 mph and covers only half a mile in the meantime. The result s frequent traffic congestion.When the drivers are in search of a parking space, the possibility for accidents increases as they give less attention to the road. A sophisticated car parking system can only solve these problems. As a result, the proposed system captures via the USB camera and processes the images at parking lot through image processing and gives the information of the empty car parking slots. The parking system setup is shown in figure 4.

That is why numerous research works are taking place in this area all around the world. Empty parking slot detection is the first phase of any smart parking system. The second phase is sharing this information to the drivers who are in search of parking lots. This is done by providing them a link through local host communication. We can monitor whether a slot is free or not through the webpage. These are the methods used for detecting empty parking slots.

CONCLUSION

The proposed smart car parking system will overcome all the problems and complexity that are there in the old and conventional car parking system in apartments, malls and other busy buildings. Smart car parking system will be a impactful change in the urban lifestyle, which is filled with automobiles.We see that, this new system is an added value to the built-up way of living. In the current world, where automated driving is developed by Tesla, Inc and Google cars are initiated has growing interest among the people which will be an enhancement of great magnitude. Automated cars can do parking on their own, if this car parking technique is a part of their built in system.Hence, this simple concept when released, will be one of those revolutionary changes in everyday activities.Successful implementation of smart parking systems can effectively reduce a lot of problems related to traffic congestion in urban areas. Wastage of fuel and time in search of a vacant

parking space will be significantly reduced and the complete utilization of the available parking areas can make our cities really smart. Parking slot detection and user notification are the two major sections of a smart parking system. The empty parking space detection was initially done by deploying a number of sensors in the parking lot. It is highly expensive and complicated to install.But the advancement of image processing has enabled us to use images of the parking area to find out empty spaces. In this paper a comparative study of the various parking space identification techniques has been done. Also the image processing based system models has been presented as a replacement for sensor based systems. A very efficient and simple technique for parking slot identification based on optical character recognition (OCR) has been introduced in this paper. The camera installed in the parking lot captures the image of the parking area with specially numbered parking spaces.Through this process, we could achieve the goal for monitoring and controlling the parking area through image processing technique.

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