Next generation parking system (NGPS)

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ABSTRACT: Design of a system which dynamically monitors the availability of parking spots in a parking lot and notifies drivers of the vacant and occupied spots before they enter the parking lot. The system uses cameras which are installed in a high view of a parking lot, to capture pictures of the entire lot every several seconds and then analyzes the pictures captured using the image processing algorithm that we have developed. After that, the analyzed result is sent to the display unit located at the entrance of the parking lot in order to represent a real time map of the parking lot. Thus, before the driver enters into the parking lot, he or she can make an accurate decision on where to park. This document is going to provide you an overview design of our smart parking system and will talk about the system's existing solutions, proposed design solution and the results obtained.

Keywords **-** Edge detection, Image processing and color coding.

I. INTRODUCTION

Nowadays, car has been one of the most useful transportations for the people. In the most major cities, almost every driver has experienced of busy cruising for a vacant parking spot in a very crowded parking lot, above ground parking lot, below ground parking lot. Since a driver cannot visually assess whether or not there is a vacant parking spot in the parking lot he or she wants to enter, and the parking lot operator has no responsibility to tell you whether or not there is a vacant parking space, or even some parking lots don't have the parking lot operator. Therefore, the only way for a driver to looking for a vacant spot to park is that he or she needs to drive through the entire parking lot to cruise an available parking spot for him or her. If the space of parking lot is huge and multi-leveled, it will be very time consuming. Thus, if the driver is running out of time and looking for a vacant parking spot in a huge parking lot is very frustrating. For example, if a student is driving to college to have an important exam and looked for a vacant spot to park while the minutes are ticking away towards the starting of the exam.

According to various researches on the time spent cruising for a parking space, the average time varies from 3.0 to 13.5 minutes, with distance drove varies from a half kilometer to more than a kilometer. If the driver is informed about how many parking spots are available and also the locations of the vacant spots in parking lot before entering the lot, he or she will not have to waste time and fuel to cruise for a vacant parking spot in a crowded parking lot.

II. EXISTING SOLUTIONS

Parking management system has three main components: occupancy detection unit, main management unit, and availability indicator unit. There exist a number of solutions to occupancy detection unit and availability indicator unit of the system. Please note that following possible design solutions already exist in the current market.

1. Ultra Sonic Sensor

Ultra Sonic Sensors located on top of each parking space detect presence of vehicle in the designated parking space. Ultra sonic sensor generates high frequency sound waves to its objects and interprets the echoes to determine the distance to the object. The main advantage of ultra- sonic sensor is its accuracy to detect the presence of vehicle However; installing sensors on top of every single spot of parking lot require considerable Installation costs. Also the wiring to main management system and maintenance costs is a significant disadvantage of ultra-sonic sensor. [1]

2. Induction Loop Sensor

These sensors can also be installed under parking spaces to detect presence of vehicles above them. Induction loop is electromagnetic detection system where conducting loop is installed under the ground. When vehicle is on top of conducting loop, it induces current in the wire loop, thus decreases inductance. Decrease in inductance then triggers the output electronics unit which send signal to the main control unit. The advantage of installing induction loop sensor is the easiness of maintenance. As the sensors are buried under the ground, it can tolerate harsh weather conditions. However, induction loop sensors need significant amount of money for initial installation and replacement in case of failure. [2]

3. Pressure Sensor

Pressure Sensors are similar to inductive loops in terms of installation process. To detect the pressure difference caused by weight of vehicle, pressurized tubes filled with liquids are buried under ground. When vehicle is parked above the sensor, the weight of vehicle exerts pressure on the tubes. This causes the pressure monitor to detect the pressure changes on tubes, which then transmits signal to the main control unit. Pressure sensors are not commonly used for vehicle detection as they are sensitive to temperature changes and have low accuracy. When vehicles are parked, it is not guaranteed that the wheels step on the pressure tubes. Moreover, installation and maintenance costs are disadvantages of pressure sensors. [3]

III. PROPOSED DESIGN SOLUTION

The proposed design solution consists of a system that can detect whether a car is parked in a parking spot or not. The system can be installed and removed in any parking without any damage to the parking. The design process consists of development of both small size prototype and full size prototype which use the same program for image processing. The only difference between the small size prototype and full size prototype is the components used. These components include the cameras, control box, and the LCD display screen.
The system uses 2 cameras to capture 3D pictures of the entire parking in a very timely fashion and analyses the pictures using image processing; the result is then sent to the LCD display screen in order to represent a real time map of parking. The small size prototype uses VGA cameras while the full size prototype requires 720p cameras which have higher quality.

The control box is the main body of this system where it communicates with cameras and does all image processing. The control box in the small prototype is a Microcontroller (Microchip PIC32) which runs a program to do both image processing and storing data. A small industrial computer is used instead of the Microcontroller in the control box. The control box is installed at a place where it can't be accessed by regular people for security purposes.

A 3D layout of the parking lot with location of parking spaces is generated by the system at the time of installation. This layout is customizable and is different for all parking lots. Figure number 1 shows a sample picture of a parking lot which is captured using cameras and used in the system. The captured image of parking at any instant of time is sent to the control box to be analyzed and compared with the captured image at the previous instant of time using image processing. The program compiled in microcontroller then starts detecting cars based on the edges of cars and finding where each car is located at each moment. Figure number 2 shows basically where the cars are located which is the key for defending whether a car is parked in a parking spot or not. The system then compares locations of cars with the layout of the entire parking and represents the result as a map on the LCD display screen. The number of free parking spaces is also represented on the screen. The small size prototype uses LCD Microcontroller module as the LCD display screen while the full size prototype requires a large LCD display screen.

IV. FIGURES

Figure 1 Shows Sample Parking Lot

Figure 2 Shows Car Recognition Software

Blue lines in figure 2 indicates the detection of vehicle

The system covers out-doors parking's to a range of distance and additional cameras may be required as the distance exceeds the range. The in-door parking's also require additional cameras in order to cover the entire parking.

Additional user friendly features can be added to the system such as a wireless module in order to make the system useable by computers and smart phones in order to inform the user when the parking time expires and the parking time needs to be extended. The control box can send the data to an external storage when it's connected to a network via the wireless module which can be used by parking lot security in order to make it easier for monitoring.

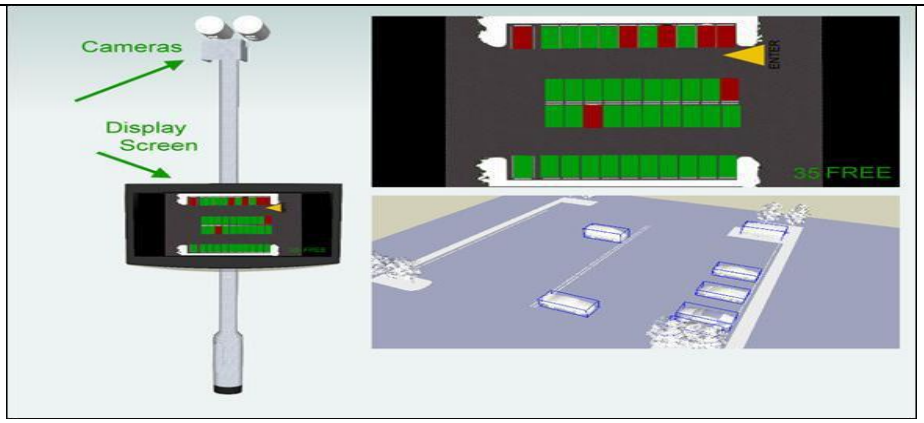


Figure 3 Shows Display Screen

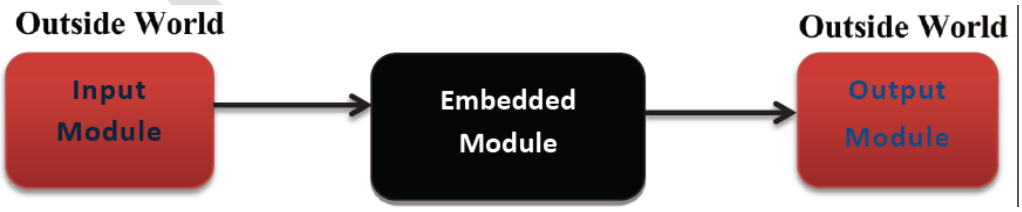
Figure 4 Shows Installed System

V. SYSTEM OVERVIEW

The Next Generation parking system is a device that can be used to efficiently assist drivers in finding free parking spaces in a parking lot without entering it. The system can be installed and removed in any parking lot without any damage to the existing facilities. It consists of three units that are integrated together to create a parking guidance system that detects available/unavailable parking spaces. The three units are as follows:

1. ***Input Module***
2. ***Embedded Module***
3. ***Output Module***

The block diagram of system representing the connection of these three units is shown in Figure 5.



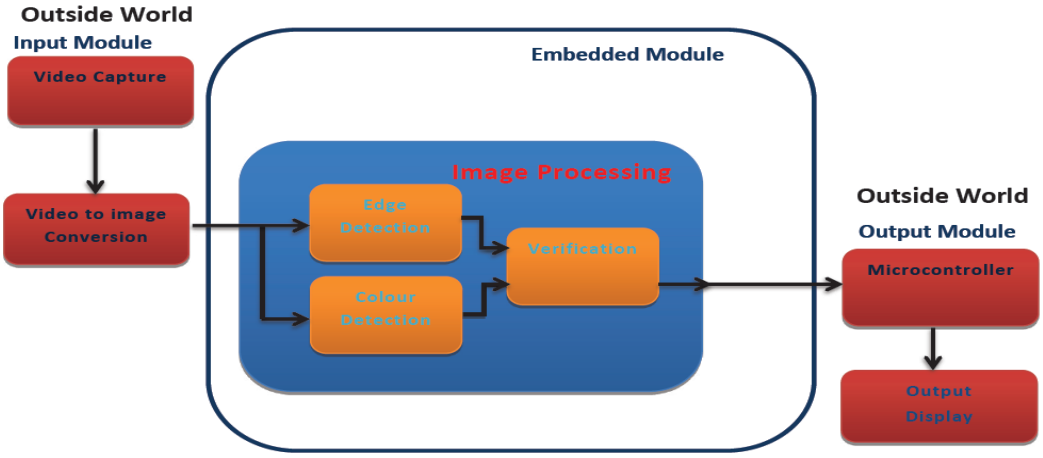
1. Input Module

The input module consists of the image capture module. It is made of a High Definition (HD) camera which is used to capture image from a parking lot. The input module uses one camera to capture image from the parking lot. However, when a camera is not sufficient to capture all parking spaces in the designated parking lot, the

NGPS team will install additional cameras to cover the extra blind spots. This module provides the processing unit the real time image of the parking lot.

2. Embedded Module

The embedded module is the brain of the system as it uses the images provided by the input module to analyze images and detect the location of vehicles. The result from embedded module is then sent to the output module. The processing module consists of three functions including color detection function, edge detection function, and verification function as they are shown in Figure 4.



The color detection function detects the occupied and unoccupied parking spaces by comparing color of pixels. This function takes the RGB value of specified parking spaces and compares them with the average color of sample points collected from roadway of parking lot. The occupied parking spaces have a different RGB value than the collected sample ground RGB value since the ground is no longer visible from the angle of the camera. In order to improve accuracy, standard deviation and block size RGB collection algorithms are implemented. The edge detection function detects the edges of vehicle and finds location of cars. The location of cars at each instant of time is then compared to the location of parking spaces using the layout of parking. The verification function confirms whether the results of the two detection methods agree or not. The verification is done by comparing the results of both methods and checking whether they agree in an acceptable range.

3. Output Module

The output module consists of the microcontroller and the output screen display. The microcontroller converts the received data from the verification function to readable data's for the output display. The output screen display is responsible for receiving the data from the processing unit and displaying them on the screen.

VI. RESULTS OBTAINED

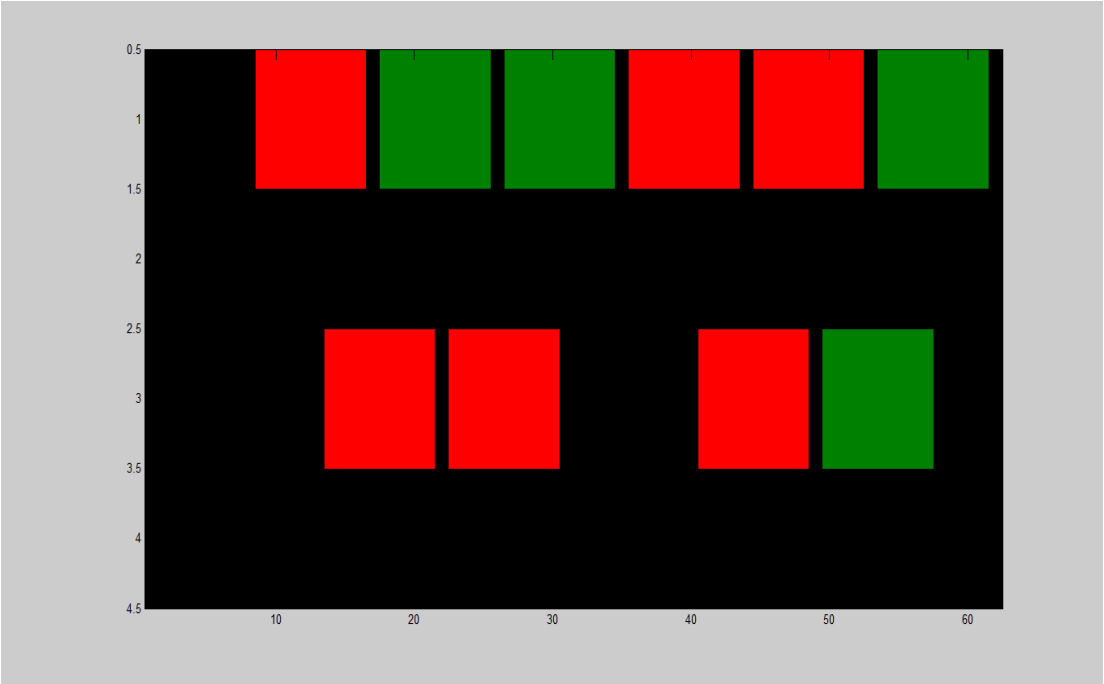


FIGURE: The Display Screen installed at the entrance of the parking lot\

VII. CONCLUSION

At next generation parking system, we are confident that are product will help save time, money and unnecessary carbon emissions while delivering a luxury service to the masses. The simplistic design, cheap and straightforward installation process and benefit to customers will make the product highly marketable. In the presence of an enthused, talented team we are confident that we shall be able to successfully develop the said product. Our focus is to come up with fully functional prototype with the most cost-efficient model which can then be custom made to suit the needs of our diverse clients. Thank you.

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