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Car parking occupancy prediction

Soumya Chowdhury
Undergraduate Student, Department of Computer Science and Engineering, SRM Institute of Science and Technology, Kattankulathur, Chennai (603203), India

Parth Brahmaxatri
Undergraduate Student, Department of Computer Science and Engineering, SRM Institute of Science and Technology, Kattankulathur, Chennai (603203), India

J. Selvin Paul Peter
Assistant Professor, Department of Computer Science and Engineering, SRM Institute of Science and Technology, Kattankulathur, Chennai (603203), India

***Abstract*---**Nowadays in modern cities, with the continuous growth of cars, parking slot availability is becoming a more and more difficult task. So, an efficient car parking occupancy detection system is becoming a necessity in order to reduce traffic congestion in parking lots. This paper proposes a system based on computer vision algorithms and basic image processing techniques that is capable of determining if a parking space is occupied or not, using aerial images captured through a camera. It aims to solve the issue of detecting a parking space that minimizes the time spent in searching parking lots which in turn reduces the carbon emissions that lead to a better quality of life. Current solutions available to this problem use hardware devices, IoT, sensors, CNN, and various deep learning algorithms. But the proposed system eliminates all the above complexities, thus resulting in greatly decreased expenses.

***Keywords*---**Car parking, algorithms, IoT, sensors, CNN.

Introduction

The growing populace in urban & semi-urban towns because of its immensely growing task possibilities and flashy lifestyle has added a number of concerns. One example is the rising number of motor vehicles, particularly cars, commuting between locations, which has a direct influence on the city's parking lots, which have always been few. People are buying cars despite knowing the fact they don't have vacant space to put it in which ultimately leads to parking the car on streets which is usually a very casual thing in India as we are yet to have dedicated parking meter spots, creating a blockade for the other people leading to a

disruption in flowing traffic. In cities like Delhi and Bangalore, a person spends an average of 20 mins finding a parking space in a day. This concern has led us to think of a system where finding parking space could be simplified using Cutting edge tech and ultimately reduce the time spent on searching a space.

Computer Vision

Computer Vision is one of the emerging tech stacks when it comes to dynamic image processing techniques which not only includes images but videos and live feed too. Some of its applications are object detection, 3D scene construction, image and video preprocessing and scene segmentation. Computer vision makes use of convolutional neural networks (CNNs) to process visual information at the pixel stage and deep learning recurrent neural networks (RNNs) to recognize how one pixel pertains to another.

OpenCV

OpenCV is a computer vision library that is open-source and has the ability to harness real-time image processing techniques. It is quite simple for organizations to alter and use the code as OpenCV is a product that has a BSD license. The library has more than 2500 highly efficient algorithms which can identify faces, object detection, track movements, recognize an environment and establish markers and use AR on it. The library is used by well-known companies like Google, Yahoo, Microsoft, Intel and IBM. OpenCV is based on the C++ programming language and works with all major operating systems.

Python

Python has been our preferred choice since our research primarily revolves around image processing which can be brought to use with it. Python is relatively easy to comprehend thus enabling other researchers to actively contribute to this. It supports object-oriented, functional/procedural paradigms. Since the syntax is small it's easy to read and the logic can be expressed in minimal lines of code.

Literature Review

[1] This study describes the design and implementation of a smart system that monitors parking lots by combining image processing methods for vehicle detection with wireless network technologies. The three primary components of the smart parking system proposed in this paper are as follows. These are the parking detecting nodes, which include WiFi access points (APs) distributed within each major sector of the parking facility, a WLAN-integrated local base station, and an information delivery notification system.

[2] Some of the components that the smart parking system implemented in this paper uses are Platform/Server, PIC controller and IR Sensor. The platform/server monitors and processes all actions related to the system and also detects problems. The PIC controller serves as a gateway device, collecting sensor data and sending it to the server. The IR Sensor is a device that transmits a signal when a car enters or exits a parking spot to identify available parking spots.

[3] This paper presents a theory to find a vacant place in a three-phase process. An arduino sensor installed in the parking zone interacts with free space and the user in the first phase. The second phase contains the cloud. The third phase is the user side. An Arduino IoT sensor is installed in each parking zone and it establishes contact with a mobile device using wifi.

[4] The device scans both the car and the person's face with cameras. The Optical Character Recognition Algorithm is used to scan the vehicle number plate, while the Face Recognition Algorithm is used to scan the face. To gain access to a parking spot's gate, IoT devices are employed. When we create the database, we'll start with images of each person taken from various perspectives, as shown below, so that pictures taken from any angle will have no effect on the outcome. No intruders are allowed, therefore safety is increased. If the vehicle is parked incorrectly or someone else enters the premises, an alarm will sound. The recommended answer guarantees that the whole process is automatic and that accuracy isn't jeopardized because of time constraints.

[5] The algorithm used in this paper stumbles on vacant parking areas in static overhead images using car feature point detection and color histogram classification. It breaks down into four stages: extraction of human-labeled parking area regions, pre-processing and color histogram classification, vehicle feature detection and mixing the consequences to shape the very last classification.

[6] Wireless communication has been used to reserve parking spots using GPS. Every 120 seconds, the method broadcasts the provision of areas. If all parking areas are inaccessible, no movements are recorded; in the alternative, any user is ready to call a location within 2 kilometers of their current location.

Methodology

The camera serves as a real-time input for the proposed system in this paper. The live feed is used to get all the position points of parking spaces. The regions of interest are selected by mouse clicks. For the purpose of detecting a car, the entire frame is cropped into different images one by one. The single image is converted into a binary image because binary images can easily separate objects from the background. The segmentation process helps label each pixel as a "background" or "object" and assign a black and white color accordingly. The image is then converted into grayscale to do adaptive thresholding. Adaptive thresholding is a method of calculating thresholds for smaller areas. Gaussian blur is added to the image to reduce image noise. The image is then again converted into binary. Then a medium blur is applied to the image. This could be very powerful towards salt and pepper noise in the images. The image is then dilated to develop the foreground pixels. Finally, the range of pixels is counted. If the number of pixels is less than a particularly decided value, then that region is considered unavailable and if it is more than the particularly decided value, then that region is considered available. The total and available parking spaces are then displayed on the screen.

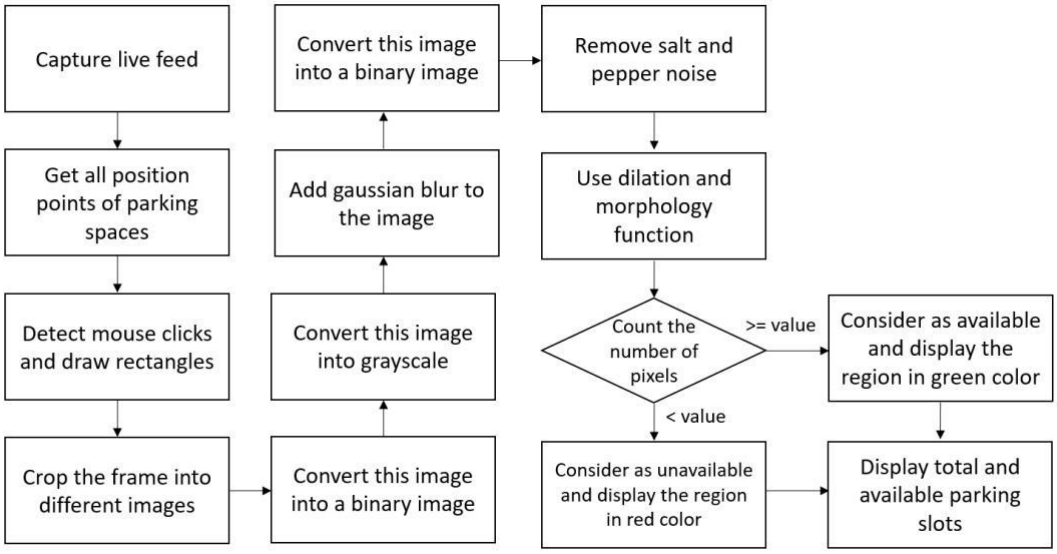

Figure 3.1 Flowchart of the proposed system

Algorithms

Adaptive thresholding

Adaptive thresholding can be applied to grayscale images only, OpenCV generally takes BGR color format. To begin with the process we first take the raw input and change it to the grayscale image with pixels in 0 and 255, 0 being black and 255 being white which later on undergoes the layers applied by the thresholding function which finally results in a binary coloured image. Adaptive thresholding is an alternate advanced version of simple binary thresholding which basically allocates different threshold values to each part of the image depending on the neighboring pixels.

The syntax of this method is as follows:

cv2.GaussianBlur(src, ksize, sigmaX[, dst[, sigmaY[, borderType=BORDER_DEFAULT]]])

Gaussian Blur

Gaussian blur uses a convolution kernel. A weighted kernel can also be used which will give a different blur effect on the image. The algorithm is slow as its processing power is dependent on the size of the image and the size of the kernel. The steps include A) picking a kernel and B) average every pixel in the kernel, processing each individual color channel separately.

The syntax of this method is as follows:

cv2.GaussianBlur(src, ksize, sigmaX[, dst[, sigmaY[, borderType=BORDER_DEFAULT]]])

Morphological operations

Morphological operations like Dilation and Erosion in OpenCV are algorithms that help you clean up small noise like small black/white dots that appear on images. If used correctly they can reduce the amount of noise or small issues with the image and thus improve the total accuracy of recognition. Hence these operations help to make the object more visible. Dilation fills in gaps and smooths down the edges of objects. It increases the object's size by adding an extra outside ring of pixels to the object's edge. Erosion, on the other hand, smoothes the object boundaries and removes isolated noisy pixels. It eliminates the item's outer layer of pixels, causing the object to shrink slightly.

Implementation

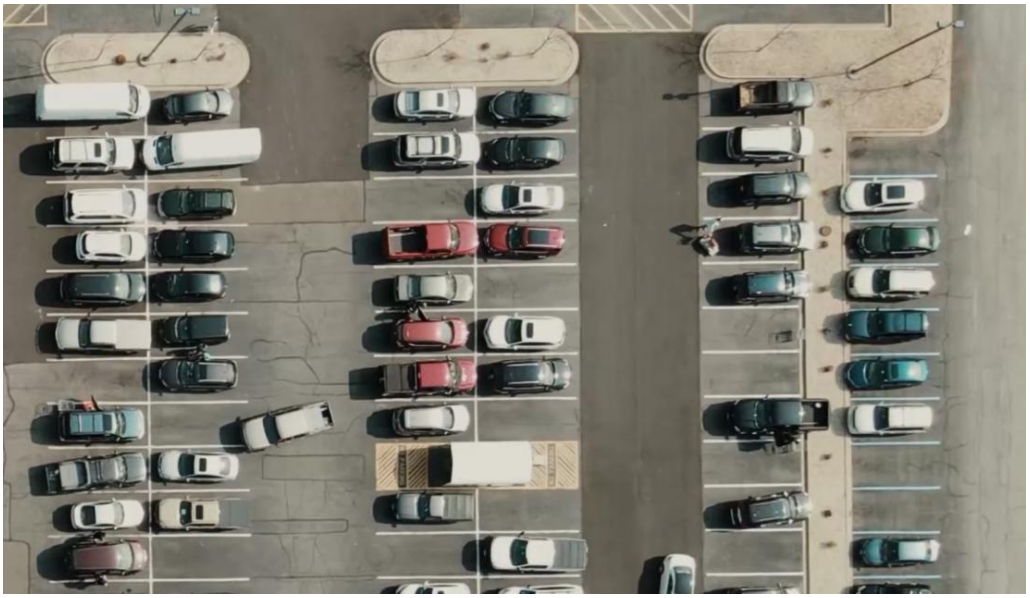

Figure 5.1 Screenshot from live video feed

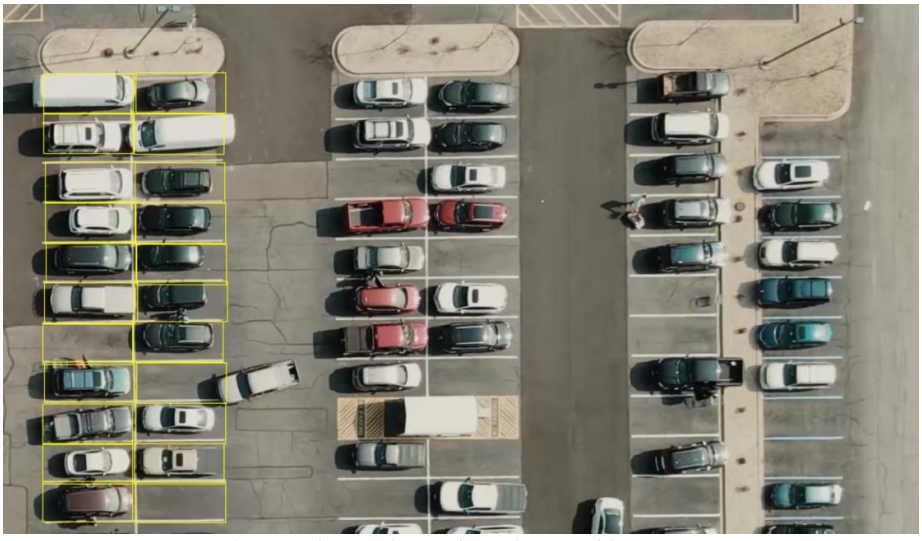

Figure 5.2 Selected regions of interest

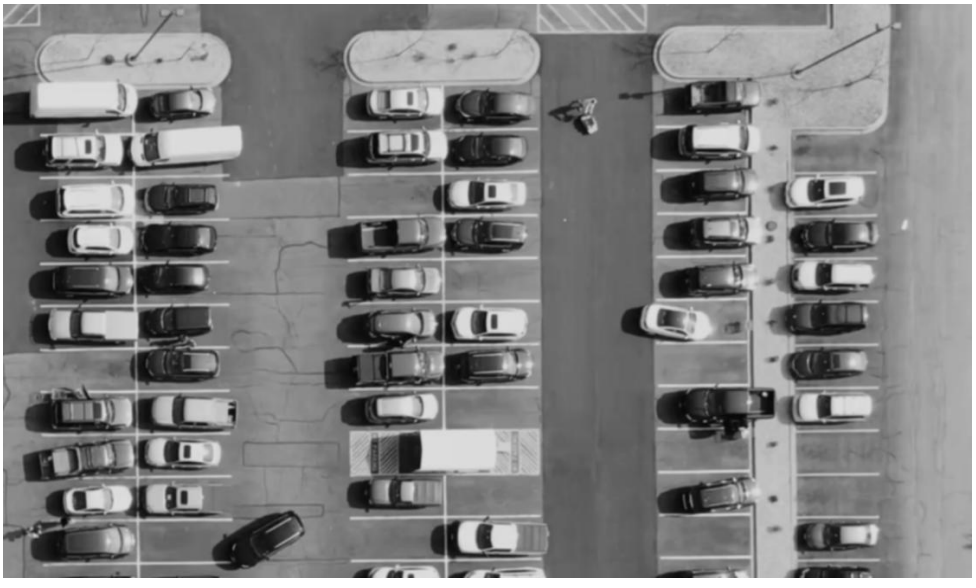

Figure 5.3 Image Blur

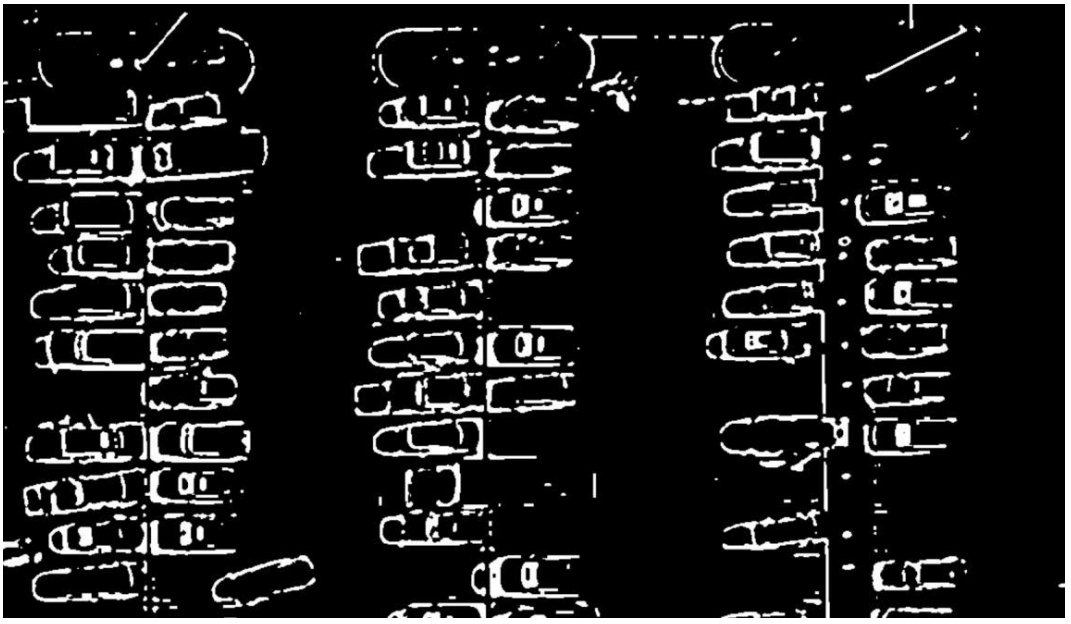

Figure 5.4 Image Threshold

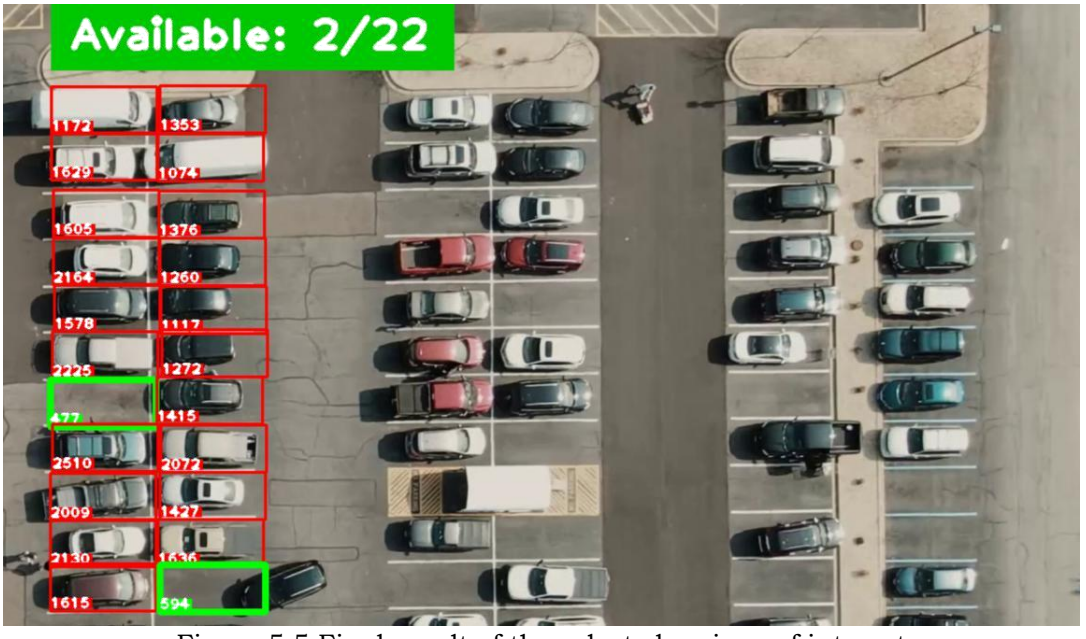

Figure 5.5 Final result of the selected regions of interest

Conclusion

There are various methods today which can guide us to make a full functioning system to find parking space for your vehicle. Our approach also was one such where we used a live video feed as our main input and used the most efficient image processing techniques using OpenCV, Python and computer vision algorithms to create an interface which can effectively identify vacant/occupied spaces. The POC is ready to implement using hardware devices like a camera and a mobile interface for android/ios devices facilitated by cloud infrastructure.

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