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Parking Occupancy Detection Using Convolutional Neural Networks

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Abstract—Sophisticated world has the gifted man not only with comforts but also with many problems, one of the unavoidable and the most challenging problem is vehicle parking problem. The unregulated parking system is leading to huge traffic and accidents. Parking the vehicle in the parking space is highly unorganized and people have to manually check for the vacant places for parking their vehicles. So most of the people will park their vehicles in empty spaces or on the road which increases the problem further. In recent years, a lot of papers have been published addressing this issue. However, implementing them is highly expensive due to their usage of the costly sensor technology and other hardware requirements. But this paper proposes an intelligent parking system for vacancy detection using convolution neural networks that give accurate results under any Circumstances.

Keywords—Convolution neural networks, Parking lot, Vacancy detection.

I. INTRODUCTION

A recent survey shows that during rush hours in the biggest cities the traffic generated by cars searching for parking spaces takes up to 40% of the total traffic because if driver wants to find a parking spot to park the vehicle, he has to park the vehicle in the road and have to check manually for the parking spaces. It takes a lot of time and fuel. So to address this problem a robust system is being designed to develop a camera-based system that takes only images as input and allows people to identify the available spots effectively, Eventually this leads to saving the time and fuel. The previous study [1], [2], [3], [4] shows that video cameras are being used to monitor the parking spaces. As most of the techniques rely on video cameras, the monitoring of parking space through visual information is the open challenge. In this paper, we intend to present a solution with the help of deep learning techniques [5] such as Convolution neural networks are robust to conditions like images in different weather conditions like sunny, cloudy, foggy etc.,. There are several methods to detect a vehicle in parking lot. One of the methods is by installing sensors in each division of parking lot and another method is through the images of parking lot taken by smart cameras. The method of using smart cameras is system becomes compact, and cost reduction becomes possible as compared to the usage of sensors [6].

This paper is organized as follows. Section II reviews about related work. Section III describes deep learning techniques and proposed approach. Section IV gives an idea about experimental results and Section V concludes the paper.

II. RELATED WORK

There are some papers that studied parking space management using techniques of image processing and computer vision.

"Parking space classification using convolution neural networks" [7] describes an approach to check whether a slot is full or occupied using binary classifier and also count the no of empty spaces. This work shows that research done in sunny and rainy seasons.

"Car parking occupancy detection using smart cameras and deep learning" [8] describes an approach for real-time parking occupancy detection using smart cameras with limited resources. However, an in-depth analysis of the performance in non-ideal situations, such as night, foggy, or snowy conditions, is left to future work.

"Parking stall vacancy indicator system" [9] analyses the approach of robust detection algorithm with the help of deep convolution neural networks.

"Intelligent parking space detection based on image processing"[10] aims to present an intelligent system for parking space detection based on image processing technique that captures and process the brown rounded image drawn at a parking lot and produce the information of the empty car parking spaces
Our proposed systems mainly focus on detecting the vehicle in a night and foggy Conditions and counting the no of vacant spaces by using convolution neural networks.

III. DEEP LEARNING TECHNIQUES FOR VEHICLE DETECTION

In this paper, we proposed an approach for parking vacancy detection with the help of Deep learning. Deep learning is a branch of artificial intelligence that aims computers to do what comes naturally to humans: learn by example. Deep learning is a computer model that learns to do classification tasks from different images and text. Deep learning models can achieve good accuracy, sometimes exceeding human-level performance. Models are trained by using a large set of labeled data and neural network architectures that contain many layers. One of the most important techniques of deep learning is Convolution neural networks [11], [12], [13] that works effectively for vision tasks. The proposed approach mainly based on Convolution neural network architecture,
Convolution neural networks are one of the main algorithms in the area of deep learning and very effective in areas such as image recognition and classification. It contains four layers compared to artificial neural networks [14] as it has only three layers like an input layer, hidden layer, and output layer.

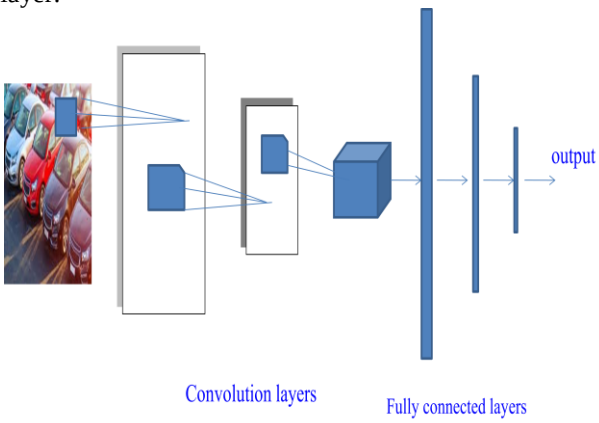

Fig 1 Illustration of Convolutional neural networks

The basic functionality of the example CNN above can be broken down into five key areas.

i. As found in other forms of ANN, the input layer will hold the pixel values of the image.
ii. The convolution layer is used to extract features from the given image
iii. The rectified linear unit aims to do element-wise activation function such as sigmoid to the output of the previous layer
iv. The pooling layer is used to reduce the dimensionality of each feature by using downsampling but retains most of its important information.
v. The purpose of the Fully Connected layer is to use these features for classifying the input image into various classes based on the training dataset.

This system validated with the approach of using CNN with the help of parking lot dataset. The images from the dataset will be given to the Convolution layers to extract from the given image as shown in fig 1. After processing the output of the convolution layer and fully connected layer we can come to know that whether the car is detected or not through the output layer.

The parking lot dataset is a robust image dataset of parking lots which is an extended version of the one introduced in Almeida2013. It was extended from 105,837 to 695,899 images. In this new version, the parking spaces were captured from different parking lots under varied weather conditions. Each parking space image was manually checked and classified according to its situation (vacant or occupied) and to the weather condition observed during the image acquisition (sunny, overcast or rainy). The parking lot dataset is available for research purposes under request [15].

IV. EXPEIMENTAL RESULTS

The following figures are screenshots of the parking spaces with detection in different weather conditions like sunny, rainy and cloudy etc.,with the proposed CNN.

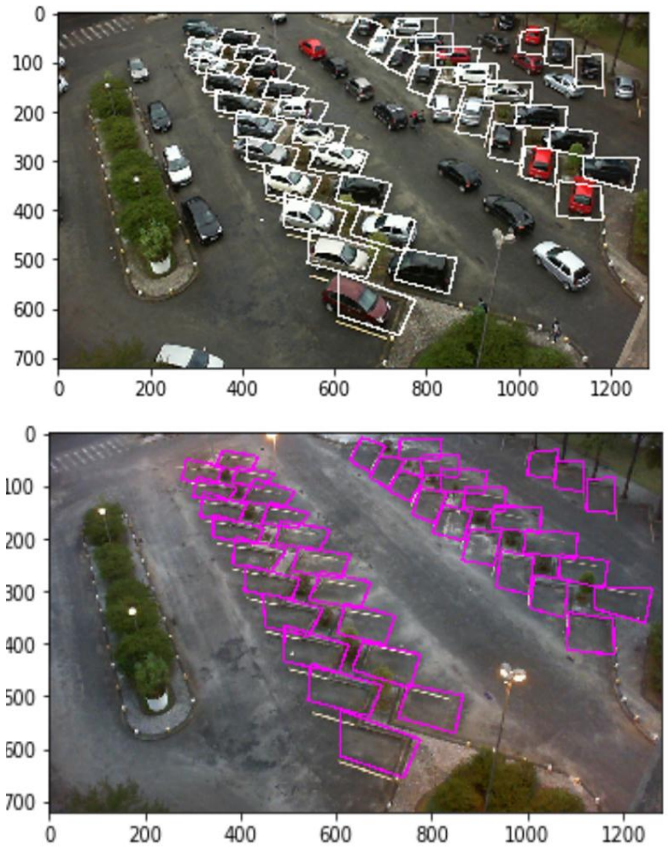

Figure 2: Car parking detection in three different areas

	UFPR04	UFPR05	PUCPR
UFPR04	99.66 %	95.46 %	96.48 %
UFPR05	96.46 %	99.70 %	97.06 %
PUCPR	95.76 %	98.48 %	95.86 %

Figure 3: Accuracy in different conditions

In the fig2 pink bounding box indicates that there is no car in the parking area and light yellow bounding box indicates car is present in the parking area and some of the segmented images of occupied and vacant spacesshown in fig4.

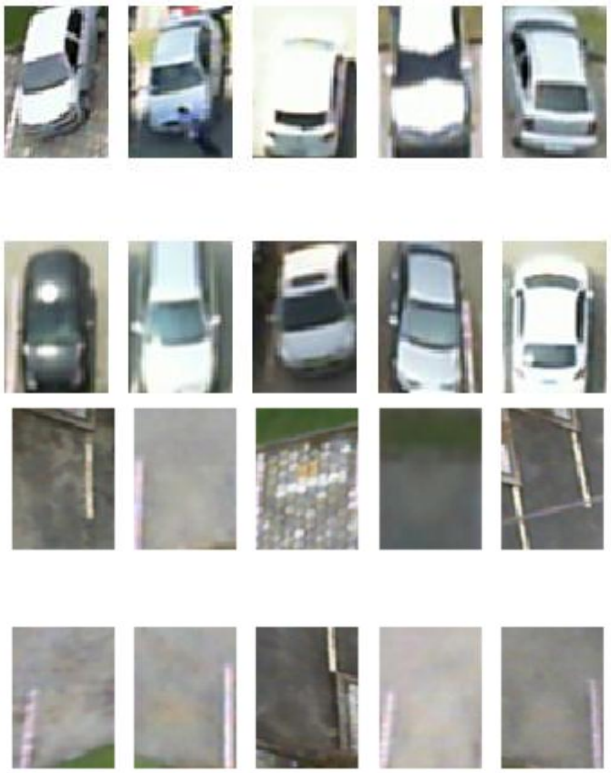

Figure 4: Segmented images of occupied and vacant spaces

In order to find robustnessof the system, it have been trained on the individual parking areas and then tested on both the same parking area and on parking areas that have not been seen.

The accuracy can be seen in fig3, when training and testing on the same parking area, the accuracy is in all cases above 99.66%. The lowest accuracy achieved is 95.46 % when training on the UFPR05 and testing on UFPR04.The total accuracy of the proposed CNN is 98.76% as there are limited images in foggy condition. This can be improved by adding more images to the dataset by training and testing with different parking areas.

V. CONCLUSION

In this paper, we proposed and evaluated an approach for parking occupancy detection using convolution neural networks with the help of smart cameras rather than the sensors that are used in previous studies. Our system effectively detects vehicle images taken from different conditions like sunny, rainy, cloudy, foggy conditions with the addition of car parking lots in fog condition images to the PKLOT dataset. Our experiments show that convolution neural networks are best suited to address this problem. It shows high accuracy even in the presence of light variations like sunny , foggy conditions.

In the future work, we can add more foggier images and night conditioned car parking lot images to the dataset to improve accuracy. And an app can be designed so that one can easily park the cars in any weather condition by opening the app in his mobile by simply sitting in the car itself. So that driver can easily navigate to the location and park the vehicle.

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