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Smart Car Parking System using Convolutional Neural Network

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***Abstract*— Our overall aim was to develop an automatic system that counts the empty spaces in a parking lot, by giving the image of the parking lot as the input. The output will be obtained as a display on the output console. In this project, we present an adequate method using few frames which are captured by a single camera for parking space detection. Our system will reduce the time required to find vacant spaces and reduce the wastage of resources. In this paper we propose a binary classifier, which is a Convolutional Neural Network that is capable of finding if the parking lot is occupied or not. For analyzing visual imagery, a class of deep learning is required which is called the Convolutional Neural Network. The final system produced an accuracy of 100%.**

Keywords- Convoltuional Neural Network; Artificial Neural Network; Image Processing.

I. INTRODUCTION

During busy hours in the city finding a parking spot, becomes a tedious process. On an average a person drives extra 30 kilometers each year to find an empty parking space. According to various studies it was found that a driver spends 8 minutes for finding a spot. During this process a lot of fuel is consumed. [12]

Recent years, many researchers have tried on improving parking lots detection systems. Some of them used visual surveillance, which requires real-time interpretation of image sequences which helped to automate the detection of parking spaces. Some other kept tracking and recording the movement of vehicles which helped them to find the empty parking space. There are 2 major approaches for identifying parking spots. Every parking spot could be pre-installed with a sensor to detect the presence of a vehicle. The alternative way is to capture visual information to determine if a parking spot is vacant or not. The first approach is quite expensive, while the second approach is very much economical.

In our project, we present a proper method by using only a few frames which are captured by a single camera for parking lots space detection. Visual information (mostly collected from pre-install security cameras) is used to determine if a parking lot is empty or not.

II. SYSTEM OVERVIEW

Our system is divided into three parts. They are as follows 1.) Visual nodes: These contain regular color camera. The image

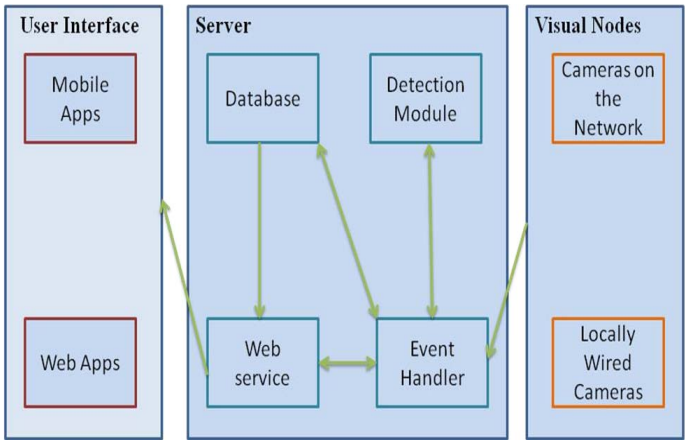

Figure 1: Block diagram of the system.

of the parking lot is taken during the entire day with the camera installed in the rooftop of a building adjacent to the parking lot. 2.) Server: The server in our system takes care of four responsibilities, it is to store the database, it is gathering data from camera, it is serving a web-service i.e. it links the database to the system's front end, and it feeds in the images from visual nodes to the detection module. Detection module is the brain which is responsible for reporting the occupancy status of a parking space. 3.) User Interface: front end of the system the parking lot information to the drivers directly. [12]

III. PRE-PROCESSING

The original image which is taken by the camera is processed to detect edges. The color image must be transformed into various forms as follows:

Color-to-Gray transform convert original color image to Gray scale image by cancelling the hue and saturation information while retaining the luminance [4]. Next is the logarithm transformation which maps the narrow range of low gray-level values in the input image into wider range of output levels. [4]

Second derivative gives a stronger response to fine details, such as thin lines and isolated points in the input image.
The next transformation is binary transformation which resembles a digital image that has only two possible values for each pixel i.e. black and white. The output image replaces all

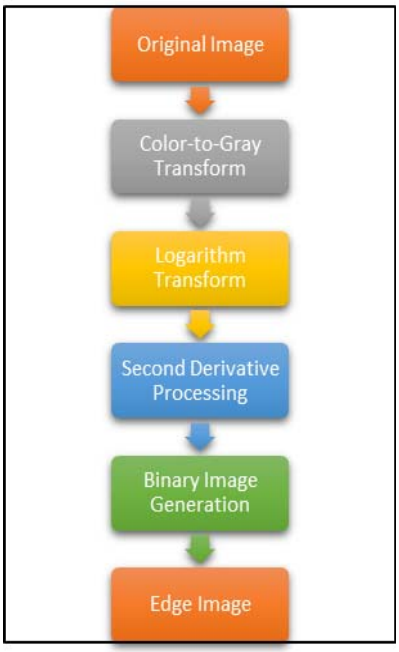

Figure 2: Preprocessing stages

pixels in the input image with 1 (white) and 0 (black) according to the luminance. Edge detection is a combination of variety of mathematical methods that aim to identify points in a digital image at which the image brightness changes sharply or, more formally, has discontinuities [5]. This becomes the most fundamental tool in image processing, machine vision and computer vision, particularly in the areas of feature detection and feature extraction [12].

IV. System Modules

A. Convolutional Neural Network

Convolutional Neural Network is an extension of Artificial Neural Network. They differ in the usage of Convolutional layers and pooling layers. The Convolutional always comes first in CNN. Let us imagine Convolutional layer as a flashlight which shines over the image and slides across the area during the process. The Convolutional operation is very simple; it multiplies the values in the filter with the original pixel values of the image. An activation map or a feature map is obtained at the output of the Convolutional layer. [6]

B. Pooling Layer

Another important layer which comes after the Convolutional layer is the pooling layer which is also referred to as down sampling layer. There is variety of pooling layer, but max-pooling is the most popular one. This can be visualized as a filter which when applied to the input volume gives an output with a maximum number in every sub-region that the filter convolves around. [5]

C. ReLU(Rectified Linear Unit)

Every convolution layer is followed by a ReLU layer to introduce nonlinearity to the system that basically has just been computing linear operation during convolution process. The ReLU layer is preferred because it works better than other nonlinear functions. Using this function, the network is able to train a lot faster without making a significant difference in the accuracy. [5]

D. Fully Connected Layer

Fully connected layer finally comes after several convolution and max pooling layers, which does the high-leveling reasoning in the neural network. Fully connected layers have neurons which have connections to all activation in the previous layers. [5]

V. Experimental Analysis

A. Dataset

For adequate training of this network requires a large number of images with cars as positive sample and near equal number of negative samples of images without car. Key factor to have a well generalized network is to have a diverse dataset. The dataset we used for this problem is PKLot "PKLot – A Robust Dataset for Parking Lot Classification" It contains 12,000 images taken from three different camera feeds of two different parking lots. The images were taken over a 30-day period at 5-minute intervals. Each parking lot image is annotated with the date, time and current weather conditions (sunny, cloudy, or rainy) [12].

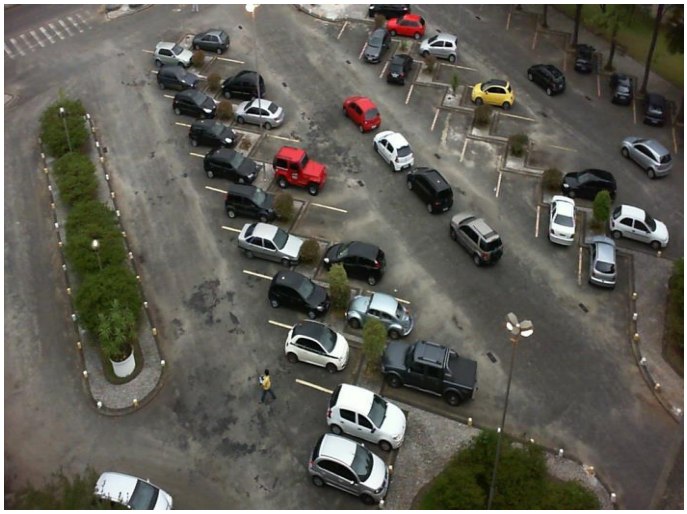

Figure 3: Examples of samples extracted from dataset.

B. Results

The system we created have been trained and tested on the available database. We computed the accuracy to measure the performance of the binary classifier, by the number of

correctly classified examples divided by the number of total examples. The system has been trained on individual parking lot available in the dataset and then tested on both the same parking area and on parking area that have not been seen in order to test the robustness of the system. As mentioned above, the Convolutional Neural Network performed really well on the classification task and scored an accuracy of 100% on the test set [2][1].

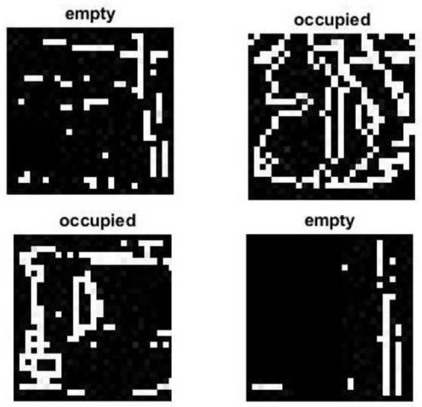

Figure 4: Examples of test data images.

VI. CONCLUSION

Our system will be the best solution towards the problem faced by most of the countries. This system would be mostly beneficial to urban areas. After the implementation of this system circling around parking lot to find a vacant spot will reduce. This will intern reduce time consumption and frustration for the driver and moreover reduces the fuel consumption and CO_2 emission. [1] The conceptualization of this paper is based on software instead of hardware which makes the system cheap to maintain and implement. This system also makes the system free from wire hassles.

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