# COMP576 Project Proposal

## Parking Space Detection in OpenCV

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## 1. Introduction

A smart camera is a vision system which are capable of extracting specific information from the real time images. This project focuses on parking space classification based on a robust image dataset of parking lots. This project starts from a single space classification to the whole parking lots. We analysis different approaches of deep learning and compare the accuracy and efficiency. To learn more about the feasibility and limitations, we also investigate how the cover in the image, the angle of the camera and the weather influence the result. After that, we aim to extend the successful model to the other parking lots.

## 2. Background/Motivation

As a graduate student who live off campus, it is difficult for students to find parking spot in the campus, We believe that, with our tool to identify available parking lots, we believe it will improve students and faculties life quality and make the best use of parking space

The goal for our research  was to take any static image or video of a parking lot and be able to automatically detect whenever a parking space was available or occupied.

OpenCV is an extensive open source library (available in python, Java, and C++) that's used for image analysis. Combining it with our knowledge of CNN and RNN, we believe we will make it more efficient and intuitive.

# 3. State Of The Art/Previous Works

## AlexNet Architecture

AlexNet is a convolutional neural network (CNN) architecture designed by Alex Krizhevsky in collaboration with Ilya Sutskever and Geoffrey Hinton[1], and it's widely used in many works. This architecture consists of 60 million parameters and 500,000 neurons. As for layers of the architecture, AlexNet includes five convolutional layers, three of them followed by max-pooling layers, and two fully connected layers followed by a 1000-way SoftMax. The activation function was non-saturating ReLU, which improves the training performance over tanh and sigmoid. This architecture can be leveraged in our parking lot occupancy classification. However, considering the limitation of computing power on monitor cameras, and the requirement of performing real-time simultaneous tasks, a simplified CNN is introduced in the next section.

## mAlexNet Architecture

With the goal of simplifying AlexNet, mAlexNet was introduced by Giuseppe Amato et al[2]. The original classification problem was simplified from 1000-class classification into binary classification (whether the lot is occupied). The structure of mAlexNet was also simplified, with three convolutional layers and two fully connected layers. The first and second convolutional layers are followed by max-pooling, LRN and ReLU. The third convolutional layer and the first fully connected layer reduce the number of filters and neurons in order to fit the binary classification. In all, the new architecture simplified the structure and the number of parameters was reduced to only 1/1340 of the original AlexNet, making mAlexNet suitable for embedded systems like security cameras.

## mLeNet Architecture

Another option provided by the author was mLeNet[3], a simplified version of LeNet. Similarly, by reducing the layers and parameters, mLeNet improves the efficiency when deployed on security cameras for parking lot vacancy detection. This architecture includes two convolutional layers followed by max pooling and two fully connected layers.

# 4. Datasets

We will use the CNRPark+EXT dataset, which contains images of vacant and occupied parking spaces. We will utilize two files, CNRPark-Patches-150x150 and CNT-EXT-Patches-150x150 in this project.

<u>CNRPark-Patches-150x150</u>: 12,584 parking space images taken in July 2015 from 2 different cameras.

- CAMERA: the camera that took the image (A or B)
- CLASS: the state of the parking space (free or busy)
- YYYYMMDD_HHMML: the date and time image collected
- SLOT_ID: local ID for the monitored slot given by each camera

<u>CNT-EXT-Patches-150x150</u>: 144,965 parking space images taken between Nov. 2015 to Feb. 2016 from 9 cameras.

- CAM_ID: the number of the camera (from 1 to 9)
- WEATHER: the weather when the image was taken (Sunny, Overcast, or Rainy)
- CAPTURE_DATE: the date image was captured, format: YYYY-MM=DD
- CAPTURE_TIME: the time image was captured, format: HH.MM
- SLOT_ID: global ID for the monitored slot

# References


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