Computer vision Course

Final Project

Topic: Detect the free parking slots

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Introduction

The aim of this project is to analyze the provided images and get how many free parking slots are present inside each image.

Algorithm

In the project I develop a computer vision algorithm in C++ and Python analyzing the images and getting if the slots in the parking lot are free or occupied. I use both traditional computer vision algorithms for feature extraction and machine learning models for making binary classification.

Import the libraries

C++ provides different libraries to ease out the computational challenges of coding and handle relatively complex problems rather easily. Here we import the essential libraries for our task. Furthermore, I used a library named "Pugixml" to deal with xml files more easily.

Load the images

Firstly, I download the parking lot datasets from the corresponding URLs.

Get the data

Image Acquisition: The main goal was to obtain images under different weather conditions (overcast, sunny, and rainy periods) by registering at each 5 minutes the environment changes. Such a setup, allows to capture sequences of images showing high variability in terms of illumination occasioned by weather changes. Due to high valium of data in the PKLot dataset I have chosen only one parking view to analyze (UFPR04 folder). Although I used only Images from one camera among three cameras available, the methods are reliable also for other two cameras.

Labeling: for each parking there is an XML file. This file containing the position and situation of each parking space. With iterating over XML file we are able to get not only the coordinates for further processes but also to label each park lot as "empty" or "occupied".

Segmentation: the individual parking spaces were extracted from each parking lot image using the information available in the corresponding XML file. In addition, the degree of the rectangle containing the parking space image was modified.

Two samples of the segmented parking spaces are depicted in Figures 1 (occupied).

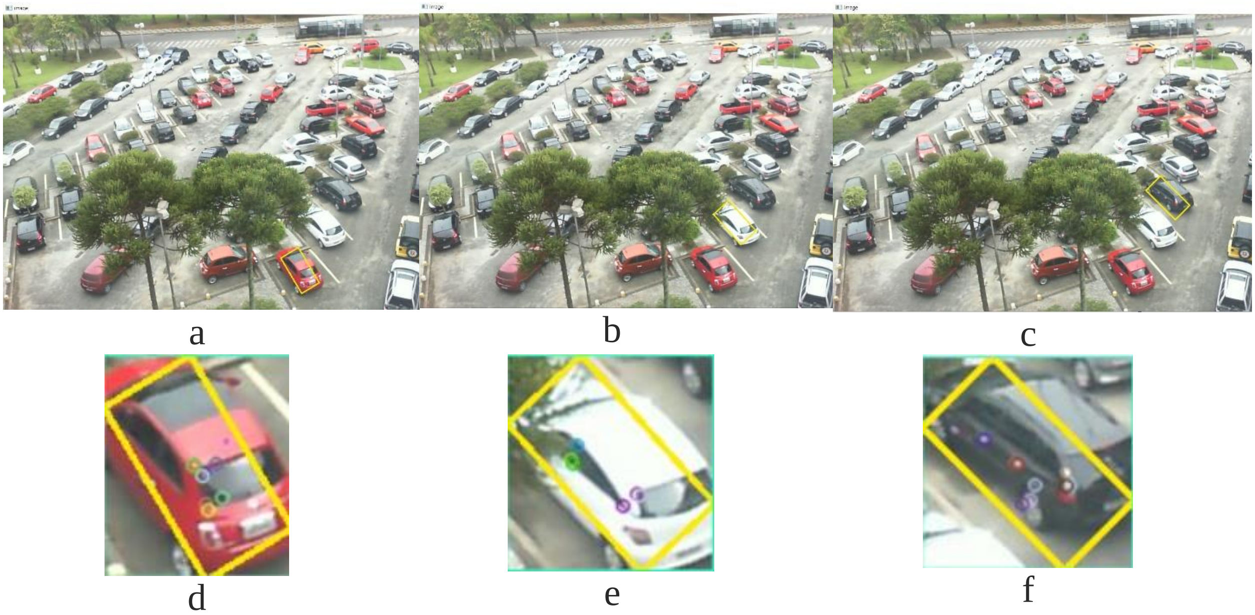

Figure 1. Segmented image: boxed lots image (a, b, c), cropped sub-image(d, e, f)

I analyze image statistics into the slot. Extract features (I use here ORB), then use ML classifiers (I use Decision tree).

ORB (Oriented FAST and Rotated BRIEF) is a Key-point detector and descriptor proposed as an efficient alternative to SIFT. It is invariant to rotation, translation and scaling. It is based at five step algorithm and we can divide them into two part: Key-point detection based on FAST algorithm and features description based on BRIEF. In the first step the algorithm built a pyramid of images at different resolution, that makes ORB invariant to scaling, in the second step, FAST algorithm is applied at each level of the pyramid an in the third step the best features are selected using the Harris score. This ends the feature detection part. Then in the fourth step, for each extracted feature, a circular window is considered and the centroid of intensity is computed in order to assign a orientation with respect to the central pixel and this makes ORB also invariant to rotation. The final step computes the BRIEF features. In this fashion I only used the Key-points not the descriptors.

I use a Machine Learning (ML) binary classifier. Firstly, I segment the slots, normalize them to a common size and orientation and then feed to the ML classifier.

Result

Just for visualization purpose I did the whole lifecycle of a random image from feature extraction, ML classifier predictions and drawing the predictions on that image with colored boxes. Figure 2 shows an image. Result of predictions: green = free; purple = occupied.

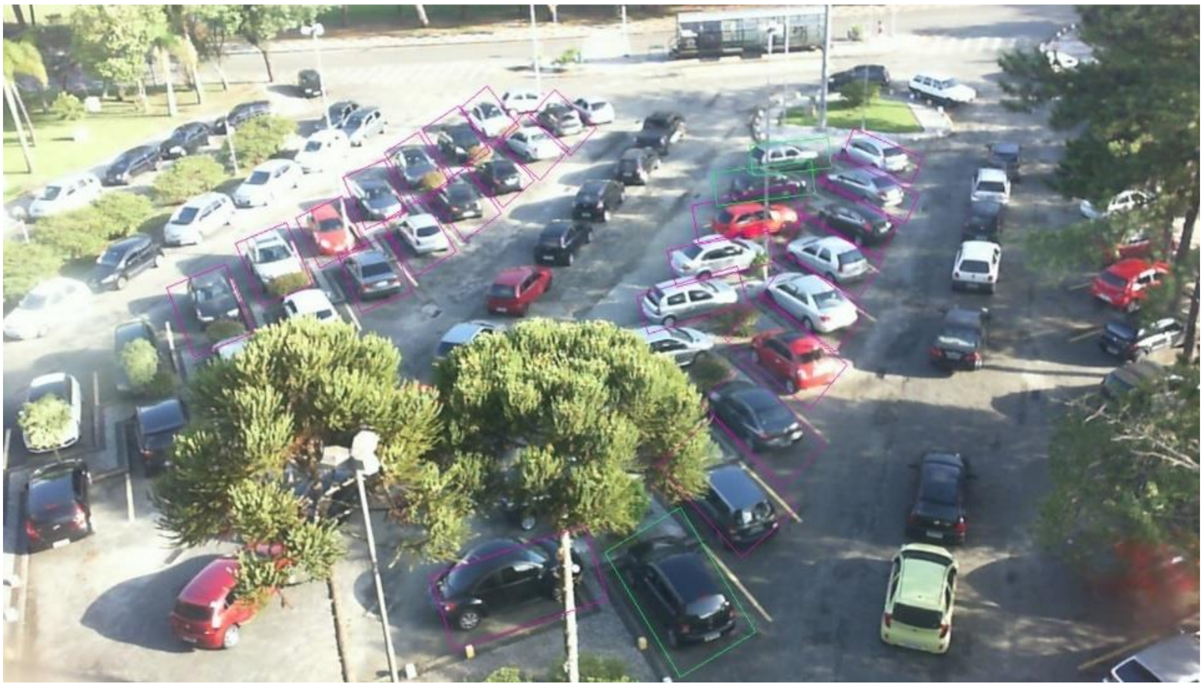

Figure 2. Result. Green = free. purple = occupied

Thank you