Vacant Parking Space Detection Algorithm
EE 368 Final Project Proposal

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Overview

It is widely observed that congestion in parking lots in high density areas is a great source of frustration for drivers. With the proliferation of car mounted GPS units and smartphones, there has been a recent increase in interest in developing ways for drivers to find vacant parking spots. Current methods rely either on counters, which can only provide the number, but not location of vacant spots, or weight sensors placed underneath each parking spot, which are not cost effective. We propose to make use of existing surveillance infrastructure and an image processing based algorithm to provide a cost efficient and robust solution. We will utilize either a MATLAB or C++/OpenCV implementation for this project and the Android platform will *not* be considered.

Algorithm

Parking space detection algorithms have been briefly studied in the past. [2] presents a brief survey and comparison of existing approaches. The two main methodologies involve using color histograms or feature extraction. [1] describes a method to use Forstner operators on training images to build a vocabulary of features, and then to match test data features to this vocabulary bank. [2] mentions that Forstner operator did not generate many interesting features in his data; instead he used the number of Harris corners in each region of interest as a metric for determining occupancy.

One particular deficiency of existing algorithms is the reliance on human input for determining regions of interest. We will address this by using a reference image with all parking spaces unoccupied to label regions of interest corresponding to individual parking spaces. The goal is to detect parking space dividing lines. Three steps will accomplish this:

1. Segment the image using color space thresholding

2. Grayscale region labelling

3. Region property filtering, including area, orientation, eccentricity, etc.

This will generate a binary image consisting exclusively of the parking space dividing lines, which can then be geometrically connected to form bounding boxes for individual parking spaces.

Certain features can be used to make a rough prediction whether a parking space is occupied or not occupied. These may include the mean grayscale value, variance, and color histogram of each region of interest. Finally, each parking space will also be segmented into different grayscale regions determined according to the method outlined by [3]. A scoring value based on an area-weighted number of regions can be used to provide an indication whether a parking space is occupied, since we expect the non-uniformity created by the presence of a vehicle would result in a greater number of regions. These features are likely sensitive to changes in lighting conditions and therefore not expected to perform particularly well. To complement this, we will implement a SIFT feature extractor to detect features in the regions of interest. We will build a database of a small window surrounding each feature in training data, and then cluster similar features into classes. For test images, we will utilize a cross-correlation between detected features such as headlights, wind-shields, etc, and database features to see if they are related. This will hopefully allow the algorithm to be robust against debris or pedestrians.

References

[1] S. Agarwal and D. Roth, *Learning a sparse representation for object detection*, in Proceedings of the European Conference on Computer Vision, vol. 4, Copenhagen, Denmark, May 2002, Springer-Verlag, pp. 113–130.

[2] N. True, *Vacant parking space detection in static images*, University of San Diego, (2007).

[3] K. Yamada and M. Mizuno, *A vehicle parking detection method using image segmentation*, Electronics and Communications in Japan (Part III: Fundamental Electronic Science), 84 (2001), pp. 25–34.