Texture-based Scenery Recognition

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Abstract—**Texture can be a powerful feature for outdoor scene recognition. This paper presents a morphological texture recognition framework based on edge information obtained by simple, gabor-like linear filters. The framework is implemented and tested on three different recognition tasks: road surface, vegetation areas and the sky. Furthermore, it is succesfully extended to solve the more difficult problem of distinguishing foliage from grass.**

I. Introduction

Texture plays an important role in the way humans perform image segmentation [1]. Likewise, texture can be a powerful feature for automated recognition. The most common approach to texture analysis is to process the image with a bank of linear filters to obtain an estimate of the spatial energy distribution, and then apply a nonlinear operator on this result to extract texture features. For example, one could use a set of Gabor filters followed by a grating cell operator. This operation closely resembles how humans perceive and recognize texture in the visual cortex [2].

Comparative studies of a number of well-established texture segmentation algorithms show that no technique is optimal for all kinds of texture [3][4], and that the choice of filters and non-linear operators should depend on the specifics of the textures one might typically encounter. These studies indicate that application-specific methods may yield further improvements on the generic state-of-the-art techniques when prior knowledge about the texture is available. This paper presents a basic texture recognition framework, and shows how it can be extended to solve difficult cases.

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II. The basic framework

A. Linear filtering

The first part of the framework is rather standard, using linear filters to obtain an energy distribution. Instead of traditional gabor filters however, a bank of simple gaussian-based filters are used as proposed by Malik *et al.*[5]. These filters allow us to extract information about the density, strength and orientation of edges in the image.

B. Non-linear operator

The novelty of our method is in the choice of non-linear operator. Instead of treating the filter outputs like a feature vector, we aggregate the outputs of the filters within a window of the image. Two different kinds of aggregating operators are explored: tresholding, and order statistics operators. For thresholding, a pixel is assigned a binary label based on whether the maximum or minimum response within the window exceeds a threshold. This corresponds with checking for flat regions, or presence of sharp edges. The order statistics operator tests whether a number of filter outputs exceeds a fraction of the maximum output within the window. This corresponds with checking for a variety of local edge orientations.

III. Proof of concept

The technique is tested on three different tasks: detecting road surface, vegetation and sky. The road surface and sky detectors are

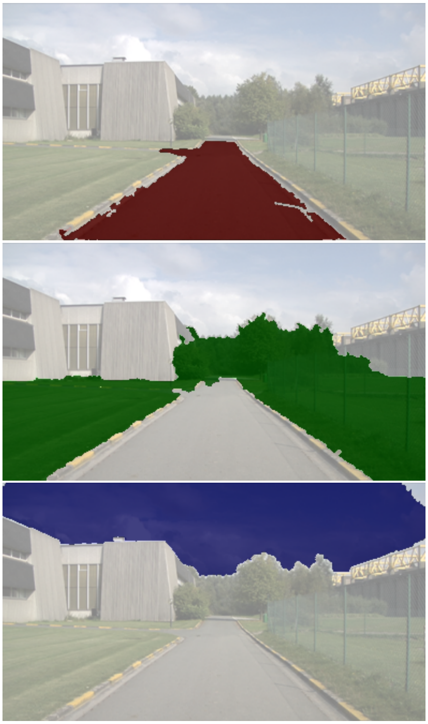

Figure 1. Results of the road, vegetation and sky detection.

based on thresholding operations, while the vegetation is detected using order statistics. A very basic color filter is added for each case. The results can be seen in figure 1.

IV. Foliage recognition

Recognition of foliage is acknowledged as a challenging task in computer vision [6]. Using a combination of the non-linear operators described earlier, coupled by morphological relationships, we were able to succesfully distinguish foliage from grass. Some results are shown in figure 2.

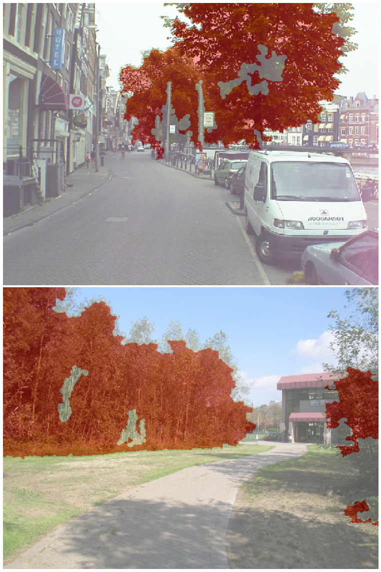

Figure 2. Results of foliage recognition.

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