ILLUMINATION-INVARIANT MORPHOLOGICAL TEXTURE CLASSIFICATION

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Abstract We investigate the use of the standard morphological texture characterisation methods, the granulometry and the variogram, in the task of texture classification. These methods are applied to both colour and greyscale texture images. We also introduce a method for minimising the effect of different illumination conditions and show that its use leads to improved classification. The classification experiments are performed on the publically available Outex 14 texture database. We show that using the illumination invariant variogram features leads to a significant improvement in classification performance compared to the best results reported for this database.

Keywords: Mathematical morphology, texture, variogram, granulometry, illumination invariance

1. Introduction

The principal tools in the morphological texture analysis toolbox are the variogram, which is a generalisation of the covariance, and the granulometry [19, 20]. These have been used successfully in a number of applications [20]. It is nevertheless desirable to place these tools in the context of current research on texture analysis methods. To this end, we first discuss how they fit into the framework of structural and perceptual properties of texture. Then we compare their performance to that of the best reported method using a standard benchmark. Additionally, an approach to solving the problem of computing illumination-invariant texture features is presented. By illumination invariance we mean that the feature vector describing a texture should be independent of the illumination conditions in which the texture image is captured.

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There has recently been much effort at comparing the performance of texture feature calculation methods on standard publically-available databases, such as the Outex databases [13]. This is done for tasks such as texture classification and texture segmentation. Classification results exist, for example, for the Local Binary Pattern (LBP) [14] and the Gabor filter approaches [12]. In this paper, we compare the performance of the standard morphological texture description methods for the task of texture classification.

Texture analysis tools have mostly been applied to greyscale images. Colour textures have however received much attention recently, with many greyscale texture analysis methods being extended to colour images. There are three main approaches to the analysis of a colour texture [15]:

Parallel approach: Colour and texture information is processed separately. The global colour is characterised, usually by means of a colour histogram. The intensity is used with greyscale texture descriptors to characterise the texture.

Sequential approach: Colour information is processed first to create an image labelled by scalars. Greyscale texture algorithms are then applied to this labelled image.

Integrative approach: This can be divided into single- and multi-channel strategies. Single-channel strategies apply greyscale texture analysis algorithms to each colour channel separately, while multi-channel strategies handle two or more channels simultaneously.

Many greyscale texture description techniques have been recast in the integrative framework: cooccurrence matrices [1, 15], run length [5] and Gabor filtering [16]. There is however no agreement yet as to whether the integrative approach functions better [15] or worse [12] than the parallel approach.

We begin with a brief overview of the morphological texture description methods (Section 2), and relate these to the perceptual properties of texture in Section 3. Our proposed transformation allowing illumination invariant classification of textures is presented in Section 4. The experimental setup, texture features used and results are presented in Sections 5, 6 and 7 respectively.

2. Morphological texture processing

We briefly summarise the variogram and granulometry as well as their extensions to colour textures.

Variogram

The variogram is a notion which generalises the covariance [19]. We make use of it here as it is easier to generalise to colour images than the covariance.