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Scene analysis using an integrated composite neural oscillatory elastic graph matching model

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Abstract

Scene analysis is so far one of the most important topics in machine vision. In this paper, we present a neural oscillatory model integrated with an elastic graph dynamic link model to provide an automatic means of processing color images. The system involves: (1) multi-frequency bands feature extraction scheme using Gabor filters, (2) automatic figures-ground object segmentation using a composite neural oscillatory model, and (3) object matching using an elastic graph dynamic link model. Using an image gallery of over 3000 color objects, with the recognition of 6000 different scenes, our model shows an average recognition rate of over 95%. For occluded objects in cluttered scenes, the model can still maintain a promising recognition rate of over 87%. Compared with that of the contemporary scene analysis models of gray-level images based on a coupled oscillatory network, the proposed model provides an efficient solution for color images using the composite neural oscillatory model (CNOM). Coupled with the elastic graph dynamic link model (EGDLM), the object recognition process takes less than 35 s on average to complete, which is quite promising in many applications.

Keywords: Scene analysis; Composite neural oscillatory model; Elastic graph dynamic link model; Gabor filters; Object recognition

1. Introduction

One of the most difficult and challenging problems in machine vision is the understanding and analysis of color scenes. Unlike most pattern recognition problems, such as face recognition [1–3] and handwritten character recognition [4–6], in which pattern recognition models are confined to a specific scope of problem domains, well-defined templates, contours or distinct landmarks [7,8] can be applied as cues for pattern recognition. However, in scene analysis, the problem domain may not have been clearly defined for machine recognition. A typical scene of a snapshot in the office might involve some furniture, computer equipment, desktop accessories, and staff. Each of these falls into a different scope of pattern categories, with its own specific "features" and "templates". Owing to the enormous number of objects that could appear in a nature scene, it is impossible and impractical for a recognition system to store all the different templates before performing scene understanding and scene analysis.

Three main problems need to be considered for an effective scene analysis system. First of all, the model should provide an automatic and efficient "figure-ground" segmentation scheme in order to extract the "dominant" objects from the scene. Secondly, an effective object recognition model is needed to perform pattern matching between the scene figures and the object gallery stored in the model. Lastly, in the nature scene, objects can appear under various transformations, such as illumination, translation, rotation, reflection, dilation and most important—occlusion. Therefore, object

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