Using Global Colour Features for General Photographic Image Indexing and Retrieval

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Abstract

At the present time there is a growing demand for the development of content-based image retrieval. This paper attempts to address the problems of indexing and retrieval of general photographic images. An indexing and retrieval scheme is introduced which models human colour perception. An initial evaluation of an implementation of the scheme reveals reasonable classification effectiveness, and a refinement method is proposed to overcome the problem of intrinsic colour appearance encountered with the implementation.

1 Introduction

In recent years there has been an explosion in the availability and use of digital photographic images, because of the availability of suitable storage and delivery devices, scanners, digital cameras, etc. There is a consequent demand for the development of content-based image retrieval. However, the current technologies for indexing and retrieval of general photographic images are inadequate for many practical applications.

This paper attempts to address this problem of indexing and retrieval of photographic images. The limitations of colour indexing techniques which arise from contents of photographs of natural scenes are explored. In order to overcome the difficulties, an indexing and retrieval scheme is introduced which models human colour perception. The application of the scheme to improve retrieval effectiveness is presented.

2 The Problems of Using Colour Features

The contents of general photographic images are more complex and variable than other image collections; current indexing and retrieval schemes are therefore of limited value [1]. The effectiveness of retrieval using colour features is being widely investigated in the research community [2]. However, there is a need to address the problems of intrinsic colour appearance in photographs which result in difficulties with using colour features.

Firstly, lighting conditions have a great influence on the colour appearances of photographs. Strong lighting condition often result in saturated colours; conversely, colours become unsaturated under dim lighting conditions [4]. For example, an apple which appears a natural red colour in strong light, becomes dark red or even grey in low light. This variation results in errors in the similarity measure between two images computed using colour matching. Since we would probably like photographs of the same object under different lighting conditions to be similarly indexed such errors represent a significant barrier to the use of colour features for this purpose.

The second problem is that many photographs contain dark shadows or bright reflections. For example, there often appear large areas of shadow in pictures of woodland; or a black car may appear to contain a large white area because of reflections in sunshine. These appearances result in inaccuracy of measuring sizes and contours of subjects [5].

Neither conventional photographic materials nor digital image systems are likely to record all natural colours precisely. For instance, the string of a gold necklace seems yellow or orange, and silver coins look like grey on photographs. Unfortunately, in current image retrieval systems this creates significant barriers to, for example, querying for "gold" objects.

3 An Indexing and Retrieval Scheme

This paper introduces an indexing and retrieval scheme which models human colour perception. It aims to define a common language to reduce the gap between the colour distributions described by human eyes and the actual colour appearances on photographs.

The first stage of the scheme uses a filtering algorithm, which transforms natural colours on photographs into several major perceptual colour groups such as black, white, red, blue, etc. Currently the algorithm attempts to identify ten perceptual

colour groups. Initial results encourage our view that the filtered data has the ability to overcome the influence of different lighting conditions, and provide enough indexing capacity for a range of practical tasks (as suggested by Gong et al [3]). The perceptual colour groups provide a compact description language for users to construct an expressive query by using perceptual colours. For example, searching for a clear sky could simply query for blue whether it is light blue, dark blue, turquoise, or cyan.

In the second stage, based on the definition the perceptual colour groups, a colour indexing algorithm is introduced to generate an expressive index key for colour distributions of image contents. The algorithm extracts a vector of perceptual colours, ordered by predominance of colour in the image. As more colour descriptors are used, the index key becomes more and more expressive although of course consequently larger. Next, all of the images on which the indexing algorithm operates are clustered using a hierarchical classification.

4 The Results and Refinement

Currently, a prototype experimental system has been implemented based on the colour indexing and retrieval scheme. The initial results reveal reasonable effectiveness of classification. Images which seem to contain similar colour distributions are grouped into the same groups, and their slight differences are distinguishable as sub-groups. Given a suitable user interface, people are likely to find the construction of queries using this scheme more natural than approaches based, for example on specifying colour saturation or omitting naturalistic clustering.

Most of the images which fail to cluster into the expected colour groups result from the problems of reflection, shadowing or lighting intensity. For example, photographs of apples may be clustered into the red group; however, a large area dark shadow which human eyes ignore may result in clustering into the grey groups. Another difficulty is that of distinguishing the perceptual colour groups precisely.

At present we are investigating a new retrieval method which aims to overcome the problem of spurious predominant colour retrieval by excluding these spurious colour groups while constructing a query. For example, in order to avoid the influence of dark shadows appearing on photographs of natural scenes, the grey group or/and black group are excluded temporarily. In other words, the hierarchical classification is effectively reconstructed excluding the unexpected colour groups. According to the results of initial retrieval tests, the method provides a significant improvement of effectiveness.

5 Conclusion

To sum up, this paper suggests that the difficulties of intrinsic colour appearance on general photographic images have a great influence on the accuracy of indexing using colour features. The use of perceptual colour groups have the ability to overcome the problem of various lighting conditions. The problems of shadows and reflection may be improved by refining the refined query excluding intrinsic colour appearance. Overall, the indexing and retrieval scheme shows a reasonable effectiveness of classification. Most importantly it provides users with an achievable way to retrieve general photographic images using human perceptual colours.

References

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