Abstract

Content Based Image Retrieval (CBIR) – a challenging need of today, aims at retrieving visually similar images from abundantly available / accessible images for a given query image.

The thesis encompasses wide scope covering development of novel algorithms for image segmentation, feature extraction & representation and image retrieval. A challenging task of development, implementation and integration of various novel algorithms to result into GUI based, selectable multimodal processing of single, selectable query image for retrieval of similar images has been achieved successfully. These novel algorithms include:

- Edges and prominent boundaries detection
- Foreground separation
- Image retrieval based on
  - Color codes feature of entire image
  - Foreground color codes feature
  - Foreground shape correlation
  - Combination of foreground color codes feature and shape correlation
  - Extracted face region from images containing complex background for retrieval similar face images

Proposed prominent boundaries detection and foreground separation algorithms emphasize on 'proper' image segmentation, addressing a fundamental problem of computer vision for meeting a prime requirement for a development of a generic CBIR. Prominent boundaries, prominence measure, watershed algorithm with various levels of Haar wavelet decompositions are effectively incorporated together for proper segmentation and feature extraction by enforcing reliable processing of low level cues for avoiding breaks as well as under segmentation by utilizing continuity preserving, well localized visually prominent boundaries for foreground – background separation. The problem of over segmentation is addressed by compositely considering proximity influence and watershed algorithm.

The edge detection method based on candidate boundaries and proximity influence of all four channels detects well localized and delineated perceptually significant edges. The edge detection response of proposed method outperforms edge responses of ACD Photo Editor, MS Photo Editor and Adobe Photoshop. Quantitative analysis & comparisons of edge responses show better performance measure (F-measure) for the proposed method.

The prominent boundaries detection results, segmentation results and foreground extraction results have been qualitatively compared with (i) Human segmented images of standard database BSDB [Fowlkes, on line] [Martin, 2001] and (ii) with results of JSEG [Deng, on line] [Deng, 2001] for the effect of texture & illumination variations on segmentation and suitability of the algorithms for foreground – background separation. Quantitative analysis yielding high performance measures for extracted foreground with respect to ground truth foreground has been presented to endorse effectiveness of the method.

Proposed image retrieval approaches follow two streams of techniques for achieving a theme - *"Relaxed feature description for better Recall and simultaneous emphasizing of reliable processing of cues leading to precise feature extraction for better Precision"*. The first stream of technique for image comparison is based on color distribution wherein RGB colors are represented by proposed innovative & computationally efficient broad color descriptors called *color codes*. The technique is suitable for finding near similar images intended for achieving higher Recall. The second technique emphasizes reliable processing of low level cues for precise and well localized prominent boundaries detection, eventually leading to foreground extraction. The extracted foreground is compared on basis of shape correlation and foreground color codes for similar image retrieval. Moreover, a composite approach consisting of foreground shape and foreground color codes provides selectable proportion of weights in composite similarity measures to enable users to match the need based on category & perception for a query image. The exclusion of background and corresponding features supports object based search for image retrieval. The foreground detection based face extraction method and similar face image retrieval from the image containing complex background has been presented as an application specific CBIR, illustrating effectiveness of various proposed algorithms.

Proposed user selectable image retrieval algorithms facilitate user to map needs & choice for bridging semantic gap, to meet subjectivity of perception & challenges offered by image diversities. The query response analysis and performance measures – Precision, Recall & F measures along with P – R curves carried out for various algorithms show effectiveness of the algorithms, indicating higher Precision at higher Recall.

The developed algorithms have been tested on diversified images of various standard image databases, indicative of a step forward on the road-map of continuous & endless technical evolution towards a perfect & versatile CBIR ...