IMAGE SLICING AND STATISTICAL LAYER APPROACHES FOR CONTENT-BASED IMAGE RETRIEVAL

By

JEHAD QUBIEL ODEH AL-NIHOUD

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

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To My Family with My Love

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

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Chairman: Associate Professor Hajah Fatimah Ahmad, Ph.D.

Faculty: Computer Science and Information Technology

Two new approaches for colour features representation and comparison in digital images to handle various problems in the field of content-based image retrieval are proposed. The first approach is a double-layered system utilising a new technique, which is based on image slicing, combined with statistical features extracted and compared in each layer (ISSL). The images database is filtered in the first layer based on the similarities of brightness compared with the query image and ranked in the second layer, based on the similarities of the contrast values between the query image and the set of candidate images retrieved through the first layer. Although different distance measurements are available, the city block known as L1-norm distance measurement is used. This is due to its speed efficiency and accuracy. Different experiments are applied to different database sets, containing different number of images. The results show that the approach is scalable to the varying size of the database, robust, accurate, and fast. A comparison

between the colour histogram approach and the proposed approach shows that the proposed system is more accurate and the speed of performance is much better. A new paradigm to choose the proper threshold value is proposed based on the autocorrelation of the distance vector. Moreover, an image retrieval system based on entropy as a visual discriminator is developed and compared with ISSL. The results show that the proposed ISSL approach is able to achieve better precision and reaches higher recall levels as compared with entropy approach.

The second proposed technique for colour based retrieval is the Eigenvalues approach. Findings show that the interpretation of the Eigenvalues, as identity or signature for the square matrix, makes it possible to map this concept to the different bands of the image. The approach relies on calculating the accumulative distances between the query image and the images database, using the accumulative Eigenvalues of each band. The approach is tested, using different image queries over different database sets and the results are promising. Furthermore, the proposed approach is compared with ISSL approach and entropy approach, using different query images over a database set of 2000 images.

In addition, a shape-based retrieval system is proposed. The system is double-layered, in which the first layer is used to filter the images database based on colour similarity. This allows the reduction in the number of candidate images, which need to be manipulated, using the shape retrieval technique in the second layer. The technique utilises a low-level image processing operations with “Dilate” as a morphological operator. Laplacian of Gaussian (LoG) is used to smoothen and detect the edges of the objects. Dilate on the

other hand is used to solidify the object and fill in the holes, and correlation coefficient is proposed as a new means to shape similarity measurement. Experiments show that the approach is fast, flexible, and the retrieval of images is highly accurate. It is also able to overcome the numerous problems that are associated with the usage of the low-level image processing operation in image retrieval.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

PENDEKATAN PENGHIRISAN IMEJ DAN LAPISAN BERSTATISTIK UNTUK DAPATAN SEMULA IMEJ BERASASKAN KANDUNGAN

Oleh

JEHAD QUBIEL ODEH AL-NIHOUD

Disember 2004

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Hasil kajian ini mencadangkan dua pendekatan untuk perwakilan dan perbandingan ciri-ciri warna di dalam imej digital bagi menangani pelbagai masalah di dalam bidang dapatan semula imej berasas kandungan. Pendekatan pertama ialah penggunaan teknik baru iaitu sistem lapisan berganda. Sistem ini berasaskan penghirisan imej iaitu penggunaan gabungan ciri-ciri statistik dan perbandingan di dalam setiap lapisan (ISSL). Ianya dilakukan dengan menapis imej-imej dalam pangkalan data dalam lapisan pertama berdasarkan kepada kesamaan kecerahan sesuatu imej dan dibandingkan dengan imej carian dan dikelaskan di dalam lapisan kedua. Pengkelasan ini adalah berdasarkan kepada kesamaan dalam nilai keterangan bagi sesuatu kecerahan imej di antara imej carian dan set imej-imej capaian terpilih melalui lapisan pertama.

Pendekatan ini juga menggunakan teknik pengukuran L1-norm sebagai pengukuran jarak disebabkan oleh kecekapan dan ketepatan kelajuannya dalam membuat penapisan dan perbandingan imej-imej. Pelbagai kajian dijalankan ke atas set-set pangkalan data yang berbeza yang mengandungi bilangan imej yang berlainan. Hasil kajian ini menunjukkan bahawa pendekatan ini bersesuaian digunakan untuk pelbagai saiz pangkalan data dimana ianya, teguh, tepat dan pantas dalam menghasilkan dapatan semula imej. Perbandingan juga dibuat di antara penggunaan pendekatan histogram warna dan pendekatan yang dicadangkan dan ianya menunjukkan bahawa sistem yang dicadangkan lebih tepat dan prestasi kelajuannya adalah lebih baik. Paradigma baru juga digunakan untuk memilih nilai ambang yang dicadangkan berdasarkan kepada autokorelasi bagi jarak vektor. Sistem berasaskan dapatan semula imej ke atas entropi sebagai visual diskriminator juga dibangun dan dibandingkan dengan ISSL dan hasil daripada ini ianya menunjukkan bahawa pendekatan ISSL yang dicadangkan boleh digunakan untuk mencapai ketepatan yang lebih baik dan mencapai tahap perolehan yang lebih tinggi berbanding dengan pendekatan entropi.

Teknik kedua yang dicadangkan untuk dapatan semula berasas warna adalah berdasarkan pendekatan Eigenvalues. Hasil kajian menunjukkan interprestasi Eigenvalues sebagai identiti atau pengenalan untuk matriks segiempat sama bagi membolehkan ianya memeta konsep ini ke atas jalur-jalur imej yang berbeza. Pendekatan ini bergantung kepada perkiraan jarak terkumpul di antara imej carian dan imej-imej di dalam pangkalan data menggunakan Eigenvalues yang terkumpul bagi setiap jalur. Pendekatan ini diuji dengan menggunakan carian imej yang berbeza ke atas set-set pangkalan data yang berlainan dan

hasilnya menunjukkan ianya adalah lebih tepat. Pendekatan ini juga dibandingkan dengan pendekatan ISSL dan pendekatan entropi dengan melakukan ujian yang menggunakan imej carian yang berbeza di dalam set pangkalan data yang mempunyai 2000 imej.

Kajian ini juga mencadangkan sistem dapatan semula berasas bentuk. Sistem ini mempunyai dua lapisan di mana lapisan pertama digunakan untuk menapis imej-imej dalam pangkalan data berdasarkan kepada kesamaan warna pada imej tersebut. Ini akan menyebabkan penurunan dalam bilangan imej terpilih yang perlu dimanipulasi dengan menggunakan teknik dapatan semula bentuk di dalam lapisan kedua. Teknik ini menggunakan operasi pemprosesan imej bertahap rendah dengan 'Dilate' sebagai operator morfologi. Laplacian of Gaussian (LoG) pula digunakan untuk melicinkan dan mengesan sempadan-sempadan bagi sesuatu objek manakala 'Dilate' digunakan untuk memadatkan dan mengisi objek-objek ini ke dalam lubang-lubang dan pekali korelasi digunakan sebagai satu kaedah untuk mengukur kesamaan bentuk. Kajian menunjukkan pendekatan ini lebih pantas, fleksibel dan dapatan semula imejnya lebih tepat. Ianya juga boleh menyelesaikan pelbagai masalah yang melibatkan penggunaan operasi pemprosesan imej bertahap rendah di dalam bidang dapatan semula imej.

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I certify that an Examination Committee met on 2nd December 2004 to conduct the final examination of Jehad Qubiel Odeh, on his Doctor of Philosophy thesis entitled "Image Slicing and Statistical Layer Approaches for Content-Based Image Retrieval" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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This Thesis submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee are as follows:

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DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations, which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

_____

JEHAD QUBIEL ODEH ALNIHOUD

Date:

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES