



**UNIVERSITI PUTRA MALAYSIA**

**CONTENT-BASED IMAGE RETRIEVAL THROUGH EXTENDED  
NORMALISED RIDGELET-FOURIER AND MULTI-RESOLUTION JOINT  
AUTO CORRELOGRAMS**

**MAS RINA BINTI MUSTAFFA**

**FSTM 2011 35**

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NORMALISED RIDGELET-FOURIER AND MULTI-RESOLUTION JOINT  
AUTO CORRELOGRAMS**



**By**

**MAS RINA BINTI MUSTAFFA**

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

**December 2011**



*TO MY HUSBAND, PARENTS, FAMILY, AND FRIENDS...*

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: Professor Hajah Fatimah Ahmad, PhD**

**Faculty : Computer Science and Information Technology**

Three methods for Content-based Image Retrieval (CBIR) have been proposed which are the Multi-resolution Joint Auto Correlograms (MJAC) as a colour-based approach, the Extended Normalised Ridgelet-Fourier (ENRF) as a shape-based approach, and the Integrated Colour-Shape descriptor (ICS) which combines the proposed colour and shape approaches.

Colour Auto Correlogram (CAC) is one of the most promising colour-spatial descriptors. However, the conventional CAC and most of its advancements are sensitive to scale, are only based on a single feature, and are computed in the spatial domain. The MJAC is introduced as an extension of several CAC advancements by allowing multiple image features to represent an image rather than just colour and extracting them at different image sub-bands to provide different physical structures

of the image in the frequency domain. The Ridgelet transform (RT) is performed on the RGB colour space and the grey-scale version of the images to provide the multi-resolution levels. The colour feature is extracted from the Ridgelet coefficients of the RGB colour space while other image features such as gradient magnitude, rank, and texturedness are extracted from the Ridgelet coefficients of the grey-scale image. Each of these image features is quantised and an auto correlogram is then performed on the respective quantised image feature coefficients. Retrieval experiments conducted on the 1000 SIMPLicity image dataset have shown that the proposed MJAC is able to obtain a higher precision rate of 78.52% compared to the benchmark methods.

Complicated shapes can be effectively characterised by using a description with multiple resolutions. One popular multi-resolution method is the RT which has enjoyed very little exposure in describing shapes for CBIR. Apart from that, many of the existing RTs are only applied on images of size  $M \times M$ . For  $M \times N$  sized images, they need to be made  $M \times M$  or segmented into  $M \times M$  sub-images prior to processing. Furthermore, a different set of  $\rho$  and  $\theta$  for the Radon transform parameters need to be utilised according to the image size which results in computational complexity. Therefore, the ENRF has been proposed to tackle the above-mentioned issues regarding the previous work on Ridgelet descriptors by introducing a shape descriptor based on RT which is able to handle images of various sizes. The shape descriptor can then be applied in content-based shape retrieval applications. The utilisation of the ellipse template for better image

coverage and the normalisation of the RT are introduced. For better retrieval, a template-option scheme is also introduced. The proposed ENRF has been tested on 1400 standard MPEG-7 CE-1 B image dataset and the retrieval effectiveness obtained by the proposed method is higher than the comparable methods, which is equivalent to 55.02%.

The performance of the proposed colour and shape features can be further improved through feature fusion. ICS has been introduced by providing a scheme to integrate the proposed colour and shape descriptors to boost the performance of CBIR. Experimental results on 100 SIMPLIcity image dataset have shown that the proposed combination scheme is able to achieve a precision rate of 53.50%, slightly higher than the proposed colour-only and shape-only descriptors.

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

**DAPATAN SEMULA IMEJ BERASASKAN KANDUNGAN MELALUI  
RIDGELET-FOURIER TERNORMAL LANJUTAN DAN KORELASI  
AUTOMATIK BERSAMA PELBAGAI RESOLUSI**

Oleh

**MAS RINA BINTI MUSTAFFA**

**Disember 2011**

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Tiga kaedah baharu untuk Dapatan Semula Imej Berasaskan Kandungan (CBIR) telah dicadangkan iaitu Korelasi Automatik Bersama Pelbagai Resolusi (MJAC) sebagai pendekatan warna, Ridgelet-Fourier Ternormal Lanjutan (ENRF) sebagai pendekatan bentuk, dan pemerihal warna dan pemerihal bentuk bersepadu (ICS) yang menggabungkan pendekatan warna dan pendekatan bentuk yang dicadangkan.

Korelasi Automatik Warna (CAC) adalah salah satu pemerihal warna dan ruang yang paling berpotensi. Bagaimanapun, CAC tradisional dan kebanyakan daripada kemajuannya peka terhadap skala, berdasarkan ciri tunggal, dan dikira dalam domain ruang. MJAC telah diperkenalkan sebagai satu perluasan CAC dengan membenarkan pelbagai ciri imej untuk mewakili imej daripada hanya warna dan mengekstrak ciri-ciri imej tersebut pada sub jalur imej yang berlainan untuk

menyediakan struktur fizikal yang berbeza bagi gambar dalam domain frekuensi. Transformasi Ridgelet (RT) dilakukan pada ruang warna RGB dan versi kelabu imej-imej untuk menyediakan peringkat resolusi pelbagai. Ciri warna diekstrak dari koefisien Ridgelet dalam ruang warna RGB manakala ciri-ciri imej lain seperti magnitud kecerunan, kedudukan, dan susunan corak diekstrak dari koefisien Ridgelet imej kelabu. Setiap ciri imej ini dikuantisasikan dan korelasi automatik kemudian dilakukan pada koefisien-koefisien ciri imej yang telah dikuantisasikan tersebut. Eksperimen-eksperimen dapatan semula yang dijalankan ke atas 1000 set data imej SIMPLIcity telah menunjukkan bahawa MJAC yang dicadangkan telah berupaya memperoleh kadar ketepatan yang lebih tinggi iaitu 78.52% berbanding dengan kaedah-kaedah tanda aras.

Bentuk-bentuk rumit boleh dicirikan secara efektif dengan menggunakan keterangan dengan beberapa resolusi. Salah satu kaedah resolusi pelbagai yang popular ialah RT di mana ia telah dengan jayanya digunakan dalam banyak bidang. Bagaimanapun, pemerihal tersebut telah menikmati pendedahan yang sangat sedikit dalam menggambarkan bentuk-bentuk untuk CBIR. Selain itu, kebanyakan daripada RT yang sedia ada hanya diaplikasikan untuk imej-imej bersaiz  $M \times M$ . Bagi imej-imej  $M \times N$ , ia perlu dijadikan  $M \times M$  atau dibahagikan menjadi subimej-subimej  $M \times M$  sebelum pemprosesan. Tambahan pula, set *rho* dan *theta* yang berbeza untuk parameter transformasi Radon perlu digunakan berdasarkan kepada saiz imej yang membawa kepada komplikasi pengiraan. Lantarannya, ENRF telah dicadangkan untuk menangani isu-isu yang disebutkan di atas berkaitan dengan pemerihal



Ridgelet yang terdahulu dengan memperkenalkan pemerihal bentuk berdasarkan RT yang mampu mengendalikan imej-imej pelbagai saiz. Pemerihal bentuk tersebut kemudian boleh digunakan dalam aplikasi-aplikasi dapatan semula bentuk berasaskan kandungan. Penggunaan templat elips untuk liputan imej yang lebih baik dan penormalan RT adalah diperkenalkan. Bagi dapatan semula yang lebih baik, skim opsyen templat juga diperkenalkan. ENRF yang dicadangkan telah diuji pada 1400 set data imej MPEG-7 CE-1 B standard berdasarkan 11 nilai piawai ketepatan-perolehan. Eksperimen-eksperimen telah membuktikan yang keberkesanan dapatan semula yang diperoleh oleh kaedah yang dicadangkan adalah lebih tinggi berbanding kaedah-kaedah setanding yang bersamaan dengan 55.02%.

Prestasi ciri warna dan bentuk yang dicadangkan boleh selanjutnya diperbaiki melalui gabungan ciri. ICS telah diperkenalkan dengan menyediakan satu skim menyepadukan pemerihal warna dan pemerihal bentuk yang dicadangkan untuk meningkatkan prestasi CBIR. Hasil eksperimen pada 100 set data imej SIMPLIcity membuktikan yang skim gabungan dicadangkan telah berkeupayaan mencapai kadar ketepatan 53.50% yang mana ia adalah lebih tinggi sedikit daripada pemerihal hanya warna dan pemerihal hanya bentuk yang dicadangkan.

## ACKNOWLEDGEMENTS

‘Syukur Alhamdulillah’, finally this thesis is completed. First and foremost, I would like to thank my supervisor, Professor Dr. Hajah Fatimah binti Dato Ahmad for her constant support and guidance. She gave me enough time to start my research and trusted that I would accomplish something. I am also grateful to my Supervisory Committee Members, Professor Dr. Haji Ramlan bin Mahmud and Associate Professor Dr. Shyamala C. Doraisamy for their guidance and valuable ideas given throughout the duration of this research study.

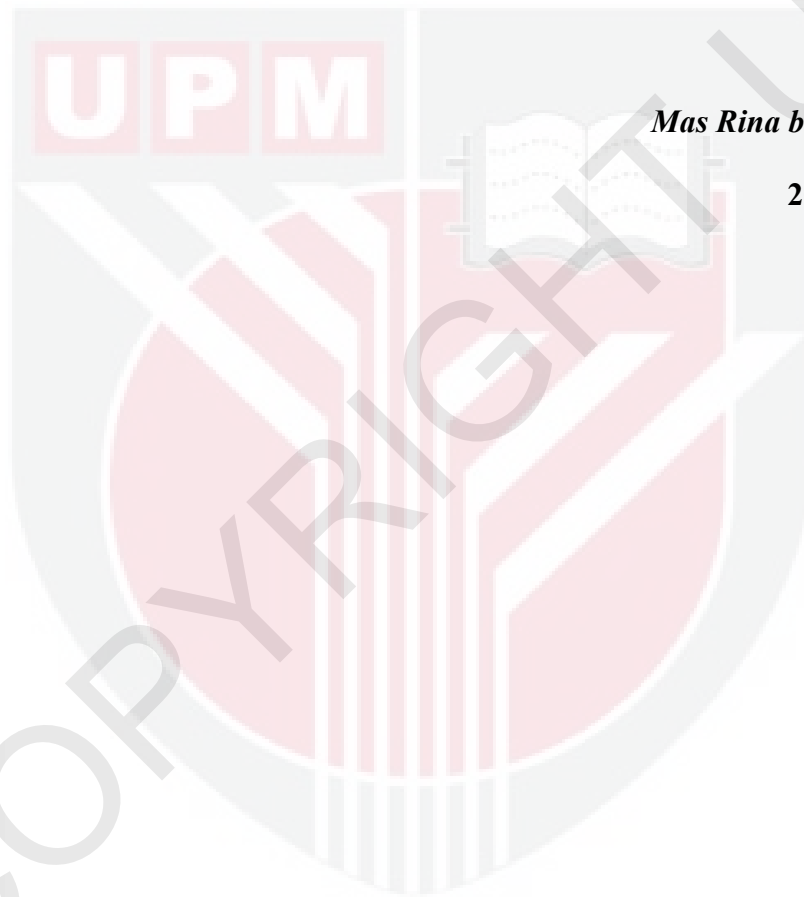
My gratitude also goes to the Ministry of Higher Education and Universiti Putra Malaysia for granting the sponsorship and study leave which allows me to pursue this PhD without having to think about paying the fees and able to concentrate fully on my studies.

A big thank you to both of my parents, Mr. Mustaffa Mohd. Som and Mrs. Azizah Zabidi and the rest of the family for giving me all the support that I need and have been encouraging me to pursue my studies until this far. I am also grateful to my friends whom have given their support and ideas.

Last but not least, a very big thank you to my beloved husband, Mr. Mohd. Azrin for all the ideas, attention, and encouragement that you gave during the ups and downs of the ‘stressful’ moments. You have always been there for me and you always

know the right thing to say to make me feel better whenever I am feeling down with my work. All of your kind deeds will indeed be remembered and I can never thank you enough for that.

Hopefully the completion of this work will mark the starting point for many more quality research works in future, Insya-Allah.



*Mas Rina binti Mustaffa*

**2011**

I certify that a Thesis Examination Committee has met on 19 December 2011 to conduct the final examination of Mas Rina binti Mustaffa on her thesis entitled “Content-Based Image Retrieval Through Extended Normalised Ridgelet-Fourier and Multi-Resolution Joint Auto Correlograms” in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Doctor of Philosophy.

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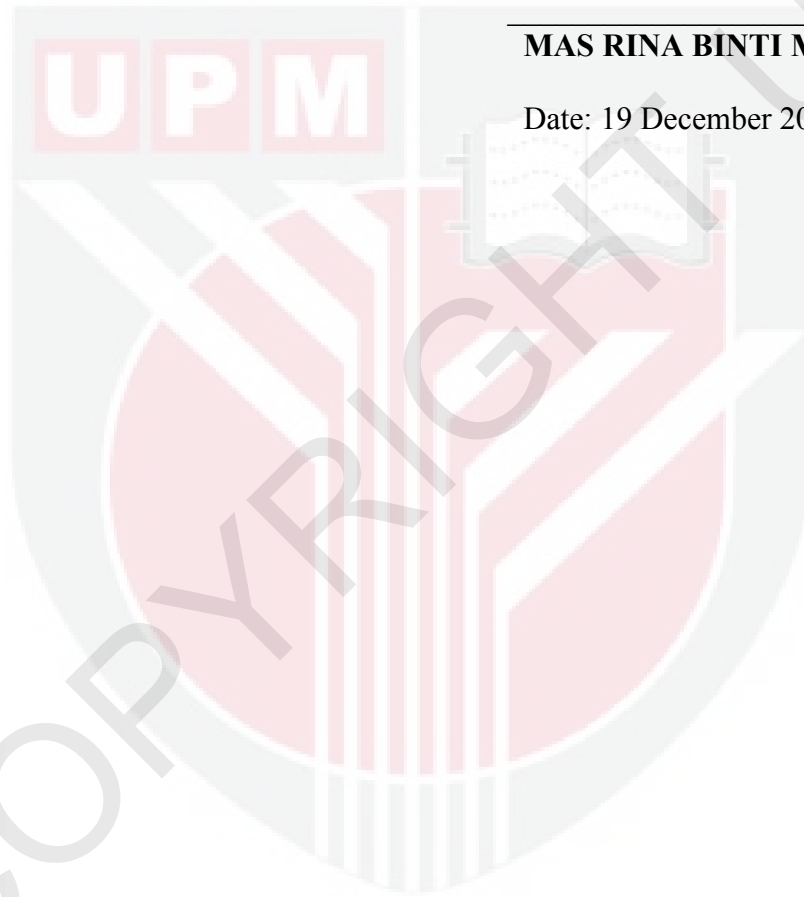
## DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.

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**MAS RINA BINTI MUSTAFFA**

Date: 19 December 2011



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