Faculty of Electronics and Computer Engineering

A REGION-BASED PRINCIPAL COMPONENT ANALYSIS (PCA) TECHNIQUE FOR MEDICAL IMAGE COMPRESSION

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DECLARATION

I declare that this thesis entitled “A Region-based Principal Component Analysis (PCA) Technique for Medical Image Compression” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : ……...

Name : Lim Sin Ting

Date : ……

APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Doctor of Philosophy.

Signature	:	……...
Supervisor Name	:	Professor Dr. Nurulfajar Bin Abd Manap
Date	:	……...

DEDICATION

To my beloved mother and father

ABSTRACT

Principal Component Analysis (PCA) is capable of completely decorrelating input data in the transform domain. However, PCA is limited in image compression because there is a need to encode the eigenvectors of the input data and thereby affects the rate-distortion performance. In an effort to improve rate-distortion performance, this work proposed a block-to-row PCA (BTRPCA) algorithm that employs the eigenvectors from the model image of the same image modality coupled with a row vectorization approach. Region-based compression schemes that reduce storage space while preserving the image quality of the region of interest (ROI) are receiving attention due to the increase in medical imaging data. While PCA is inherently limited by its matrix form, the Arbitrary ROI coding (ARC) proposed in this work models the ROI by means of a factorization approach and the arbitrary-shaped ROI contours and NROI are compressed using BTRPCA. In order to minimize user interaction, an automated brain segmentation technique based on midsagittal plane (MSP) and Absolute Difference Map (ADM) is then incorporated into the proposed Automated Arbitrary PCA (AAPCA). The presented result showed that BTRPCA achieves PSNR improvements of up to 10 dB compared to its PCA counterparts. The ARC outperforms JPEG, Embedded Zerotree Wavelet (EZW) and Embedded Block Coding With Optimized Truncation (EBCOT) at all tested bit rates with an average PSNR improvements of 6 dB, 18 dB and 12 dB respectively. Subjective performance analysis was in agreement with the objective performance analysis in which the AAPCA is capable of extending beyond the compression limits of the conventional PCA algorithm and that the quality of the surroundings of ROI is degrading gracefully at *bpp* as low as 0.25. The research has successfully developed an improved region-based compression scheme for medical images where lossy and lossless compression is implemented in one PCA architecture. Continuation of this study include using different encoding schemes to boost the rate-distortion performance and extraction of multiple ROI.

TEKNIK ANALISIS KOMPONEN PRINSIPAL BERASASKAN RANTAU UNTUK PEMAMPATAN IMEJ PERUBATAN

ABSTRAK

Analisis Komponen Prinsipal (PCA) berkemampuan untuk menyahsekaitan sepenuhnya data masukan di dalam domain jelmaan. Walau bagaimanapun, PCA adalah terhad di dalam pemampatan imej kerana terdapatnya keperluan untuk mengekod vektor eigen bagi data masukan dan oleh itu menjejaskan prestasi kadar herotan. Di dalam usaha meningkatkan prestasi kadar herotan, tugasan ini mencadangkan algoritma PCA blok-ke-baris (BTRPCA) yang menggunakan vektor eigen daripada imej model yang terdiri dari imej modaliti yang sama yang dipadankan dengan pendekatan penvektoran baris. Skim pemampatan berasaskan rantau yang mampu mengurangkan ruangan simpanan di samping mengekalkan kualiti imej pada rantau yang diminati (ROI) menerima perhatian kerana terdapat peningkatkan data di dalam data pengimejan perubatan. Walaupun PCA sememangnya terhad di dalam bentuk matriksnya, Pengekodan ROI Arbitrari (ARC) yang dicadangkan di dalam tugasan ini memodelkan ROI melalui pendekatan pemfaktoran dan kontur ROI serta NROI berbentuk arbitrari yang dimampatkan menggunakan BTRPCA. Untuk meminimumkan interaksi pengguna, satu teknik pembahagian otak berdasarkan Satah Midsagittal (MSP) dan Peta Bezaan Mutlak (ADM) digabungkan di dalam PCA Arbitrari Automatik (AAPCA) yang dicadangkan. Keputusan yang dibentangkan menunjukkan bahawa BTRPCA mencapai peningkatan PSNR sehingga 10 dB berbanding rakan PCA yang lain. ARC mengatasi prestasi JPEG, Wavelet Pokok-Sifar Terbenam (EZW) dan Pengekod Blok Terbenam dengan Pemepatan Optimum (EBCOT) pada semua kadar bit yang diuji dengan purata peningkatan PSNR sebanyak 6 dB, 18 dB dan 12 dB. Analisis prestasi subjektif bersepakat dengan analisis prestasi objektif, iaitu AAPCA berkemampuan untuk melangkaui had mampatan algoritma PCA konvensional dan kualiti persekitaran ROI adalah merosot dengan baik pada bpp serendah 0.25. Penyelidikan ini telah berjaya membangunkan skim pemampatan berasaskan rantau yang ditingkatkan untuk imej perubatan, di mana pemampatan hilang dan tanpa hilang dilaksanakan di dalam satu senibina PCA. Kesinambungan kajian ini termasuklah menggunakan skim pengekodan yang berbeza untuk meningkatkan prestasi kadar herotan dan pengekstrakan ROI berbilang.

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