MULTISPECTRAL PALM VEIN IMAGE FUSION FOR CONTACTLESS PALM VEIN VERIFICATION SYSTEM

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SUPERVISOR’S DECLARATION

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Master of Science.

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I hereby declare that the work in this 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 Universiti Malaysia Pahang or any other institutions.

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ABSTRAK

Sistem pengecaman biometrik semakin memberi perhatian dengan usaha untuk melindungi keselamatan dan maklumat kami dalam dunia penyamaran digital ini. Pengecaman urat tapak tangan adalah pengecaman biometrik yang terkenal kerana biometric ini menunjukkan tahap pengecaman yang tinggi. Walau bagaimanapun, kerumitan dan keunikan corak urat tapak tangan menyebabkan pengecaman yang kurang tepat. Imej berkualiti rendah akan memberi kesan kepada proses sistem walaupun proses pengekstrakan ciri urat tapak tangan adalah sempurna. Ini adalah sebab daripada imej kontras yang tidak jelas dan rendah. Terdapat kajian yang dibuat menunjukkan bahawa kemungkinan menggunakan kaedah gabungan imej akan meningkatkan ketepatan pengiktirafan ke tahap yang lebih tinggi. Imej gabungan adalah satu kaedah dengan mengumpulkan maklumat penting dari semua imej dan membuat imej baru yang mempunyai maklumat penting dari semua imej. Gabungan imej dapat memberi maklumat penting dengan meningkatkan kualiti dan kebolehgunaan data daripada imej input tunggal sahaja. Dalam tesis ini, Discrete Cosine Transform (DCT) adalah salah satu algoritma gabungan imej yang dicadangkan dalam pengecaman urat tapak tangan. Imej akan dibahagikan kepada blok yang berturut-turut dan akan ubah menjadi pekali DCT. Pekali DCT akan melalui peraturan fusion dan akan diubah kembali ke imej gabungan dengan menggunakan IDCT. Dalam tesis ini, pangkalan data CASIA digunakan untuk memberi tiga jenis spectrum iaitu 700 nm, 850 nm dan 940 nm. Terdapat empat kombinasi gabungan imej yang boleh dibentuk dalam tesis ini iaitu kombinasi dua imej 700 nm dengan 850nm, 700 nm dengan 940 nm, dan 850 nm dengan 940 nm dan juga gabungan tiga imej dengan semua jenis spektrum. Gabungan imej dengan Multi-resolution DCT (MRDCT), DCT Partition Frequency DCT (FPDCT) dan Laplacian Pyramid DCT (LPDCT) diperkenalkan untuk menggabungkan maklumat dari pelbagai jenis spektrum jarak dan menberikan imej output yang lebih jelas dalam corak vein tapak tangan. Dalam tesis ini, gabungan imej antara tiga jenis spektrum mencapai tahap yang lebih baik daripada gabungan imej antara dua jenis spektrum. MRDCT melakukan kadar EER yang terbaik 5.53% berbanding dengan FPDCT dan LPDCT dalam imej gabungan tiga jenis spectrum. Kaedah konvensional seperti Multi-resolution Singular Value Decomposition (MSVD), Wavelet Transform dan Energy of Laplacian (EOL) hanya dapat mencapai kadar EER sebanyak 6.58%, 6.83% dan 8.64% masing-masing. Di samping itu, MRDCT dengan gabungan tiga jenis spektrum menunjukkan penurunan kadar EER sebanyak 9% berbanding dengan imej 700 nm tunggal, 7% berbanding dengan imej 850 nm tunggal, dan 6% berbanding dengan imej tunggal 940 nm. Ia membuktikan bahawa gabungan imej MRDCT sesuai untuk pengecaman urat tapak tangan. Terdapat dua jenis keadah Scale Invariant Feature Transform (SIFT) and Speeded Up Robust Feature (SURF) berdasarkan pengekstrakan ciri urat tapak tangan disiasat. Algoritma SIFT mencapai penurunan kadar EER sebanyak 12% pada 700 nm, 8% pada 850 nm, 7% pada 940 nm berbanding dengan algoritma SURF. Hasilnya menunjukkan bahawa algoritma SIFT mencapai kadar pengecaman yang lebih baik dan mengekstrak lebih banyak maklumat dan pasangan sepadan berbanding dengan algoritma SURF. Sebagai kesimpulan, gabungan imej MRDCT dengan pengekstrakan SIFT sesuai digunakan dalam sistem pengecaman biometric urat tapak tangan tanpa sentuhan sensor.

ABSTRACT

Biometrics recognition system are getting more attention in efforts to protect our security and information in this world of digital impersonation. Palm vein recognition are well-known in biometrics recognition where it shows a high level of authentication. However, there is still an unsolved issued in accuracy due to the complexity and uniqueness of palm vein pattern. Low quality image provides unclear and low contrast image affecting the process although palm vein feature extraction is perfect. There were studies to investigate the possibility that fusion methods would improve or enhance the accuracy to a higher level. Image fusion is a method to collect necessary information from all input image with different sources and create an output image that ideally has information from input image. Fused image can provide more information than single input image that improve quality and applicability of data. In this work, image fusion algorithms based on Discrete Cosine Transform (DCT) in palm vein recognition is proposed. Input image will be divided into consecutive blocks and transformed into DCT coefficients. Fusion rule will be applied within the DCT coefficients and transformed back into fused image using inverse DCT. In this work, CASIA database is used to provide three types of wavelength spectrum which are 700 nm, 850 nm, and 940nm. There are four combination of image fusion that can be formed, dual combination with 700 nm and 850nm, 700 nm and 940 nm, 850 nm and 940 nm and triple combination of all wavelength. Multi-resolution DCT (MRDCT), Frequency Partition DCT (FPDCT) and Laplacian Pyramid DCT (LPDCT) image fusion is introduced on fusing more informative information from different types of wavelength and resulting in an image with finer details of vein patterns in the output image. In this work, triple combination of image fusion achieve better than dual combination of image fusion. By fusing three wavelength spectrums, MRDCT performed the best at 5.53% in EER rate compared to FPDCT and LPDCT. The conventional method such as Multi-resolution Singular Value Decomposition (MSVD), wavelet transform and Energy of Laplacian (EOL), were only able to achieve EER rate of 6.58%, 6.83% and 8.64% respectively. In addition to that, MRDCT with triple wavelength spectrum fusion showed a significant drop in EER by 9% compared with single 700 nm image, 7% compared with single 850 nm image, and 6% compared with single 940 nm image. It proved that MRDCT image fusion is suitable for palm vein recognition. For feature extraction, two types of local invariant feature based method was investigated, Scale Invariant Feature Transform (SIFT) and Speeded Up Robust Feature (SURF). SIFT algorithm achieved a reduction in EER rate by 12% in 700 nm, 8% in 850 nm, 7% in 940 nm compared with the SURF algorithm. The result shows that SIFT algorithm achieved a better recognition rate and extract more information and matching pairs compared to SURF algorithm. In conclusion, MRDCT image fusion with SIFT feature extraction are suitable to use in contactless palm vein recognition system.

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LIST OF SYMBOLS

X	Determinant of hessian
I_{FU}	Fused image
ɸ	Fusion strategy
m	Gradient magnitude
.H	Hessian matrix
A	Image sample
.ɵ	Orientation
.I	Original image
.σ	Scale

LIST OF ABBREVIATIONS

AC	Alternating current
CCD	Charge-coupled device
CHVD	Competitive hand valley detection
CLAHE	Contrast limited adaptive histogram equalization
DoG	Difference of gaussian
DCT	Discrete cosine transform
DWT	Discrete wavelet transform
EOL	Energy of laplacian
JPEG	Joint photographic experts group
LBP	Local binary pattern
LDP	Local derivative pattern
LDTP	Local directional texture pattern
LTrP	Local tetra pattern
MIND	Maximal intra neighbour difference
MPC	Maximal principal curvature
MSVD	Multi resolution singular value decomposition
MF	Mutual foreground
NIR	Near infrared light
ORB	Oriented fast and rotated BRIEF
PINs	Personal identification numbers
RDF	Radian distance function
RANSAC	Random sample consensus
ROI	Region of interest
SIFT	Scale invariant feature transform
SVD	Singular value decomposition
SURF	Speeded up robust feature

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