ANDROGENIC HAIR PATTERN RECOGNITION FOR BIOMETRIC IDENTIFICATION

THESIS

Proposed as One of the Requirement to Finish Electrical Engineering Graduate Program

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Abstract

To identify criminal or pedophile in online child pornography images and video is a challenging task when the faces and other distinguish features are not shown. To address these kind of problems, the system of recognition using androgenic hair pattern is being developed. Androgenic hair pattern stated to be the newest biometric trait since 2014. There were 4 different methods that were compared in this thesis, Haar wavelet transform, principal component analysis, hierarchical Gaussian scale space and scale invariant feature transform (SIFT). For the first three methods, 400 images were tested for the recognition system. Hierarchical Gaussian scale space produced 94,23 % precision of recognition using 10-fold cross validation with histogram equalization. The method defeated other two methods, Haar wavelet transform with 83,48 % precision of recognition and principal component analysis with 75.19 % precision of recognition. The next design used smaller version of androgenic hair database, 50 images with extreme condition of only 2 images variation for one respondent. For this latest system design, the SIFT algorithm gave the best performance of 38% precision of recognition and was superior to other previous three methods, Haar wavelet transform, principal component analysis and hierarchical Gaussian scale space that only produced around 30-32 % precision of recognition.

Keywords: androgenic hair pattern; biometric identification; Haar wavelet transform; principal component analysis; scale-invariant feature transform

Abstrak

Untuk dapat melakukan identifikasi pelaku kriminal atau pedofil pada kasus kejahatan seksual anak-anak yang tertangkap kamera atau video digital menjadi tantangan yang sulit ketika wajah atau fitur unik dari kriminal tersebut tidak terlihat. Untuk dapat mengatasi kesulitan ini, telah dibangun sistem pengenalan berbasis pola rambut androgenik. Pola rambut androgenik menjadi ciri biometrik baru sejak tahun 2014. Terdapat 4 metode yang dibandingkan di dalam tesis ini, transformasi wavelet Haar, analisis komponen utama, skala ruang hierarki Gauss dan *scale-invariant feature transform* (SIFT). Untuk ketiga metode pertama, 400 gambar digital diuji untuk sistem pengenalan. Metode skala ruang Hierarki Gauss menghasilkan keakuratan presisi sistem terbaik yaitu 94,23 % menggunakan validasi silang 10-lipat dengan ekualisasi histogram. Metode ini mengalahkan transformasi wavelet Haar yang memberikan presisi 83,48 % dan analisis komponen utama yang menghasilkan 75,19 % presisi keakuratan. Desain sistem selanjutnya menggunakan versi basis data yang lebih kecil, 50 gambar digital dengan kondisi ekstrem hanya 2 variasi gambar yang diambil dari setiap responden. Untuk desain sistem terakhir ini, algoritma SIFT memberikan keakuratan presisi terbaik yaitu 38 % dan mengalahkan ketiga metode sebelumnya transformasi wavelet Haar, analisis komponen utama dan skala ruang Hierarki Gauss yang hanya menghasilkan sekitar 30-32% presisi keakuratan.

Kata kunci: analisis komponen utama; identifikasi biometrik; pola rambut androgenik; *scale-invariant feature transform*; transformasi wavelet Haar

THESIS VALIDATION

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ORIGINALITY STATEMENT

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Is the results of literature study, research and the creation of my own work with guidance from my thesis supervisor which was appointed with the Letter of Decision from Electrical Engineering Graduate Program Head Department.
This thesis has never been submitted for achieving magister title on this kind of graduate program in another university. The source of all information, data and results from this thesis was declared clearly and can be checked for its truth.

Jakarta, 14 October 2017

REGINA LIONNIE

PREFACE

It has been a wonderful experience and delight opportunity to finish this research and summarize it in this thesis. I would like to express my gratitude to the almighty God above, my son, my family and friends, also to Universitas Mercu Buana Jakarta, Electrical Engineering Graduate Program, especially my supervisor and my MTEL 18 friends.

Researching is a never ending journey. One can find latest hypothesis, proves it and go back to research it again. That is the beauty of the research because we can never have enough of it. I, personally, do research to improve the condition of my country and hope that one day my research can show significant changes to Indonesia.

To all other researchers around the world, especially in Indonesia, I would like to say that if you have ever find a problem in your research or in your life, never give up. The only limitation is yourself. You, are the only one reason, preventing you to achieve your dream. Believe in yourselves and you are doing half the journey already.

Regina Lionnie

to Benji,

my sweet boy,

whose smile can light up the world....

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LIST OF ABBREVIATION

GOH	Gabor orientation histogram
HWT	Haar wavelet transform
PCA	principal component analysis
HGSS	hierarchical Gaussian scale-space
SIFT	scale-invariant feature transform
IA	image alignment
FP	hair follicle position
HE	histogram equalization
SF	sharpening filter
SmF	smoothing filter
SIFT	scale-invariant feature transform
LoG	laplacian of Gaussian
DoG	difference of Gaussian
TP	true positive
FP	false positive
P	percentage
RGB	red green blue
SVD	singular value decomposition
PDF	probability distribution function
dom	dominant
NM	no match
DR	distance ratio
App	approximation subband
H	horizaontal subband
V	vertical subband
D	diagonal subband
ev	eigenvalues
O	octave
L	level

LIST OF APPENDIX