AN EFFICIENT INDEXING AND RETRIEVAL OF IRIS BIOMETRICS DATA USING HYBRID TRANSFORM AND FIREFLY BASED K-MEANS ALGORITHM TITLE

EMAD TAHA KHALAF

Doctor of Philosophy (Computer Science)

UNIVERSITI MALAYSIA PAHANG

UNIVERSITI MALAYSIA PAHANG

NOTE : * If the thesis is CONFIDENTIAL or RESTRICTED, please attach a thesis declaration letter.

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(Supervisor's Signature)

Full Name : DR.MUAMER N. MOHAMMED

Position : SENIOR LECTURER

Date :

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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.

_____

(Student's Signature)

Full Name : EMAD TAHA KHALAF

ID Number : PCC13010

Date :

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EMAD TAHA KHALAF

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ABSTRAK

Ledakan pertambahan bilangan imej biometrik yang disimpan di dalam kebanyakan pangkalan data telah menjadikan pengelasan imej sesuatu yang mandatori. Proses sebegini boleh mempengaruhi kelajuan capaian data, selain menyokong proses pengambilan semula. Para penyelidik kini menumpukan perhatian terhadap usaha mengenal pasti ciri-ciri imej yang sesuai digunakan untuk pengelompokan dan pengindeksan dengan proses carian yang efisien. Kaedah tersedia tidak mampu mengekstrak bilangan ciri terpenting imej iris yang mencukupi untuk proses pengelompokan dan pengindeksan. Namun begitu, salah satu kelemahan pengelompokan ialah proses mengekstrak ciri-ciri terpenting. Suatu gabungan tiga kaedah transformasi iaitu Transformasi Kosinus Diskret (Discrete Cosine Transformation, DCT), Transformasi Gelombang Diskret (Discrete Wavelet Transform, DWT) dan Penguraian Nilai Tunggal (Singular Value Decomposition, SVD) untuk menganalisis imej iris dan mengekstrak ciri-ciri setempatnya belum pernah digunakan untuk pengelompokan dan pengindeksan imej. Masalah lain berkaitan pengelompokan ialah ketika memilih sentroid awal secara rawak untuk setiap kelompok. Kelemahan ini diatasi menggunakan Algoritma Kunang-kunang (Firefly Algorithm, FA) kerana ia mampu melaksanakan carian global dan mempunyai kadar penumpuan pantas untuk mengoptimumkan pusat pengelompokan awal algoritma K-purata (K-means algorithm), menggunakan sejenis jarak Euclid terwajar untuk mengurangkan kecacatan akibat data hingar dan lain-lain ketidakpastian. Tesis ini membentangkan suatu kaedah baru untuk mengekstrak ciri paling sesuai daripada imej biometrik iris untuk mengindeks pangkalan data dalam tempoh dan kawasan carian yang minimum. Kaedah dipertingkatkan ini menggabungkan tiga kaedah transformasi untuk menganalisis imej iris dan mengekstrak ciri-ciri setempatnya. Kaedah ini menggunakan algoritma pengelompokan K-purata terwajar berasaskan FA diperbaik untuk mengoptimumkan pusat pengelompokan awal algoritma K-purata, yang dikenali sebagai Algoritma Pengelompokan K-purata Terwajar-Algoritma Kunang-kunang Diperbaik (Weighted K-means clustering-Improved Firefly Algorithm, WKIFA). Bertujuan carian dan ambilan semula, suatu teknik selari cekap dibentangkan dengan membahagi kumpulan ciri-ciri kepada dua pohon-b berdasarkan kunci indeks. Carian dalam suatu kumpulan boleh dilakukan menggunakan algoritma carian separuh untuk meningkatkan masa tindak balas untuk pengambilan semula data. Sistem ini diuji menggunakan pangkalan data umum. Dapatan kajian menunjukkan bahawa sistem pengindeksan ini mempunyai kadar penembusan yang agak rendah, iaitu pada 0.98%, 0.13% dan 0.12% dan kadar tersasar tong yang rendah pada 0.3037%, 0.4226% dan 0.2019% berbanding pangkalan data iris tersedia masing-masing, milik Akademi Sains - Institut Automasi China (CASIA), Universiti Bath (BATH) dan Pangkalan Data Institut Teknologi Kanpur, India (IITK). Dapatan kajian untuk WKIFA diperbaik menunjukkan bahawa kaedah ini lebih berkesan untuk peringkat pengelompokan sistem. Malah, ia melebihi prestasi K-purata tradisional dengan mengurangkan kadar penembusan kepada 0.131%, 0.088% dan 0.108% dan meningkatkan ketepatan dengan mengurangkan kadar tersasar tong kepada 0.2604%, 0.309% dan 0.1548%, masing-masing untuk pangkalan data yang dinyatakan terdahulu. Analisis kerumitan masa pengambilan semula pula menunjukkan bahawa kerumitan pengiraan dikurangkan kepada O (log N), iaitu lebih baik berbanding kaedah sedia ada.

ABSTRACT

The explosive increase in the number of biometric images saved in most databases has made image indexing mandatory. These processes could influence the speed of data access as well as support their retrieval. Hence, researchers are focusing on how to determine suitable image features to be used for clustering and index, with an efficient searching process. The existing methods are unable to extract sufficient number of the most important features of iris image for clustering and indexing processes. However, one of the weaknesses of clustering is the process of extracting the most important features. A combination of three transformation methods, namely, Discrete Cosine Transformation (DCT), Discrete Wavelet Transform (DWT), and Singular Value Decomposition (SVD) for analyzing the iris image and for extracting its local features have yet to be utilized for image clustering and indexing. Another problem related to clustering is when choosing the initial centroids for each cluster randomly. To overcome this disadvantage, the Fireflies Algorithm (FA) was used because it has the ability to perform global searches and has quick convergence rate to optimize the initial clustering centers of the K-means algorithm, using a kind of weighted Euclidean distance to reduce the defects made by noise data and other uncertainties. This thesis presents a new method to extract the most relevant features of iris biometric images for indexing the database within minimum time and search area. The enhanced method combines three transformation methods for analyzing the iris image and extracting its local features. It uses a weighted K-means clustering algorithm based on the improved FA to optimize the initial clustering centers of K-means algorithm, known as Weighted K-means clustering-Improved Firefly Algorithm (WKIFA). For searches and retrieval, an efficient parallel technique has been presented by dividing the group of features into two b-trees based on index keys. Searches within a group can be done using a half-searching algorithm to improve the response time for data retrieval. The system has been tested on publicly available databases. The experimental results showed that the indexing system has a considerably low penetration rate of 0.98%, 0.13%, and 0.12%, and lower bin miss rate of 0.3037%, 0.4226%, and 0.2019% compared to the existing iris databases of the Chinese Academy of Science - Institute of Automation (CASIA), University of Bath (BATH), and Database of Indian Institute of Technology Kanpur (IITK), respectively. Results of the improved WKIFA showed that it was more effective for the clustering stage of the system. It even outperformed the traditional K-mean, by reducing the penetration rates to 0.131%, 0.088%, and 0.108%, and improving the accuracy by reducing the bin miss rate to 0.2604%, 0.309%, and 0.1548% of the aforementioned databases, respectively. Analysis of time complexity of retrieval showed that the computational complexity was reduced to O (log n), which was better than the existing methods.

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LIST OF SYMBOLS

σ	$M \times N$ Diagonal Matrix
$D(x)$	Distance with Nearest Cluster
$O(1)$	Logarithmic Time
$T(n)$	Frequency of Time
U	$M \times M$ Orthogonal Matrix
V	$N \times N$ Orthogonal Matrix
σ_1	First Singular Value
σ_2	Second Singular Value
$\sum \dot{D}$	lower-frequency coefficient
μ	average of all intensity value
θx	probability of points
D(x)	distance to center
f(xi)	objective function in firefly
r	fluorescence brightness
γ	light intensity
β	attraction
E_i	value of energy
$F_{i,j}$	dimensional of features
X_{id}	first component
ω	overall distribution of the sample data
Γ_i	number of data in the cluster
f(n)	the number of comparisons required
C^i	the candidate set
T_{max}	Maximum number of iterations
$O(1)$	constant in in complexity theory
$O(\log(n))$	logarithmic in in complexity theory
$O((\log(n))^c)$	polylogarithmic in in complexity theory
$O(n)$	linear in in complexity theory
$O(n^2)$	quadratic in in complexity theory
$O(n^c)$	polynomial in in complexity theory
$O(c^n)$	exponential in in complexity theory

LIST OF ABBREVIATIONS

AES	Advanced Encryption Standard
AHE	Adaptive Histogram Equalization
AR	Accuracy Rate
ATM	Automated Teller Machines
BATH	University of Bath Iris Image Database
BM	Rate of Bin Miss
BWT	Borrows-Wheeler Transform
CASIA	Chinese Academy of Sciences Iris Image Database
CLAHE	Contrast Limited Adaptive Histogram Equalization
CM	Confusion Matrix
CMC	Curve of Cumulative Match Characteristic
DB	Database
B-tree	Binary Tree
DCT	Discrete Cosine Transform
DFT	Discrete Fourier Transform
DWT	Discrete Wavelets Transform
EER	Equal Error Rate
FAR	False Acceptance Rate
FBI	Federal Bureau of Investigation
FMR	False Match Rate
FNMR	False Not Match Rate
FRR	False Rejection Rate
FTC	Failure to Capture
FTE	Failure to Enroll
GAR	Genuine Acceptance Rate
HFP	High Frequency Power
IAFIS	Fingerprint Identification System
IBA	International Biometric Association
IBIA	International Biometric Industry Association
ICE	Iris Challenge Evaluation Iris Image Database
ID	Identification

IDCT	Inverse Discrete Cosine Transform
IITK	Indian Institute of Technology Kanpur
IS	Identification Services
LBP	Local Binary Pattern
MMU1	Multimedia University Iris Image Database
NBSP	National Biometric Security Project
NGI	Next Generation Fbi Iafis
NIR	Near Infrared
NIST	National Institute of Standards And Technology
PCA	Principle Component Analysis
PDA	Personal Digital Assistant
PR	Penetration Coefficient
PRNG	Peak Signal-To-Noise Ratio
ROC	Curve of Receiver Operating Characteristic
ROI	Region of Interest
SIFT	Scale Invariant Feature Transform
SPLDH	Signed Pixel Level Difference Histogram
SURF	Speed Up Robust Features
SV	Singular Values
UBIRIS	University of Beira Interior Iris Image Database
UIDAI	Unique Identification Authority of India
UPOL	University of Palackeho And Olomouc
WVU	West Virginia University Iris Image Database
WKIFA	weighted K-means based on improved Firefly
FR	firefly algorithm

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