FACE DETECTION: A COMPARISON BETWEEN HISTOGRAM THRESHOLDING AND NEURAL NETWORKS

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CERTIFICATION

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ABSTRACT

Face Detection: A Comparison Between Histogram Thresholding and Neural Networks

Face detection is an important process in many applications such as face recognition, person identification and tracking, and access control. The technique used for face detection depends on how a face is modelled. In this thesis, a face is defined as a skin region and a lips region that meet certain geometrical criteria. Thus, the face detection system has three main components: a skin detection module, a lips detection module, and a face verification module. Multi-layer perceptron (MLP) neural networks and histogram thresholding techniques have been used for skin and lips detection. In order to test the face detection system, two databases were created. The images in the first database, called In-house, were taken under controlled environment while those in the second database, called WWW, were collected from the World Wide Web. Only the skin and the lips colour in the normalised RGB colour scheme were used for the skin and lips detection respectively. A new method for obtaining the r, g, and b components of the normalised RGB systems from the R, G, and B components of the RGB system was proposed. It was found out that the proposed method, called maximum intensity normalisation, gives higher percentage of correct skin detection than the conventional rgb colour scheme regardless of the database used or the skin detection method. Two methods were used to find the number of neurons in the hidden layer of the MLP. The first method use binary search between a minimum and a maximum values while the second method use sequential search with a stopping criteria. The effect of scale factor, facial expressions and minor occlusions with glasses on skin, lips and face detection was investigated. It was found out that, as the scale factor increases the percentage skin and lips detection error decreases. However, the percentage decrease in skin and lips detection errors depends on the intensity normalisation, the detection method and the chrominance component used. But the scale factor did not have any effect on the face detection. In general, the facial expression did not have any significant effect on skin detection. However, for lips detection, the laughing expression did give the highest lips detection error followed by smiling expression. Furthermore, the percentage increase in lips detection error as a result of the facial expression depends on the intensity normalisation, the detection method and the chrominance component used. As for face detection, the facial expression has a negative effect on the correct face detection especially at scale factor of 3. Although, the minor occlusion increases the skin detection error it has no significant effect on the performance of face detection.

ABSTRAK

Pengesan wajah merupakan proses penting dalam banyak aplikasi seperti pengesanan wajah, pengenalan diri dan pengesanan, dan akses kawalan. Teknik yang digunakan dalam pengesan wajah bergantung kepada wajah dimodelkan. Dalam Desertasi ini, wajah dimodelkan sebagai bahagian kulit dan bahagian bibir yang memenuhi beberapa kreteria geomatrik. Oleh itu, system pengesan wajah mempunai tiga komponen utama: Modul pengesan kulit, modul pengesan bibir, dan modul pengasahan wajah. Rangkaiaan "multi-layer perceptron" (MLP) neuro dan teknik-teknik diambang histogram telah digunakan bagi mengesan kulit dan bibir. Bagi menguji sistem pengesan wajah, dua pangkalan data telah dibina. Imej di dalam pengkalan data yang pertama, dinamakan "In-house" telah diambil dalam persekitaran yang terkawal sementara yang berada di dalam pangkalan data yang kedua, dinamakan "WWW" telah dikumpul daripada Rangkaian Web Sedunia "World-Wide Web". Hanya warna kulit and bibir dalam skema warna rgb telah digunakan begi mengesan kulit dna bibir. Satu kaedah baru, dinamakan "maximum intensity normalisation", bagi memperoleh komponen-komponen rgb daripada komponen-komponen RGB telah dicadangan. Didapati bahawa kaedah yang dicandankan member peratusan betul yang tingi daripada skema rgb konvensional tidak kira apa pangkalan data digunakan atau kaedah pengesan kulit. Dua kaedah telah digunakan bagi mencari bilangan neuron dalam lapisan tersembunyi "hidden layer". Kaedah pertama menggunakan pencarian secaraa binary di antara nilai-nilai minimum dan maksimum sementara kaedah yang kedua menggunakan pencarian secara sequen dengan kreteria untuk berhenti. Kesan factor scala, eksperasi wajah dan sedikit aklusi-aklusi dengan cermin di atas kulit, pengesan bibir dan wajah telah diuji kaji. Didapati bahawa, semakin meningkat peratus factor scala, ralat pengesan kulit dan bibir menurun. Walau bagaimanapun, peratus ralat menurun dalam pengesan kulit dan bibir bergantung kepada skema warna, kaedah pengesan dan komponen "chrominance" yang digunakan. Tetapi factor scala tidak member kesan apa-apa kepada pengesan wajah. Pada keseluruhanya, ekspresi wajah tidak member kesan yang besar atau bermakna kepada pengesan kulit. Walau bagaimanapun, bagi pengesan bibir, ekspresi ketawa telah member kesan ralat yang tinggi diikuti oleh ekspresi senyuman. Walau bagaimanapun, bagi pengesan bibir, peratus ralat meningkat bergantung kepada skema warna, kaedah pengesan dan komponen warna "chrominance" yang digunakan. Dan bagi pengesan wajah, ekspresi wajah member kesan negative terutamanya pada factor scala 3. Walaupun, aklusi kecil akan meningkatkan ralat pengesan kulit ia tidak member kesan yang signifikan kepada prestasi pengesan wajah

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LIST OF ABBREVIATIONS

CIE	Commission Internationale de l'Eclairage
EI	Error Index
EM	Expectation Maximization
FAR	False Acceptance Rate
FLD	Fisher's Linear Discrimination
FRR	False Rejection Rate
GMM	Gaussian Mixture Model
LDNN	Lips Detection Neural Network
MAP	Maximum a Posteriori
ML	Maximum Likelihood
MLP	Multi-Layer Perceptron
NSE	Non-Skin Error
PCA	Principal Component Analysis
PDF	Probability Density Function
PSE	Percentage Segmentation Error
RCE	Restricted Coulomb Energy
ROC	Receiver Operating Characteristics
SDNN	Skin Distinction Neural Network
SE	Skin Error
SNoW	Sparse Network of Winnows
SOM	Self-Organising Map

LIST OF SYMBOLS

T_l^c	Lower Threshold for Chrominance Component C
T_h^c	Higher Threshold for Chrominance Component C
T^c	Threshold for Chrominance Component C
NE_s^J	The Number of Skin Pixels Incorrectly Classified as Non-Skin
NE_{ns}^J	The Number of Non-Skin Pixels Incorrectly Classified as Skin
%C	Percent Correct Classification
λ_s	The Mahalanobis Distance from the Vector X to the Mean Vector M_s
$\lambda_{S,T}$	A Standard Threshold
b	The Blue Chrominance Component of the rgb Colour Space
B(x,y)	The Value of the Blue Chrominance Component at the x,y Coordinates
b(x,y)	The Value of the Normalised Blue Chrominance Component at the x,y Coordinates
C	A Given Chrominance Component
C1	Class 1
C_{11} and C_{22}	Correct Classification
C_{12}	False Rejection
C2	Class 2
C_{21}	False Acceptance
C_b	The Blue Chrominance of the YC_bC_r Colour Space.
C_{ij}	Cost Function
C_r	The Red Chrominance of the YC_bC_r Colour Space.
C_s	The Covariance Matrix of the Skin Chrominance
C_s	The Covariance Matrix Of The Skin Chrominance
f_j	The Joint Probability Distribution Function

g	The Green Chrominance Component of the rgb Colour Space
G(x,y)	The Value of the Green Chrominance Component at the x,y Coordinates
g(x,y)	The Value of the Normalised Green Chrominance Component at the x,y Coordinates
g/b	The Ratio of the Green and Blue Chrominance Components of the rgb Colour Space.
M	The Total Number of Images in the Database
M(x,y)	Pixel at the x,y Coordinates in the Manually Segmented Image
M_s	The Mean Vector of the Skin Chrominance
N	Total Number of Pixels in the Image (equal to NC1 + NC2)
NC1	Number of Pixels of Class 1 in the Image
NC2	Number of Pixels of Class 2 in the Image
NCC1	Number of Class 1 Pixels Correctly Classified
NCC2	Number of Class 2 Pixels Correctly Classified
NEC1	Number of Class 1 Pixels Incorrectly Classified
NEC2	Number of Class 2 Pixels Incorrectly Classified
N^J	The Number of Pixels in Image J
$N_M(x,y)$	Pixel at the x,y Coordinates in the Normalised Image using Maximum Intensity Normalisation Method
$N_P(x,y)$	Pixel at the x,y Coordinates in the Normalised Image using Pixel Intensity Normalisation Method
$N_s(c)$	The Number of Skin Pixel in Colour C
Ns(X)	The Number of Skin Pixel in Colour X
Ns'(c)	The Number of Non-Skin Pixel in Colour C
Ns'(X)	The Number of Non-Skin Pixel in Colour X
O(x,y)	Pixel at the x,y Coordinates in the Output (Segmented) Image
P(C)	The Probability Of Colour C Occurring In an Image.
P(C/S)	The a Priori Probability of a Pixel P(X,Y) being Skin
P(S)	The Estimated Skin Probability
P(S/C)	The Probability of a Pixel with colour C being a Skin
P(S')	The Estimated Non-Skin Probability