EIGENFACE BASED ALGORITHMS TO RECOGNIZE NOISY AND OCCLUDED FACES

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Dedicated to my beloved mother Mrs.G.Bala and my wife Mrs.Shahida Begum

"Thank you for everything"

Abstract of thesis presented to the Senate of Kolej Universiti Sains dan Teknologi Malaysia in fulfillment of the requirement for the degree of Master of Science

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Face recognition is one of the remarkable human abilities to recognize people, while building a computer based face recognition system is still an active on-going research. Although the research in face recognition technology has grown gradually for the past five decades, computer based face recognition systems which are commercially available at present are still at infancy stage and have some practical limitations. In this research, two main problems in face recognition system, namely noise and occlusion had been identified for research focus. In this research, Eigenface Technique (EFT) had been employed as a core technique for recognizing faces under noisy and occluded conditions. Extensive experimental runs have been carried out by subjecting faces with various types of noise and variety of random occlusions.

In the first part of the experiments, the Olivetti Research lab's (ORL) face database consisting of 400 face images with various poses and face expressions had been

used. In the second part of the evaluations a new face database had been created with 200 Malaysian face images. Experimental results showed that a threshold based criteria which had been applied in the traditional EFT, is not feasible to recognize noisy and occluded faces. In this thesis, an EFT based algorithm had been proposed which bypasses thresholds that are set in the traditional EFT. Similarity measures based on Euclidean distance is applied in the proposed algorithm to recognize noisy faces without the need to use any filters. It had been demonstrated that the proposed algorithm can withstand a reasonable degree of noise as compared to the existing EFT.

In the second part of this thesis an EFT based semi-automatic patch matching algorithm had been introduced to recognize faces with major occlusions. The proposed algorithm recognizes occluded faces by gathering non occluded patches as clues from the user.

The EFT based algorithm yielded 95% recognition rate, for a Gaussian and salt and pepper noise, with noise content up to 12%, without the use of any filters. The proposed patch matching algorithm had been proved to recognize faces with more than 70% random occlusions and yielded about 76% to 83% recognition rate. These results justified the robustness of the algorithms.

Abstrak tesis yang dikemukakan kepada Senat Kolej Universiti Sains dan Teknologi Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

ALGORITHMA BERASASKAN *EIGENFACE* BAGI MENGECAM WAJAH BISING DAN WAJAH TERLINDUNG

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Pengecaman wajah merupakan salah satu keajaiban dalam sistem pengecaman wajah manusia. Sehubungan dengan itu, pembangunan sistem pengecaman wajah berkomputer masih dalam proses penyelidikan yang aktif pada masa kini. Walaupun kemajuan dalam teknologi pengecaman wajah telah mula berkembang secara berperingkat sejak 5 dekad yang lalu, sistem pengecaman wajah berkomputer yang wujud secara komersial pada masa sekarang masih pada tahap yang terhad kerana terdapat banyak kekangan praktikal. Dalam penyelidikan ini, dua masalah utama dalam pencaman wajah telah dikenal pasti sebagai fokus penyelidikan iaitu kesan bising dan kesan terlindung pada imej wajah manusia. Dalam penyelidikan ini, teknik *Eigenface* (EFT) telah digunakan sebagai asas bagi menyelesaikan masalah tersebut. Pelbagai eksperimen telah dijalankan bagi menguji keberkesanan algoritma yang dibangunkan dalam 2 keadaan tersebut.

Dalam bahagian pertama eksperimen, sebanyak 400 sampel imej wajah manusia dalam pelbagai posisi wajah dan luahan perasaan yang diambil dari pangkalan data Makmal Penyelidikan Olivetti telah digunakan. Dalam eksperimen di bahagian kedua, satu pangkalan data wajah 200 rakyat Malaysia telah dibangunkan. Hasil eksperimen menunjukkan kriteria berdasarkan nilai ambang yang digunakan dalam EFT asal tidak sesuai digunakan bagi pengecaman wajah dalam keadaan bising dan terlindung. Dalam tesis ini, algoritma berasaskan kepada teknik EFT tanpa menggunakan nilai ambang telah dicadangkan. Algoritma ini menggunakan pengukuran jarak Euklidan sebagai ukuran kesamaan antara wajah manusia tanpa menggunakan sebarang teknik penapisan. Teknik ini telah disahkan dapat menampung tahap kebisingan yang berpatutan berbanding dengan teknik EFT sedia ada.

Pada bahagian kedua tesis ini, satu algoritma baru spara automatik menggunakan kaedah tampalan padanan yang berasaskan kepada teknik EFT telah diperkenalkan bagi mengecam wajah dalam keadaan terlindung. Algoritma ini memerlukan pengguna memberi sedikit petunjuk wajah manusia pada keadaan yang tidak terlindung. Algoritma yang berasaskan EFT mencapai kadar pengecaman 95% bagi kesan bising Gausian dan *salt and paper* dengan kandungan bising sehingga 12% tanpa menggunakan sebarang kaedah penapisan. Algoritma padanan tampalan yang telah dicadangkan telah berjaya mengecam wajah manusia dengan kesan lindungan rawak pada kadar pengecaman antara 76% sehingga 83% di mana tahap keadaan lindungan rawak adalah lebih daripada 70%. Keputusan ini menunjukkan kelasakan algorima ini dalam mengecam wajah manusia dalam keadaan terlindung.