UNIVERSITI PUTRA MALAYSIA

3D-BASED MULTI-ETHNIC FACIAL EXPRESSION DATABASE AND RECOGNITION SYSTEM

HABIBU RABIU

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By

HABIBU RABIU

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

March 2013

DEDICATIONS

THIS WORK IS DEDICATED TO MY LATE PARENTS
MALAM RABIU ABDURRAHAMAN AND BINTA RABIU

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

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Chair: M.Iqbal Saripan, PhD

Faculty: Engineering

Facial expression accounts for greater percentage of meanings in human interactions. Additionally, it conveniently and non-intrusively allows humans to convey their emotional state or social signs. Accurate recognition of facial expressions should therefore usher ways to the much dreamt human-computer interaction and smart environment. In such scenarios, computers are expected to communicate with human through a seamless and non-intrusive manner. Most researches on this subject were conducted on two dimensional imaging paradigms and have recorded a remarkable performance. However, changes in illumination and pose variations are two issues that impede the performance of such system and constrained them to a very tight acquisition condition. Three dimensional method on the other hand is invariant to both illumination and pose variations and has additional depth information associated with it. This thesis investigates a novel approach to expression recognition using the 3D method. A new Multi-ethnics 3D-based facial expression database called (UPM-3DFE) is developed, which specifi-

cally addressed the issues of database ethnic distribution and subject outfit. Additionally, a novel method for automatic face detection and segmentation is also proposed. In this method, three salient points from each face image are robustly and automatically detected using face's surface curvature map. The detected points are then used in selecting the appropriate sphere radius to segment the face. In the face alignment step, a new method is also proposed, that aligned the face images intrinsic coordinate system to the world coordinate system. The feature extraction was accomplished using both geometrical and appearance features; distances, angles and line directions are used as the geometrical features, while local binary pattern filter was used in extracting the appearance features. In the final step, Support Vector Machine is employed to classify the selected features into their appropriate groups: neutral, happy, sad, angry, fear, disgust and surprise. The system achieved average classification accuracy of 92.1% for the line direction features, 89.9% for the angle features, 86.5% for the distance features and 76.3% for the local binary pattern features. This system competes favourably with several existing approaches compared with, and the results obtained are promising.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

SISTEM PENGKALAN DATA DAN PENGECAMAN MIMIK MUKA PELBAGAI ETNIK BERASASKAN 3D

Oleh

HABIBU RABIU

Mac 2013

Pengerusi: M.Iqbal Saripan, PhD

Fakulti: Kejuruteraan

Ekspresi mimik muka memberi maksud yang sangat bermakna dalam interaksi manusia. Tambahan pula, ianya membolehkan manusia untuk menzahirkan keadaan emosi atau tanda sosial mereka dengan mudah dan lancar. Pengecaman ekspresi muka yang tepat seterusnya dapat menjadi pendorong dalam merealisasikan interaksi manusia-komputer dan persekitaran pintar. Dalam scenario itu, komputer dijangka dapat berkomunikasi dengan manusia secara lancar dengan interaksi tanpa sempadan. Kebanyakan penyelidikan dalam bidang ini telah dijalankan dalam paradigma imej dua dimensi dan telah merekodkan pencapaian yang memberangsangkan. Walau bagaimanapun, perubahan pencahayaan dan variasi peragaan adalah dua isu utama yang menyekat prestasi sesebuah sistem dan menjadikan proses pemerolehan imej sangat terbatas. Sebaliknya, kaedah tiga dimensi tidak dipengaruhi oleh kedua-dua pencahayaan dan variasi peragaan serta mempunyai maklumat tambahan iaitu kedalaman. Tesis ini mengkaji pendekatan baru bagi pengecaman ekspresi menggunakan kaedah 3D. Satu pangkalan data baru bagi ekspresi muka pelbagai etnik berasaskan 3D (UPM-3DFE) telah diban-

gunkan, di mana ianya secara spesifik menangani isu berkenaan pangkalan data taburan etnik dan pemakaian subjek. Di samping itu, satu kaedah baru bagi pengesanan dan segmentasi muka secara automatik telah dikemukakan. Bagi langkah ini, tiga titik penting dari setiap imej muka dikesan secara kukuh dan automatik menggunakan rajah lengkungan permukaan muka. Titik yang dikesan kemudiannya digunakan bagi memilih jejari sfera yang sesuai untuk segmentasi muka. Bagi langkah penjajaran muka, satu kaedah baru juga telah dicadangkan, yang mana menjajarkan sistem koordinat intrinsik imej muka kepada sistem koordinat bumi. Pengekstrakan sifat diperolehi menggunakan ciri-ciri geometri dan penampilan; jarak, sudut, dan arah garisan digunakan bagi ciri geometri, manakala turas corak binari tempatan digunakan dalam pergekstrakam ciri-ciri penampilan. Dalam langkah terakhir, Mesin Sokongan Vektor (SVM) digunakan bagi mengklasifikasikan ciri-ciri terpilih kepada beberapa kategori yang bersesuaian; neutral, gembira, sedih, marah, takut, jijik dan terkejut. Sistem ini mencapai purata ketepatan klasifikasi sebanyak 92.1% bagi ciri arah garisan, 89.9% bagi ciri sudut, 86.5% bagi ciri jarak dan 76.3% bagi ciri corak binari tempatan. Sistem ini setanding dengan beberapa kaedah sedia ada dan keputusan yang diperolehi adalah amat memberangsangkan.

ACKNOWLEDGEMENTS

All praise is due to Allah Subhanahu Wa Ta'ala. The one and the only creator of universe, who created man from dust and blessed him with knowledge. Allah say in the Quran 1433 years ago "On the judgement day the hearing, the sight, and the skins of people will bear witness against them as to (all) their deeds" (Fussilat 41:19-23). This fact was only discovered by science few years ago (Mehrabian, 1971). I am thankful to Allah for enabling me to complete this work successfully.

Secondly, the author gratefully acknowledges the support, guidance, advice, encouragement he received from his indefatigable supervisor, Associate Professor, Dr. M.Iqbal Saripan who tirelessly keeps supporting me from the beginning of this project until it turns to a real success.

Similar appreciations and thanks also goes to Assoc. Prof, Dr. Hamiruce M. Marhaban and Dr. Syamsiah Mashohor for their valuable observations, comments and encouragement. Their expert guidance and support have served as a great motivation for me to pursue this project to successful conclusion.

Thirdly, I would like to acknowledge the great contribution i received from my laboratory mates and entire students of Faculty of engineering and friends, especially those that participated in the UPM-3DFE database and those that help in responding to my questionnaires. Special thanks goes to Mr. Fathullah Hakim the laboratory technician, Sulaiman Mahmood, Hafrizal, Wira Hidayat and Naeem Hussien who tirelessly posed before my 3D-scanner for image specimens. I am also thankful to the Faculty of Engineering and the staffs for providing me with all the logistics needed for this project.

Thanks are due to Dr. Ahmed M. Mharib and Omar M. Ceesay for their support and patience in putting me through with their great knowledge and skills on MATLAB package.

I certify that a Thesis Examination Committee has met on MARCH 2013 to conduct the final examination of HABIBU RABIU on his thesis entitled 3D-BASED MULTI-ETHNIC FACIAL EXPRESSION DATABASE AND RECOGNITION SYSTEM in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Doctor of Philosophy

Members of the Thesis Examination Committee were as follows:

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DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.

HABIBU RABIU

Date: 1 March 2013

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