

Sudan University of Science and Technology

College of Graduate Studies



**Automatic Wrinkles Detection Algorithm to
Assess The uniqueness of Facial Wrinkles**

**خوارزمية الكشف التلقائي عن التجاعيد لتقييم تفرد تجاعيد
الوجه**

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By

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ABSTRACT

Facial recognition considered as an important applications due to increasing needs to it in several fields in last decades. But facial recognition applications may effected by several conditions such as poor resolution, occlusion, blur, illumination and pose variation. This is why latest researches in face recognition have focused on new areas of using facial features rather than the typical features like: eyes, nose, mouth, chin, and ears. The new features are called facial micro-features or facial soft biometric such as scars, freckles, moles, and wrinkles. Facial wrinkles considered as natural features appear as people get older. Existing wrinkles detection algorithm focusing on forehead horizontal lines' detection, while, it is better to detect wrinkles (vertical and horizontal) for entire face rather than just forehead wrinkles. The primary aim of this research is to develop a new wrinkle detection method for all facial regions and construct new method to investigate If the uniqueness of facial wrinkles. Therefore, the performance of wrinkle detection algorithms on entire face has been evaluated, and proposes to use an enhancement technique to improve the performance. The methods have been evaluated using selected images from Face Recognition Technology (FERET) and selected images from new Sudanese dataset. In the experiment phase, the selected images were manually annotated by researcher to construct ground truth. The experiments showed that; the proposed method performed better in detecting facial wrinkles when compared to the state-of-the-art methods. When evaluated on FERET dataset, the average Jaccard

similarity index (JSI) are 56.17% for proposed method , 31.69% and 15.87% for Hybrid Hessian Filter and Gabor Filter, respectively. Moreover, a new method to investigate the uniqueness of facial wrinkles is proposed using Modified Hausdorff Distance (MHD). We presented experiments on selected images from FERET and Sudanese dataset using manually and automatically detected facial wrinkles. The experiments showed that the wrinkles for same subject achieve the lowest Mean Absolute Error (MAE) of 0.4, while the different subjects achieve Mean Absolute Error (MAE) of 4.0.

المستخلص

تعتبر تقنية التعرف على الوجه تطبيقاً مهماً في عدة مجالات نظراً لتزايد الاحتياجات إليه في العقود الأخيرة، وقد تتأثر تطبيقات التعرف على الوجه بعدة عوامل مثل ضعف الدقة والانسداد والتشويش والإضاءة و اختلاف الوضعية، لذا ركزت الأبحاث الحديثة في مجال تقنية التعرف على الوجوه على مجالات جديدة لاستخدام سمات الوجه بدلاً عن السمات النموذجية مثل: العيون والأنف والفم والذقن والأذنين. تسمى السمات الجديدة ب سمات الوجه الدقيقة أو المقاييس الحيوية الدقيقة للوجه مثل الندبات والنمش والشامات والتجاعيد، حيث تعتبر تجاعيد الوجه من السمات الطبيعية التي تظهر مع تقدم السن. وتركز معظم خوارزميات كشف التجاعيد الموجودة على اكتشاف الخطوط الأفقية للجبين فقط، بينما يفضل الكشف عن التجاعيد (الرأسية والأفقية) لكامل الوجه بدلاً من تجاعيد الجبين فقط. يتمثل الهدف الأساسي لهذا البحث في تطوير طريقة جديدة لكشف التجاعيد لكامل الوجه وبناء طريقة جديدة للتحقيق في قوة تمييز تجاعيد الوجه كقياسات حيوية. لذلك، تم تقييم أداء خوارزميات الكشف عن التجاعيد على كامل الوجه ونقترح استخدام خوارزمية لتحسين الأداء. حيث تم تقييم الخوارزمية على تقنية التعرف على الوجوه (FERET) ومجموعة البيانات السودانية الجديدة. قام الباحث في مرحلة التجربة برسم التجاعيد المختارة يدوياً لبناء الحقيقة الأساسية. أظهرت التجارب أن أداء الخوارزمية المقترحة في الكشف عن تجاعيد الوجه أفضل مقارنة مع الأساليب الحديثة. وعند تقييمها على تقنية التعرف على الوجوه (FERET)، كان متوسط نسب مؤشر تشابه

جاكارد (JSI) للخوارزمية المقترحة 56.17% و 56.17%، 31.69% لمرشح هيسيان الهجين، و مرشح جابور. علاوة على ذلك تم اقتراح طريقة جديدة للتحقق من تفرد تجاعيد الوجه باستخدام مسافة هاوسدورف المعدلة (MHD). تم تقديم تجارب على صور مختارة من مجموعة (FERET) ومجموعة البيانات السودانية مستخدمين تجاعيد الوجه التي تم اكتشافها يدويًا وتلقائيًا. أظهرت التجارب أن التجاعيد لنفس الشخص تحقق أدنى متوسط للخطأ المطلق (MAE) مقداره 0.4، في حين تحقق متوسط خطأ مطلق (MAE) مقداره 4.0 لشخصيات مختلفة.

DEDICATION

To Whom I love “my Parents, my Husband, Kids, Sisters and
Brother, for their continuous encouragement and support”

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LIST OF ABBREVIATIONS

2D	2 Dimension Image
3D	3 Dimension Image
HHF	Hybrid Hessian Filter
HLT	Hessian Line Tracking
FERET	Face Recognition Technology
FG-NET	Face and Gesture Recognition Research Network Dataset
MORPH	Craniofacial Longitudinal Morphological Face Dataset
AAM	Active Appearance Model
LoG	Laplacian of Gaussian
ECRM	Electronic Customer Relationship Management
RTVTR	Ridge Thickness to Valley Thickness Ratio
GEI	Gait Energy Image
DNA	Deoxyribonucleic Acid
UV	Ultraviolet
JSI	Jaccard Similarity Index
MWP	Multiscale Wrinkle Pattern
HAP	Hybrid Ageing Patterns
SVM	Support Vector Machine
MAE	Mean Absolute Error
MPP	Marked Point Processes
RJMCMC	Reversible Jump Markov Chain Monte Carlo
GMM	Gaussian Mixture Model
LBP	Local Binary Pattern
SMO	Sequential Minimal Optimization

QP	Quadratic Programming
HD	Hausdorff Distance
MHD	Modified Hausdorff Distance

LIST OF PUBLICATIONS

#	Paper Title	Journal	Publication Date
1	<i>Automated Assessment of Facial Wrinkling: a case study on the effect of smoking</i>	<i>IEEE International Conference on Systems, Man, and Cybernetics (SMC)</i>	2017
2	<i>Facial Wrinkles Detection Algorithms: A Review</i>	<i>International Journal of Scientific Engineering and Technology, Volume No. 7, Issue No. 9, PP : 78-84</i>	2018
3	<i>Evaluation of Automatic Facial Wrinkles Detection Algorithms</i>	<i>MDPI/Jimaging journal</i>	<i>Accept after minor revision</i>
4	<i>Facial Wrinkles as Soft Biometric</i>	-----	<i>A paper under preparation</i>