Behavioral Analysis of Facial Emotions

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Abstract— *Facial expressions play an important role in community-based interactions and are often used in the behavioral analysis of emotions. Recognition of automatic facial expressions from a facial image is a challenging task in the computer vision community and admits a large set of applications such as driver safety, human-computer interactions, health care, behavioral science, video conferencing, cognitive science, and others. In this work, a deep-learning-based scheme is proposed for identifying the facial expression of a person. The proposed method consists of two parts. The former one finds out local features from face images using a local gravitational force descriptor while in the latter part, the descriptor is fed into a novel deep convolution neural networks model (DCNN). The proposed DCNN has two branches. The first branch explores geometric features such as edges, curves, and lines whereas holistic features are extracted by the second branch. Finally, the score-level fusion technique is adopted to compute the final classification score*.

I. INTRODUCTION

Facial expression recognition (FER) is considered due to its ability to mimic human coding skills. FER is indispensable in affective computing. Facial expression is an essence of non-verbal communication to express the internal behaviors in interpersonal relations. Moreover, it is a sentiment analysis technology that uses biometric to automatically recognize seven basic emotions, namely, neutral (NE), anger (AN), disgust (DI), fear (FE), happiness (HA), sadness (SA), and surprise (SU) from still images or videos. Facial expressions play an important role in community-based interactions and are often used in the behavioral analysis of emotions. Recognition of automatic facial expressions from a facial image is a challenging task in the computer vision community and admits a large set of applications such as driver safety, human-computer interactions, health care, behavioral science, video conferencing, cognitive science, and others.

II. LITERATURE REVIEW

Pattern of Local Gravitational Force (Plgf): A Novel Local Image Descriptor

D. Bhattacharjee and H. Roy (2019)

In this article, the paper demonstrated a novel local image descriptor called Pattern of Local Gravitational Force (PLGF). It is inspired by Law of Universal Gravitation. PLGF is a hybrid descriptor, which is a combination of two feature components: one is the Pattern of Local Gravitational Force Magnitude (PLGFM), and another is Pattern of Local Gravitational Force Angle (PLGFA). PLGFM encodes the local gravitational force magnitude, and PLGFA encodes the local gravitational force angle that the center pixel exerts on all other pixels within a local neighborhood. We propose a novel noise resistance and the edge-preserving binary pattern called neighbors to center difference binary pattern (NCDBP) for gravitational force magnitude encoding. Finally, the histograms of the two components are concatenated to construct the PLGF descriptor. Experimental results on the existing face recognition databases, texture database, and biomedical image database show that PLGF is an effective image descriptor, and it outperforms other widely used existing descriptors.

Reliable Crowdsourcing and Deep Locality Preserving Learning for Unconstrained Facial Expression Recognition.

S. Li and W. Deng (2019).

In this article, we present a novel facial expression database, Real-world Affective Face Database (RAF-DB), which contains approximately 30 000 facial images with uncontrolled poses and illumination from thousands of individuals of diverse ages and races. An expectation-maximization algorithm is developed to reliably estimate the emotion labels, which reveals those real-world faces often express compound or even mixture emotions. To address the recognition of multi-modal expressions in the wild, we propose a new deep locality-preserving convolutional neural network (DLP-CNN) method that aims to enhance the discriminative power of deep features by preserving the locality closeness while maximizing the inter-class scatter. They also show the DLP-CNN outperforms the state-of-the-art handcrafted features and deep learning-based methods for expression recognition in the wild system.

A Thermal Infrared Face Database with Facial Landmarks and Emotion Labels.

M. Kopaczka, R. Kolk, J. Schock (2018).

In this article, the Paper providing a large number of labeled images would allow the application of current image processing methods on the example of solving challenging face analysis tasks. We introduce a high-resolution thermal facial image database with extensive manual annotations and explore how it can be used to adapt methods from the visual domain for infrared images. An evaluation of algorithm performance shows that learning algorithms either outperform available solutions or allow completely new applications that could previously not be addressed. In our conclusion, we prove that investing the effort into acquiring appropriate training data and adapting competitive algorithms is not only a viable approach in analyzing thermal infrared images but can also allow outperforming specific task-designed solutions.

Identity-Adaptive Facial Expression Recognition Through Expression Regeneration Using Conditional Generative Adversarial Networks.

H. Yang, Z. Zhang, and L. Yin (2018)

In this article, we present a novel approach (so-called IA-gen) to alleviate the issue of subject variations by regenerating expressions from any input facial images. First of all, we train conditional generative models to generate six prototypic facial expressions from any given query face image while keeping the identity related information unchanged. Generative Adversarial Networks are employed to train the conditional generative models, and each of them is designed to generate one of the prototypic facial expression images. Second, a regular CNN (FER-Net) is fine- tuned for expression classification. Based on the minimum distance between the input image and the generated expression images in the feature space, the input image is classified as one of the prototypic expressions consequently. Our proposed method can not only alleviate the influence of inter-subject variations, but will also be flexible enough to integrate with any other FER CNNs for person-independent facial expression recognition. Our method has been evaluated on CK+, Oulu-CASIA, BU-3DFE and BU-4DFE databases, and the results demonstrate the effectiveness of our proposed method.

Facial Expression Recognition with Neighborhood-Aware Edge Directional Pattern (NEDP).

M. Abdullah-Al-Wadud, B. Ryu (2018)

In this article, we propose a novel local descriptor named Neighborhood-aware Edge Directional Pattern (NEDP) to overcome such limitations. We introduce template-orientations for the neighboring pixels, which give importance to the gradients in consistent edge directions, prioritizing the specific neighbors falling in the direction of the local edge to represent the shape of the local textures, unambiguously. Moreover, due to the effective management of the featureless regions, no such region is erroneously encoded as a feature by NEDP. Experiments of the performances for person-independent recognition on benchmark expression datasets also show that NEDP performs better than other existing descriptors, and thereby, improves the overall performance of facial expression recognition.

Facial Expression Recognition with Faster R-CNN.

J. Li, D. Zhang, J. Zhang, J. Zhang (2017).

In this article, we proposed a method of Faster R-CNN (Faster Regions with Convolutional Neural Network Features) for facial expression recognition in this paper. Firstly, the facial expression image is normalized and the implicit features are extracted by using the trainable convolution kernel. Then, the maximum pooling is used to reduce the dimensions of the extracted implicit features. Finally, the Softmax classifier and regression layer is used to classify the facial expressions and predict boundary box of the test sample, respectively. The dataset is provided by Chinese Linguistic Data Consortium (CLDC), which is composed of multimodal emotional audio and video data. Experimental results show the performance and the generalization ability of the Faster R-CNN for facial expression recognition. The value of the mAP is around 0.82.

Facial Expression Recognition Via Deep Learning.

A. Fathallah, L. Abdi (2017).

In this article, we demonstrated the new architecture network based on CNN for facial expressions recognition. We fine-tuned our architecture with Visual Geometry Group model (VGG) to improve results. To evaluate our architecture, we tested it with

many largely public databases (CK+, MUG, and RAFD). Obtained results show that the CNN approach is very effective in image expression recognition on many public databases which achieve an improvement in facial expression analysis.

Survey On RGB, 3d, Thermal, And Multimodal Approaches for Facial Expression Recognition.

C. A. Corning, M. O. Simon, J. F. Cohn (2016).

In this article, the paper presents a general overview of automatic RGB, 3D, thermal and multimodal facial expression analysis. We define a new taxonomy for the field, encompassing all steps from face detection to facial expression recognition, and describe and classify the state-of-the-art methods accordingly. We also present the important datasets and the bench-marking of most influential methods. We conclude with a general discussion about trends, important questions and future lines of research.

Automatic Pain Assessment with Facial Activity Descriptors.

P. Werner, A. Al-Hamadi (2016)

In this article, we propose a novel feature set for describing facial actions and their dynamics, which we call facial activity descriptors. We apply them to detect pain and estimate the pain intensity. Automatic recognition systems may contribute to overcome this problem by facilitating objective and continuous assessment. The proposed method outperforms previous state-of-the-art approaches in sequence-level pain classification on both, the BioVid Heat Pain and the UNBC-McMaster Shoulder Pain Expression database. We further discuss major challenges of pain recognition research, benefits of temporal integration, and shortcomings of widely used frame-based pain intensity ground truth.

Facial Expression Recognition in Video with Multiple Feature Fusion.

J. Chen, Z. Chen, Z. Chi (2016).

In this article, we analyse an effective framework to address this issue in this paper. In our study, both visual modalities (face images) and audio modalities (speech) are utilized. A new feature descriptor called Histogram of Oriented Gradients from Three Orthogonal Planes (HOG-TOP) is proposed to extract dynamic textures from video sequences to characterize facial appearance changes. And a new effective geometric feature derived from the warp transformation of facial landmarks is proposed to capture facial configuration changes. We applied the multiple feature fusion to tackle the video-based facial expression recognition problems under lab-controlled environment and in the wild, respectively. Experiments conducted on the extended Cohn-Kanade (CK+) database and the Acted Facial Expression in Wild (AFEW) 4.0 database show that our approach is robust in dealing with video-based facial expression recognition problems under lab-controlled environment and in the wild compared with the other state-of-the-art methods.

Problem Definition: Facial expressions play an important role in community-based interactions and are often used in the behavioral analysis of emotions. Recognition of automatic facial expressions from a facial image is a challenging task in the computer vision community and admits a large set of applications such as driver safety, human-computer interactions, health care, behavioral science, video conferencing, cognitive science, and others. Facial expression recognition (FER) is considered due to its ability to mimic human coding skills. FER is indispensable in affective computing. Facial expression is an essence of non-verbal communication to express the internal behaviors in interpersonal relations. Moreover, it is a sentiment analysis technology that uses biometric to automatically recognize seven basic emotions, namely, neutral (NE), anger (AN), disgust (DI), fear (FE), happiness (HA), sadness (SA), and surprise (SU) from still images or videos. Although a considerable amount of works was conducted for developing instruments to access emotions, recognizing human expressions is still a challenging task that is affected by definite circumstances especially when performed in the wild. In Proposed method of Gobar wavelets Haar wavelet, Local Binary Pattern (LBP), Histogram of oriented gradients (HOG), Histogram of bunched intensity values (HBIV), Dynamic Bayesian Network (DBN), etc. On the other hand, geometric features are obtained by transforming the image into geometric primitives such as corner or minutiae points, edges, and curves.

Drawbacks

- Difficult to achieve better performance on large data.
- Traditional approaches are not up to the real FER application requirements.

- Require high computational cost.
- Occupied Large Space.

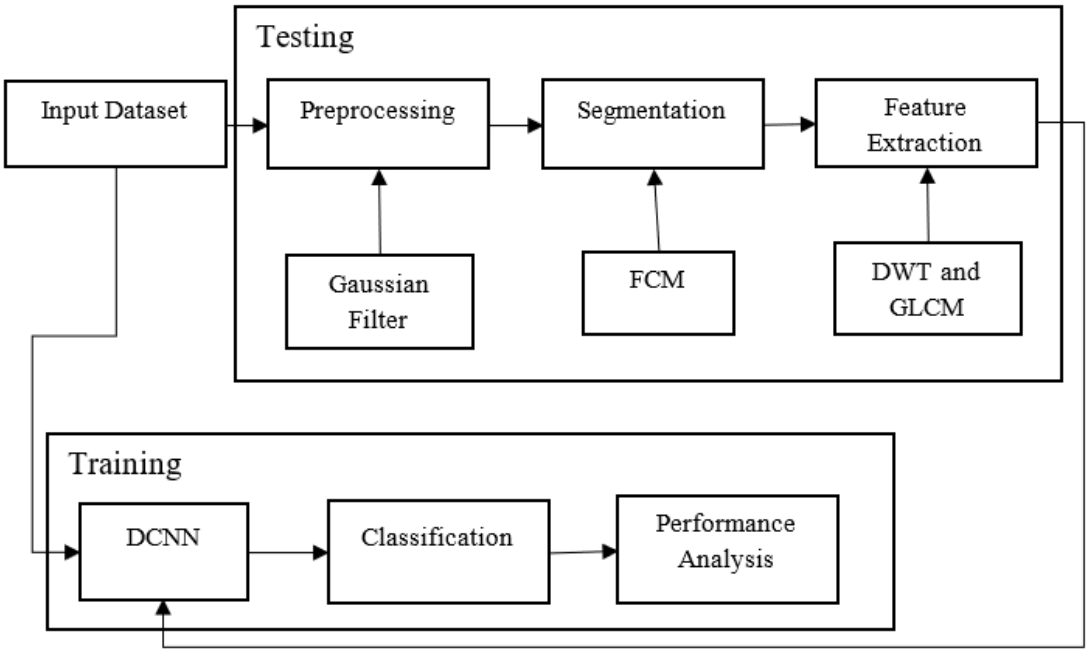
III. PROPOSED WORK

Facial expressions play an important role in community-based interactions and are often used in the behavioral analysis of emotions. Recognition of automatic facial expressions from a facial image is a challenging task in the computer vision community and admits a large set of applications such as driver safety, human-computer interactions, health care, behavioral science, video conferencing, cognitive science, and others. In our proposed method, a deep-learning-based scheme is proposed for identifying the facial expression of a person. The proposed method consists of two parts. The one finds out local features from face images using a local gravitational force descriptor while in the latter part, the descriptor is fed into a novel deep convolution neural networks model (DCNN). Over the past few years, feature extraction from image data using deep convolution neural networks (DCNN) has gained popularity in various computer vision tasks. By virtue of using DCNN, many breakthroughs were achieved for image classification problems especially face related recognition tasks. It is observed that DCNN has outperformed the traditional methods with hand-crafted features in recent years. The proposed DCNN has two branches. The first branch explores geometric features such as edges, curves, and lines whereas holistic features are extracted by the second branch. Finally, the score-level fusion technique is adopted to compute the final classification score.

Advantages

- DCNN for FER was designed to provide better discrimination ability by combining the central loss function and the verification recognition model.
- Better Performance.

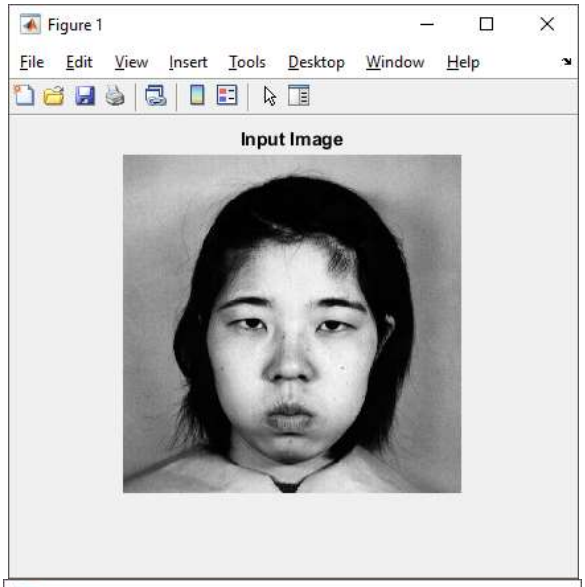
Accurate results can be obtained, when compare to the other system.

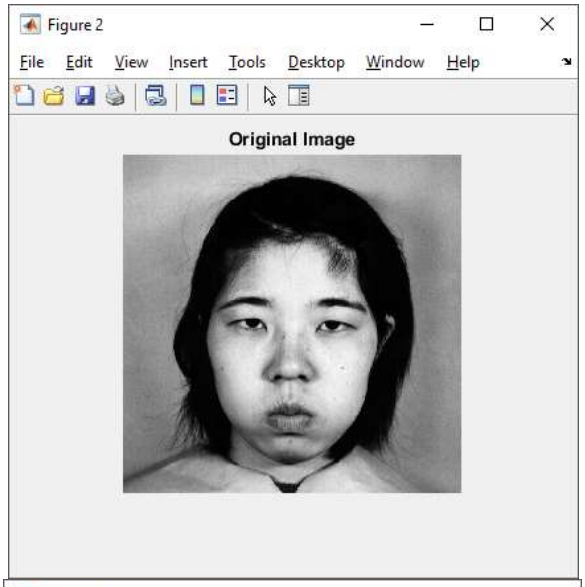


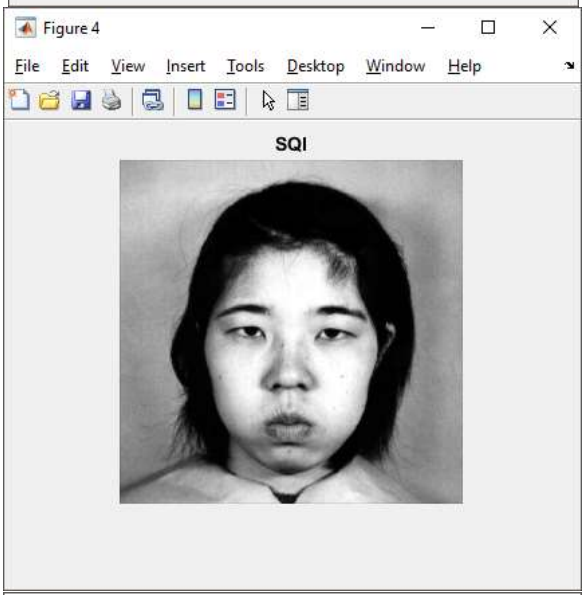
IV. IMPLEMENTATION

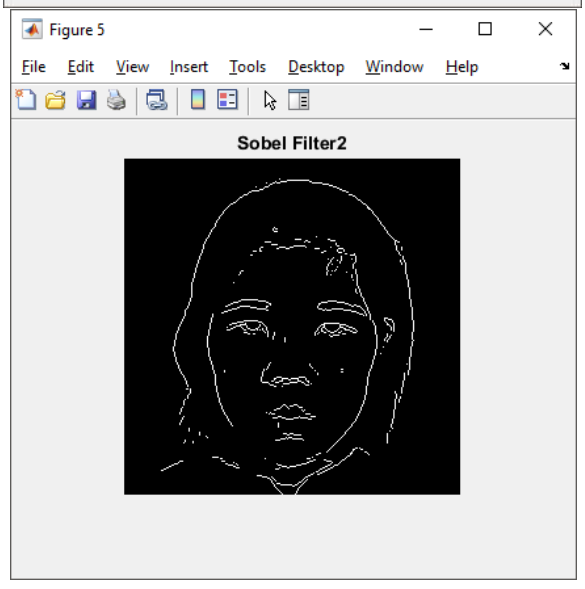
- Datasets
- Preprocessing
- Segmentation
- Feature Extraction

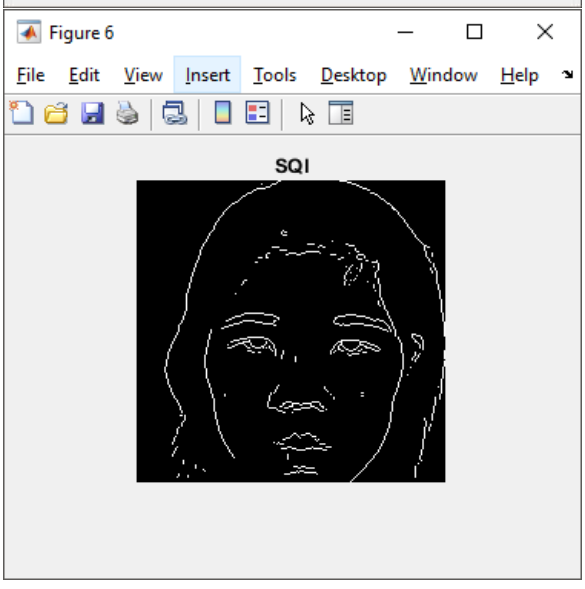
- Classification











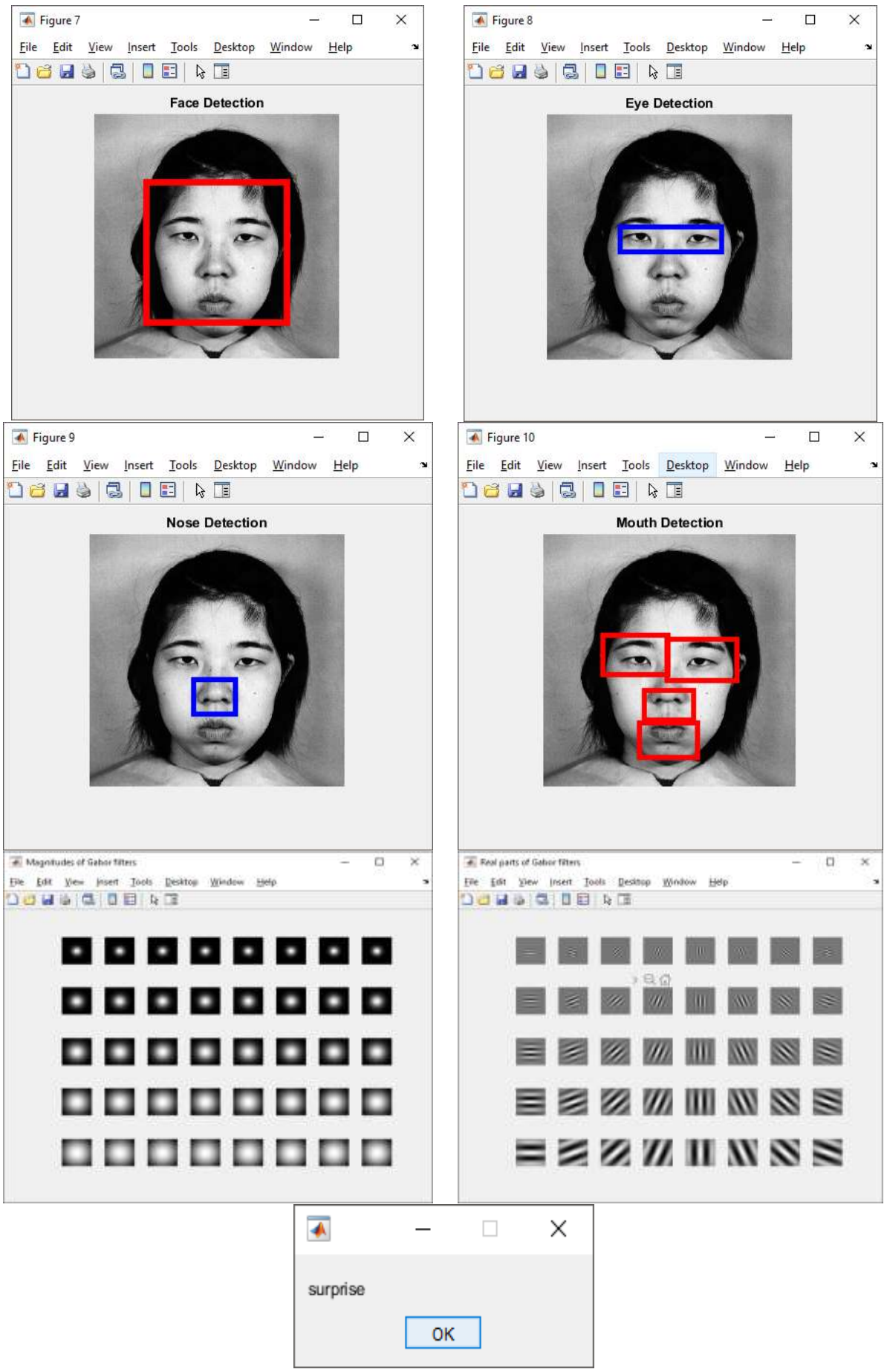


Figure 7
File Edit View Insert Tools Desktop Window Help
Face Detection
Figure 8
File Edit View Insert Tools Desktop Window Help
Eye Detection
Figure 9
File Edit View Insert Tools Desktop Window Help
Nose Detection
Figure 10
File Edit View Insert Tools Desktop Window Help
Mouth Detection
Magnitudes of Gabor filters
Real parts of Gabor filters
surprise
OK

V. CONCLUSION

Facial expressions under lab-controlled environments are different from those in the wild, which are more natural and spontaneous. So, three databases namely, JAFFE, CK+, and KDEF, developed in a lab-controlled environment are considered in this work. In this paper, a novel DCNN framework is introduced to extract holistic features for identifying facial expression. However, before the use of the proposed DCNN model, a GF-based edge descriptor is adopted to fetch the low-level local features. The GF-based edge descriptor produces two intermediate local features namely, M and D. At the end of the proposed DCNN model, a softmax classifier is used to compute the probability values in favor of either seven facial expressions. Finally, a score-level fusion technique is employed to combine the outputs obtained by the proposed model using M and D. The proposed method achieves an average recognition accuracy of the system. Empirical results demonstrate that local as well as holistic features can together enhance the FER task. To deploy the proposed model in some real-life applications. Finally, the better results can be obtained to recognize the facial expression of the person and then obtained the better performance and accuracy of the system, when compared to the other model of the system.

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