Pose Variance, Illuminations and Occlusions involved Driver Emotion Detection System

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Abstract

Monitoring the emotions of drivers are the key aspects while designing the advanced driver assistance systems (ADAS) in vehicles. To ensure the safety and track the possibility of the accidents, the emotion monitoring will play a key role in justifying the mental status of the driver. Recent developments in face expression recognition have brought the tremendous attention across the world due to its intellectual capabilities to track the facial expressions. Machine learning and deep learning technologies have helped a lot in developing an efficient face expression recognition systems. Two novel approaches using machine learning, deep learning algorithms and residual neural networks are proposed to monitor six class of expressions of the driver in different pose variations and occlusions. We obtained the better accuracies with these two novel approaches when compared to the state of art methods.

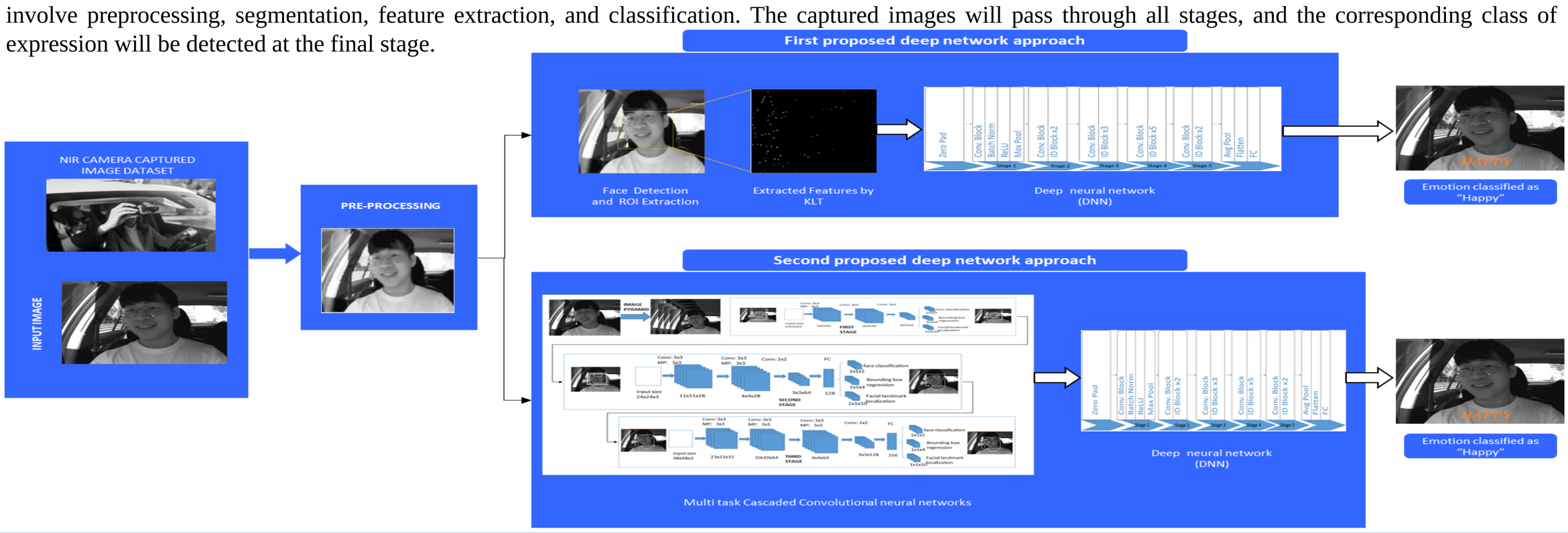
Keywords: Deep Neural Networks; advanced driver assistance systems (ADAS); face detection; K.L.T.; MTCNN; facial expression recognition; driver emotion detection; DeepNet; machine learning

Introduction

Studies proved that around 43% of crashes were avoided by co-passengers who are alerting the drivers by observing their emotions instantly. If the emotion controls the mental status of the driver then it is highly necessary to install the artificial intelligence to assist the driver in order to alert the driver to be free from the emotion influence. This particular phenomenon lead us to think and develop a novel method for driver emotion detection that can be added as one of the key features to the advanced driver assistance systems also known as “ADAS” in the intelligent vehicles. Therefore it is mandatory to the current generation vehicles to include the function to alert the driver depending on his or her state of emotion.

Proposed Driver Emotion Detection System

Although different models have been developed to monitor the human emotions from the captured images with the help of machine learning and deep learning techniques, pose variation is also a crucial parameter that should be considered while designing a driver emotion detection system. While designing the models, most of the existing works did not consider this parameter as a significant factor and caused their system to attain less accuracy in driver environmental datasets. To overcome this problem, we have proposed two novel approaches to build an efficient driver emotion detection system, including pose variation conditions, by training our models on the KDEF dataset and achieved remarkable accuracies with the existing F.E.R. methods. We have attained better accuracy on the real-time driving environmental dataset KMU-FED compared with existing driver emotion detection works with this additional functionality. The proposed algorithms involve preprocessing, segmentation, feature extraction, and classification. The captured images will pass through all stages, and the corresponding class of expression will be detected at the final stage.



Performance Evaluation

The performance of the proposed algorithms is compared with the state-of-the-art works using four different benchmark datasets and our system show good performance among them.

Comparison of Proposed approaches with the state of art methods on CK+ Database	Accuracy (%)
DNN [2016]	93.2
Inception-Resnet and LSTM [2017]	93.2
Single-WRF [2018]	92.2
Hierarchical W.R.F. with normal Information Gain [2018]	90.9
Hierarchical W.R.F. with Data Similarity [2018]	92.6
DCMA-CNN [2018]	93.4
LMRF [2020]	93.4
First Proposed Approach	93.4
Second Proposed Approach	96.1

Comparison of Proposed approaches with the state of art methods on FER 2013 Database	Accuracy (%)
D.N.N. [2016]	66.4
CNN-MNF [2018]	70.3
Simple CNN Model [2020]	65.7
eXnet [2020]	73.5
eXnet-Resnet [2020]	71.1
eXnet-DeXpression [2020]	68.0
Deep-Emotion [2021]	70.0
First Proposed Approach	83.6
Second Proposed Approach	84.5

Comparison of Proposed approaches with the state of art methods on KDEF Database	Accuracy (%)
TLCNN [2017]	86.4
TLCNN-FOS [2017]	88.2
MPCNN [2018]	86.9
DSCAE-CNN [2018]	95.5
STL+GRADIENT+LAPLACIAN RTCNN [2019]	88.1
DL-FER [2021]	96.6
RBFNN [2021]	88.8
First Proposed Approach	98.4
Second Proposed Approach	99.1

Comparison of Proposed approaches with the state of art methods on KMU-FED Database	Accuracy (%)
Facial Landmarks+WRF [2018]	94.0
CNN [2019]	97.3
SqueezeNet[2020]	89.7
MobileNetV2 [2020]	93.8
MobileNetV3 [2020]	94.9
LMRF [2020]	95.1
VGG16[2021]	94.2
First Proposed Approach	98.1
Second Proposed Approach	99.0

Conclusion

This paper proposes novel deep network approaches to determine the driver's emotions in a real-time driving environment through facial expression recognition to assist advanced driver assistance systems in intelligent vehicles. These two approaches are trained with different optimizers on the selected benchmark datasets. The work presented in this paper achieved the state-of-the-art result to solve the problems of emotions reflecting driver's behavior such as the changes in illumination, side angle positions of the sunlight, occlusions like hair and sunglasses, different angular face rotations. To assess our proposed approaches' detection capability, we have conducted experiments on four benchmark databases CK+, FER2013, KDEF, KMU-FED, which address the above-mentioned challenges.

Reference

Sukhavasi, Susrutha B., Suparshya B. Sukhavasi, Khaled Elleithy, Ahmed El-Sayed, and Abdelrahman Elleithy. 2022. "Deep Neural Network Approach for Pose, Illumination, and Occlusion Invariant Driver Emotion Detection" International Journal of Environmental Research and Public Health 19, no. 4: 2352. https://doi.org/10.3390/ijerph19042352