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Leveraging Efficient Models for Recognizing Drivers' Facial Expressions

Ibtissam saadi^{1,2}, Douglas Cunningham¹, Yassin El Hillali², Abdenour Hadid³, Abdelmalik Taleb Ahmed²

Brandenburg University of Technology Germany¹, Laboratory of IEMN, CNRS Univ of polytechnique-Hauts-de-France², Sorbonne University Abu Dhabi³.

1. Introduction

- The number of road traffic accidents has been progressively rising, reaching 1.35 million.
- The emotional state of a driver is strongly associated with traffic accidents and significantly impacts their driving performance.
- The emergence of facial expression recognition (FER) technology provides a method to assess a driver's emotional state, which in turn enhances road safety.



2. Research Objective

- Develop an accurate, efficient, and real-time DFER system.
- System should be robust enough to withstand the challenges exist on the road environment.

Improve road safety by mitigating the potential risks caused by human errors.



Fig. 1 Driving environment challenges

3. Proposed Methodology

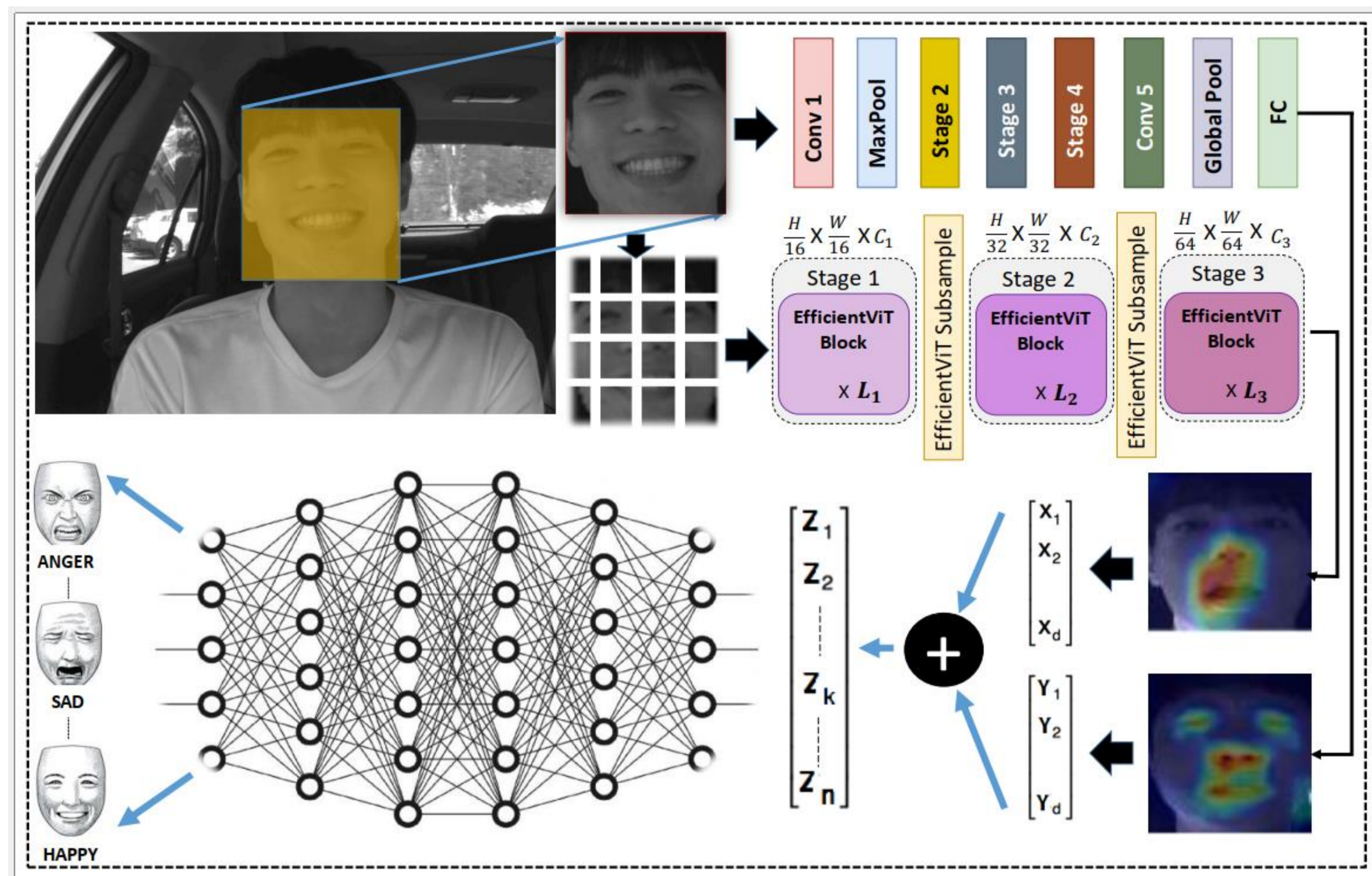


Fig. 2 Our proposed method ShuffViT-DFER Architecture.

4. Experiment Analysis and results

Datasets :



(a) KMU-FED



(b) KDEF

Results :

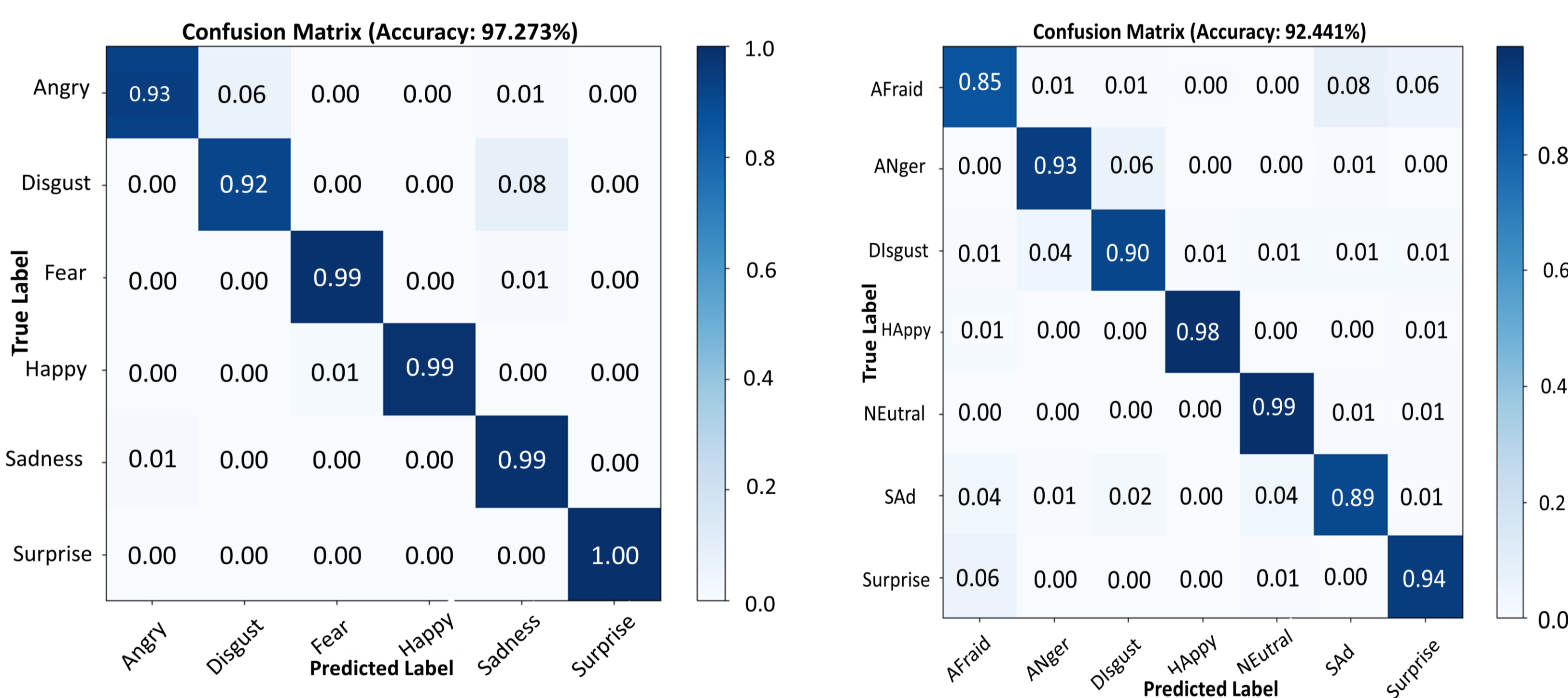


Fig. 3 Confusion Matrixes for KMU-FED and KDEF datasets

TABLE I
RESULTS OF THE ABLATION STUDY ON KMU-FED DATASET. "w" DENOTES "WITH"; "w/o" DENOTES WITHOUT; AND "C" DENOTES OUR DESIGNED CLASSIFIER

Methods	Params(M)	Processing Time(ms)	Accuracy	Precision	Recall	F1-score
ShuffleNet V2 w/o C	2.3M	1.03 ms	93.455%	0.94	0.93	0.93
ShuffleNet V2 w C	2.0M	1.11 ms	90.455%	0.90	0.91	0.90
EfficientViT-M2 w/o C	4.2M	2.80 ms	86.273%	0.86	0.86	0.86
EfficientViT-M2 w C	4.7M	2.70 ms	95.727%	0.96	0.96	0.96
ShuffViT-DFER (Ours)	5.9M	3.30 ms	97.273%	0.97	0.97	0.97

- The model balances a slight increase in parameters and processing time with low computational cost, achieving a best performance.

TABLE II
COMPARISON BETWEEN THE PROPOSED METHOD AND STATE-OF-THE-ART AND EXISTING METHODS ON THE KMU-FED DATASET

Methods	Accuracy (10 Fold)	Accuracy (5 Fold)	Accuracy (80:20)
Hierarchical WRF 2018	94.7%	NAN	NAN
CCNN 2019	97.3%	NAN	NAN
LMRF 2020	NAN	95.1%	NAN
d-RFs 2020	NAN	91.2%	NAN
FTDRF 2020	NAN	93.6%	NAN
DF 2020	NAN	90.5%	NAN
SqueezeNet 2022	83.4%	82.7%	95.83%
CNN+SVM 2022	NAN	NAN	98.64%
ShuffViT-DFER (Our method)	97.3%	95.6%	100.00%

- Our approach showed a comparable results and consistently outperforming all other approaches across different data splits on the KMU-FED dataset.

TABLE III
COMPARISON BETWEEN THE PROPOSED METHOD AND STATE-OF-THE-ART AND EXISTING METHODS ON THE KDEF DATASET

Methods	Accuracy
MPCNN 2018	86.90%
SqueezeNet 2022	86.86%
RBFNN 2022	88.80%
Efficient-swishNet DCNN 2022	85.50%
EfficientNet_FER 2023	88.17%
ShuffViT-DFER (Our method)	92.44%

- The proposed method outperformed all other methods on the KDEF dataset.

5. Conclusion

- We introduced ShuffViT-DFER, an efficient and fast method for recognizing driver's facial expressions.
- The obtained results demonstrated the effectiveness of the proposed approach.

6. Future Works

- Focus on incorporating multi-modal information by merging facial expression data with audio cues.
- Improve facial expression recognition by using multiple cameras to address the challenge of multi-view face angles

Publications :

- Saadi, I., Cunningham, D. W., Taleb-Ahmed, A., Hadid, A., & El Hillali, Y. (2024). Driver's facial expression recognition: A comprehensive survey. *Expert Systems with Applications*, 242, 122784.
- Saadi, I., Cunningham, D. W., Taleb-Ahmed, A., Hadid, A., & El Hillali, Y. " Driver's Facial Expression Recognition using Global Context Vision Transformer," *Proceedings of IEEE international conference on computer vision and machine intelligence(CVMI)*. 2023.
- Saadi, I., Cunningham, D. W., Taleb-Ahmed, A., Hadid, A., & El Hillali, Y." Driver's Facial Expression Recognition using Global Context Vision Transformer," *Proceedings of IEEE International Conference on Artificial Intelligence Circuits and Systems (AICAS)*. 2024.