

Facial Expression Recognition Under Partial Occlusion

Research Track Work

Neuro-Information Technology Department
Otto-von-Guericke-Universität, Magdeburg
Created and presented by: Esam Sharaf

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The Research Track

- 15 C.P.
- Experimental research.
- Moderate-level depth of knowledge.
- Mainly in DCNN coding.
- Working with Python (Keras, Pandas, Scikit-learn, ...).

Motivation

- Monitoring facial expressions (the pain), and contactless interaction with medical field's users; doctors and patients.
- Partial occlusions are common in the medical procedures (mask, inhalator, ..).



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<https://images.app.goo.gl/dGaZ2H4N6B1LKR6v6>

Figure 1: Examples of facial occlusions in the medical context.

Main Purpose & Features

The work aims at: assessing the recognition of AU12 and AU4 under partial occlusions by using Keras framework.

Two Action Units (AUs):

- AU12 (Lip corner puller)
- AU4 (Brow lowerer)

Two DCNN models:

- ResNet50 (binary model)
- MobileNetV2 (binary, regression model)



<https://images.app.goo.gl/GH1eePUWNEr1XqwZ8>

- 2D images from Bosphorus database
- F1 score and ICC(3,1) for evaluation

Pre-processing



(a)



(b)



(c)



(d)



(e)



(f)

Figure 2: Examples of pre-processing stage output.

Pre-trained Models - ResNet50

- As a binary classifier
- AUs: AU12 occurrence
- Key blocks:
 - 2D convolutional layer
 - Batch normalization
 - Activation function (ReLU)
- No partial occlusions implemented

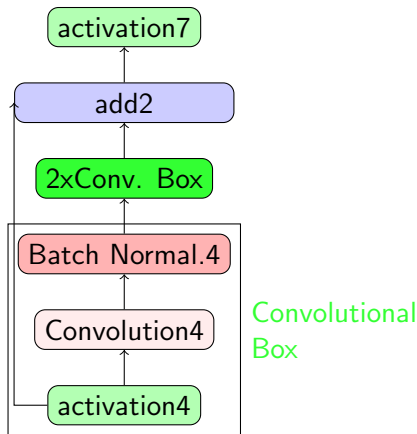


Figure 3: Key blocks of ResNet50.

Pre-trained Models - MobileNetV2

- As a binary model(AU12)
- As a regression model(AU12 & AU4)
- Key blocks:
 - Depthwise convolution
 - Pointwise convolution
- Partial occlusions were implemented

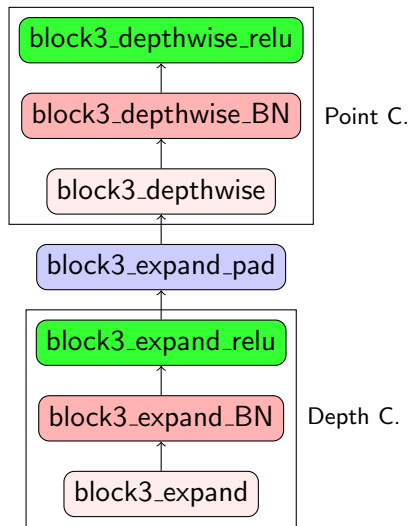


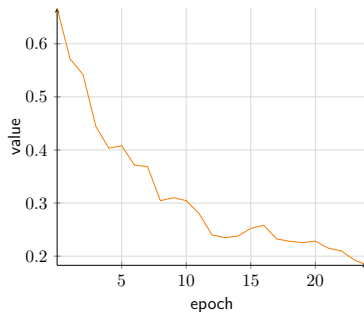
Figure 4: MobileNetV2 Key blocks.

Results - Binary Classification of AU12

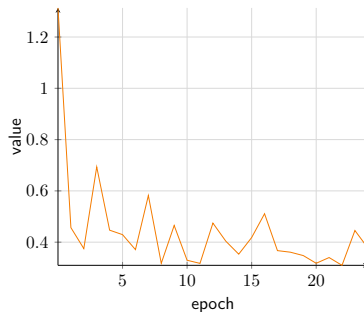
Model	Optimizer	Augmentation	F1-score
ResNet50	Adam (0.0001)	H,V,B	0.72
ResNet50	SGD (0.0001)	H,V,B	0.72
MobileNetV2	Adam (0.0001)	H,B	0.68
MobileNetV2	SGD (0.001)	H,V,B	0.72

Table 1: F1 score values comparison between two models used for binary classifications for AU12 occurrence. Third row describes data augmentation techniques as pre-processing (H = Horizontal flip, V = Vertical flip, B = Brightness adjustment).

Results - Binary Classification of AU12



(a)



(b)

Figure 5: MobileNetV2 binary classifier performance: training loss (a) and validation loss (b).

Results - Intensity Estimation of AU12 under Occlusion

AU12 State	T/V	Optimizer	Features	ICC(3,1)
No occlusion	T0/V0	Adam (0.001)	H/B/Max	0.78
Full occluded	T0/V1	Adam (0.001)	H/B/Flat	0.53
	T1/V0	SGD (0.0001)	H/B/Max	0.61
	T1/V1	Adam (0.001)	H/B/Max	0.56
Half occluded	T0/V1	Adam (0.001)	H/B/Max	0.55
	T1/V0	Adam (0.001)	H/B/Flat	0.53
	T1/V1	Adam (0.001)	H/B/Flat	0.63
Small occlusion	T0/V1	Adam (0.001)	H/B/Flat	0.59
	T1/V0	Adam (0.001)	H/B/Flat	0.68
	T1/V1	Adam (0.001)	H/B/Flat	0.66

Table 2: Correlation comparison of intensity estimation for Lip Corner Puller Action Unit (AU12) under different facial occlusion levels (fully /half /small) and no-occlusion case. T/V: states the case of training/ validation sets being under occlusion (1) or not (0). Features: H: Horizontal flip, B: Brightness adjustment, Max: Max pooling layer, Flat: Normal flat layer.

Results - Intensity Estimation of AU12 with Occluded AU4

AU4 State	T/V	Optimizer	Features	ICC(3,1)(AU12)
No occlusion	T0/V0	Adam (0.001)	H/B/Max	0.78
Full occluded	T0/V1	Adam (0.001)	H/B/Flat	0.79
	T1/V0	Adam (0.001)	H/B/Flat	0.75
	T1/V1	Adam (0.001)	H/B/Flat	0.77
Eye hole occluded	T0/V1	Adam (0.001)	H/B/Flat	0.74
	T1/V0	Adam (0.001)	H/B/Flat	0.73
	T1/V1	Adam (0.001)	H/B/Flat	0.69

Table 3: ICC(3,1) correlation comparison of intensity estimation for Lip Corner Puller Action Unit (AU12) with glass-like occluder hides AU4 area (fully, eye hole) and the initial no-occlusion case. T/V: states the case of training/ validation sets being under occlusion (1) or not (0). Features: H: Horizontal flip, B: Brightness adjustment, Max: Max pooling layer, Flat: Normal flat layer.

Results - Intensity Estimation of AU4 under Occlusion

AU4 State	T/V	Optimizer	Features	ICC(3,1)
No occlusion	T0/V0	Adam (0.001)	H/B/Max	0.30
Full occluded	T0/V1	Adam (0.001)	H/B/Flat	0.32
	T1/V0	Adam (0.001)	H/B/Flat	0.26
	T1/V1	Adam (0.001)	H/B/Flat	0.36
Eye hole occluded	T0/V1	Adam (0.001)	H/B/Flat	0.24
	T1/V0	Adam (0.001)	H/B/Flat	0.43
	T1/V1	Adam (0.001)	H/B/Flat	0.45

Table 4: ICC(3,1) correlations of intensity estimation for Brow Lowerer Action Unit (AU4) at no-occlusion, fully and eye hole occlusion cases. T/V: states the case of training/ validation sets being under occlusion (1) or not (0). Features: H: Horizontal flip, B: Brightness adjustment, Max: Max pooling layer, Flat: Normal flat layer.

Results - Intensity Estimation of AU4 with Occluded AU12

AU12 State	T/V	Optimizer	Features	ICC(3,1)(AU4)
No occlusion	T0/V0	Adam (0.001)	H/B/Flat	0.30
Full occluded	T0/V1	Adam (0.001)	H/B/Flat	0.49
	T1/V0	Adam (0.001)	H/B/Flat	0.41
	T1/V1	Adam (0.001)	H/B/Flat	0.46
Half occluded	T0/V1	Adam (0.001)	H/B/Flat	0.48
	T1/V0	Adam (0.001)	H/B/Flat	0.54
	T1/V1	Adam (0.001)	H/B/Flat	0.45
Small occlusion	T0/V1	Adam (0.001)	H/B/Max	0.51
	T1/V0	Adam (0.001)	H/B/Max	0.50
	T1/V1	Adam (0.001)	H/B/Max	0.51

Table 5: ICC(3,1) correlation comparison of intensity estimation for Brow Lowerer Action Unit (AU4) with mask-like occluder hides AU12 at three level of occlusion (fully /half /small) and initial no-occlusion case. T/V: states the case of training/ validation sets being under occlusion (1) or not (0). Features: H: Horizontal flip, B: Brightness adjustment, Max: Max pooling layer, Flat: Normal flat layer.

Summary

- The proposed models achieved good results for detecting AU12, recalling the simplicity of the pre-processing stage.
- Occluding AU12 region significantly reduced the ability to estimate AU12 intensity value with the proposed MobileNetV2 model, while occluding AU4 region had no significant effect.
- AU4 intensity estimation is more challenging, with the resulted poor correlations. Further research is needed for AU4 under occlusion case.

Thank You!
Q&A?

Literature I



Wikipedia contributors (2019). *Oxygen therapy* — *Wikipedia, The Free Encyclopedia*. https://en.wikipedia.org/w/index.php?title=Oxygen_therapy&oldid=909037842. [Online; accessed 16-September-2019].