

Facial Expression Recognition using Residual Masking Network



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Network

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Introduction

Problem definition

- **Input:** an facial image (without alignment information).
- **Output:** probabilities of seven classes.¹

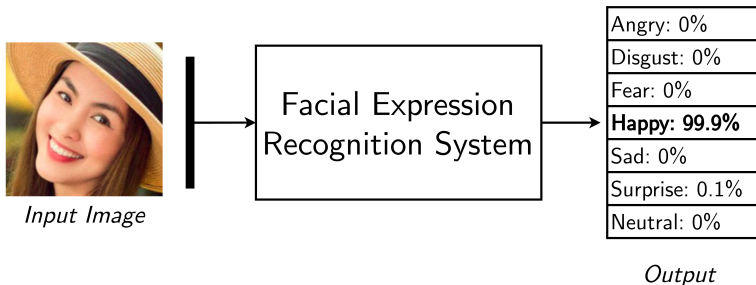


Figure -1.1: Diagram of a Simple Facial Expression Recognition API.

¹Include 6-concrete emotions and neutral state.

Facial Expressions of Emotion



Figure -1.2: Facial action ensembles for common-view facial expressions. ¹

¹Challenges to inferring emotion from human facial movements, 2019 — Barrett, Lisa Feldman, et al.

Facial landmarks

Problems

- Failure in working with small images.
- Poor confidence in complex input.
- Huge cost for labelling.

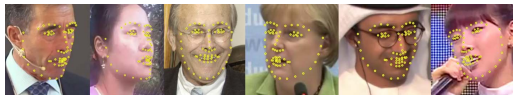


Figure -1.3: Good confidence landmarks



Figure -1.4: Poor confidence landmarks

Q: A end-to-end method to extract facial expression without this intermediate level features?

Masking Idea

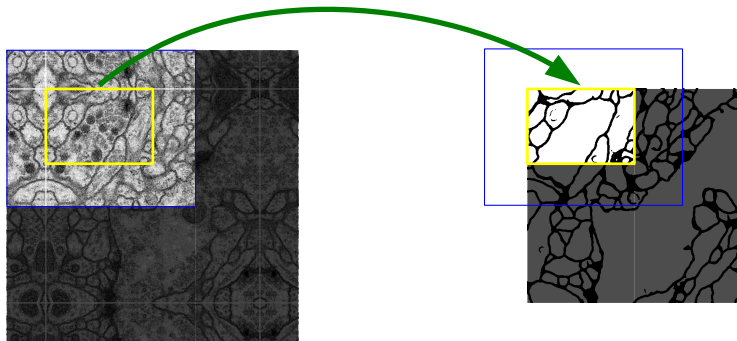


Figure -1.5: Segmentation problem input and output. ¹

¹"U-net: Convolutional networks for biomedical image segmentation." — Ronneberger et al., MICCAI 2015

Masking Idea

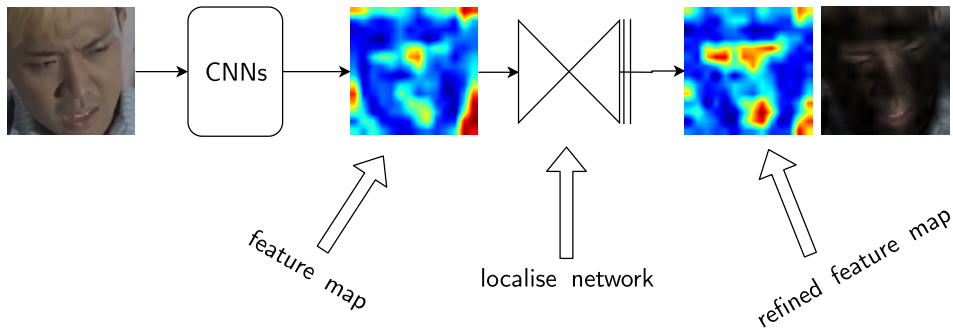


Figure -1.6: Attention to the interested area.

Masking Idea

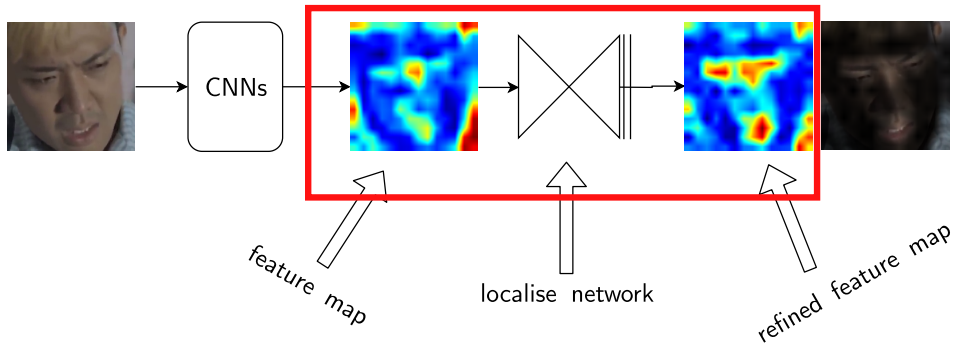


Figure -1.7: Attention to the interested area.

Masking Block

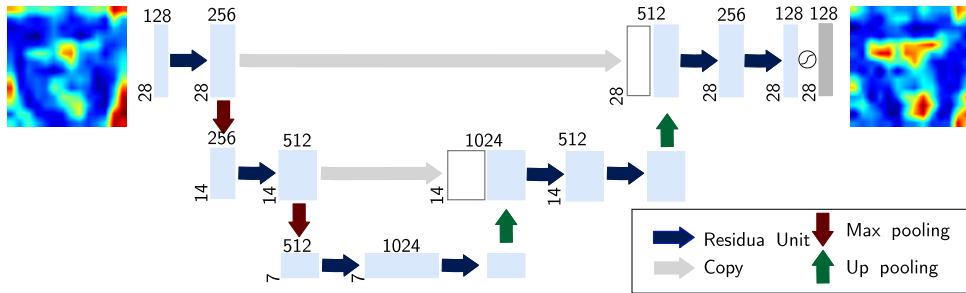


Figure -1.8: Masking Block with $depth = 3$.

The depth of Masking Block is dynamically changed by the spatial size of the input feature map.

Residual Masking Network

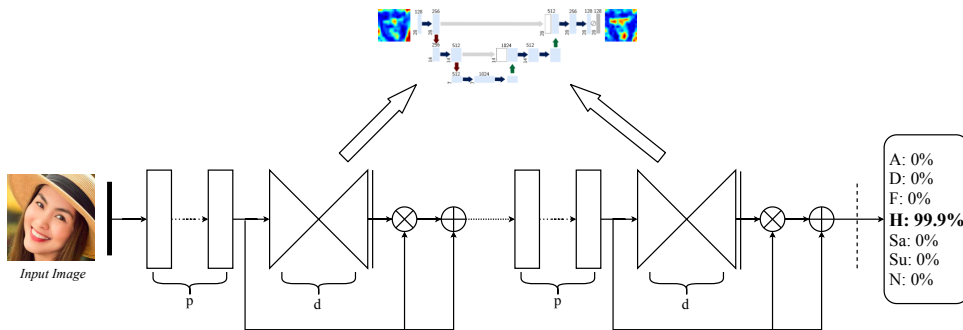


Figure -1.9: Residual Masking Network Overview.

Datasets

FER2013

- 35,887 gray-scale images
- $W \times H$: 48×48
- In-the-wild
- Widely used

VEMO

- 36,470 RGB images
- $W \times H$: Varied
- In-the-wild
- Vietnamese focused

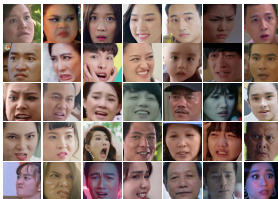


Figure -1.10: Example images

Evaluation results on FER2013

Table -1.1: Results of reproduced training models on FER2013

Name	Acc (%)
VGG19	70.80
ResAttNet56	72.63
Densenet121	73.16
Resnet152	73.22
Cbam_resnet50	73.39
ResMaskingNet	74.14

Table -1.2: Compare with reported results. ¹

Name	Acc (%)
Human Accuracy [1]	65 ±5
DNN_L_Reg [2]	66.40
DL-SVM [3]	71.16
CNN-SIFT	73.40
CNNs, BOVW, local SVM	75.42
Ensemble 8 CNNs [6]	75.20
ResMaskingNet + 6	76.82 ²

¹There is no space left, citations can be found in the dissertation.

²Ensemble the Residual Masking Network with 6 other CNNs.

Evaluation results on FER2013

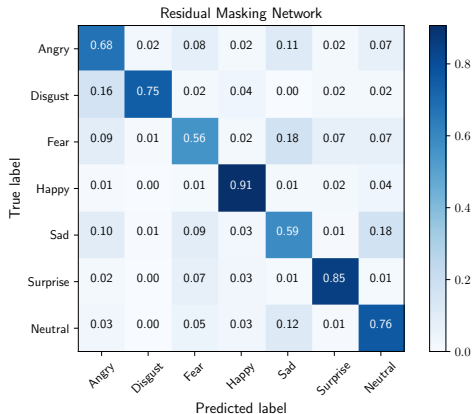


Figure -1.11: CM of RMN on FER2013



Figure -1.12: Failure cases

Evaluation results on VEMO

Table -1.3: Results on VEMO

Name	Acc (%)
ResAttNet56	60.82
Resnet18	63.94
Resnet34	64.84
ResMaskingNet	65.949

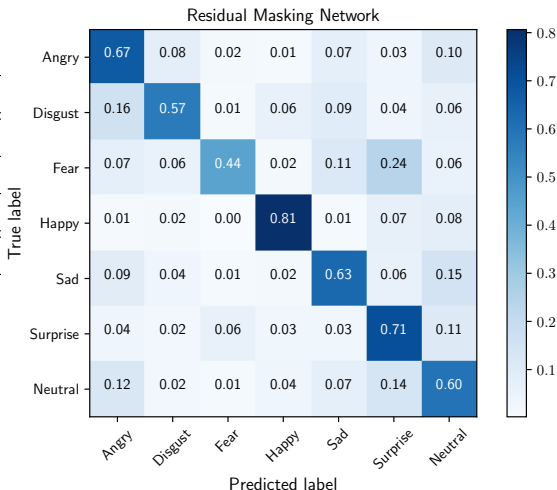


Figure -1.13: CM of RMN on VEMO.

Visualization

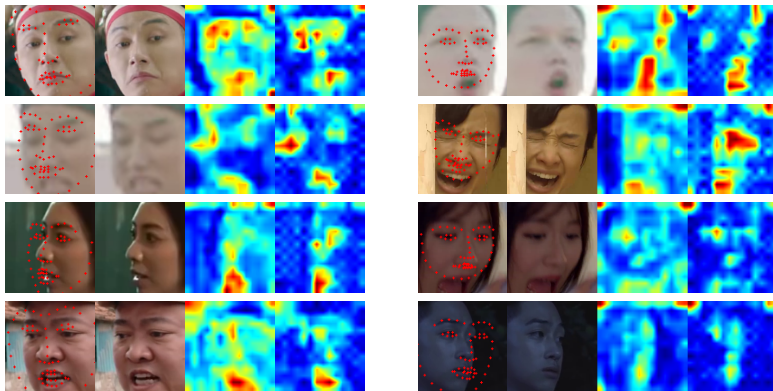


Figure -1.14: Landmark → Image → Before 3rd masking layer → After 3rd masking layer

Demo



Figure -1.15: National Assembly deputies visit Ho Chi Minh Mausoleum

Demo



Figure -1.16: Dung and Ha Lan are on Honda with Happy face - Image from Mat Biec movie

Demo

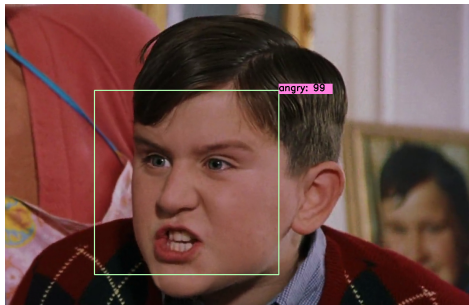


Figure -1.17: Dudley being angry - Harry Potter movie



Figure -1.18: A Vietnamese actress being sad

Summary

- Masking Idea can be used to help CNNs focus to regions of interest without facial landmarks.
- The proposed method - Residual Masking Network with Masking Idea, can produce competitive results in FER problem, ensemble with other CNNs can produce state-of-the-art result.
- Create VEMO dataset, the first novel one that supports recognizing facial expression of Vietnamese.



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Thanks for listening

Questions?

References for Table 4.2

1. Goodfellow, Ian J., et al. "Challenges in representation learning: A report on three machine learning contests." ICML, 2013.
2. Minaee, Shervin, and Amirali Abdolrashidi. "Deep-Emotion: Facial Expression Recognition Using Attentional Convolutional Network." arXiv:1902.01019 (2019).
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4. Kim, Bo-Kyeong, et al. "Fusing aligned and non-aligned face information for automatic affect recognition in the wild: a deep learning approach." CVPR Workshops. 2016.
5. Nguyen, Hai-Duong, et al. "Facial expression recognition using a multi-level convolutional neural network." ICPRAI, 2018.
6. Pramerdorfer, Christopher, and Martin Kampel. "Facial expression recognition using convolutional neural networks: state of the art." arXiv:1612.02903 (2016).



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Evaluation results on FER2013

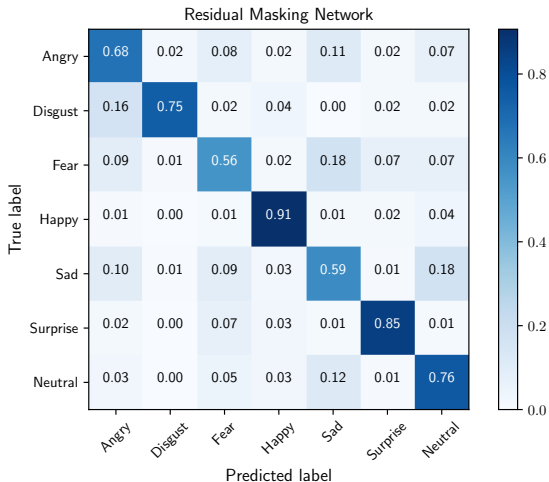
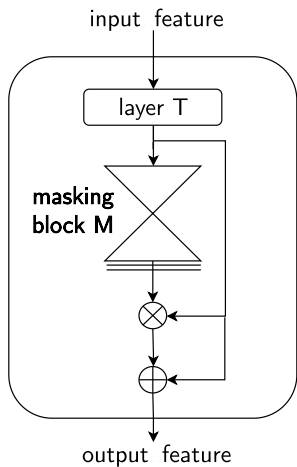


Figure -1.19: Confusion Matrix of Residual Masking Network on FER2013 dataset

Residual Masking Block



Given input feature x ,
with i is spatial index, c is channel
index.

- $t = T(x)$
- $m = M(t)$
- $b_{i,c} = (1 + m_{i,c}) * t_{i,c}$

Figure -1.20: Residual Masking Block.