A spatiotemporal deep learning solution for Automatic Micro-Expressions Recognition From Local Facial Regions

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Outline

I. Introduction

II. State-of-the-art

III. Proposed solution

IV. Experiments and results

V. Conclusion and perspectives

Outline

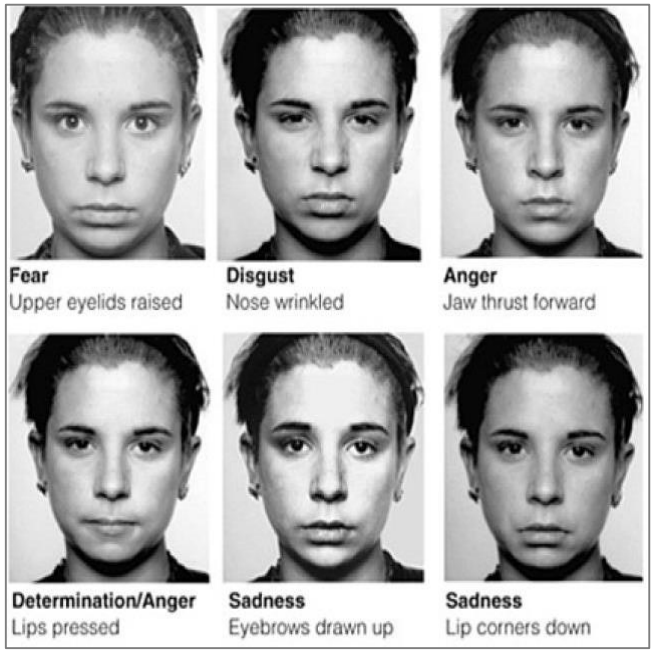
Police Interrogation

Psycho treatment

Driven warning

Macro-Expressions

- Obvions / Intense
- Global Face reaction
- > 1/2 s
- Real / Fake
- Gender, ethnicity, age, ...



Micro-Expressions

- Low intensity
- Local Face reaction
- < 1/2 s (to 1/25 s)
- Spontaneous (Real)
- Universal

Truths VS **Lies**

↓

Macro VS **Micro**

But ...

&

Challenging task

→ **Deep Learning**

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II. State-of-the-art
   I. Handcrafted Approach
   II. DL Approach
   III. Hybrid Approach
   IV. Region based Approach

III. Proposed solution

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- Handcrafted Approach
- Hybrid Approach
- DL Approach
- Region based Approach

Handcrafted Solutions

Deep Learning Solutions

Hybrid Solutions

Region based Solutions

Handcrafted Solutions :

- LBP-TOP : Local Binary Pattern on Three Orthogonal Planes
- 3D-HOG : 3D-Gradients orientation Histogram
- Bi-WOOF : Bi-Weighted Oriented Optical Flow
- HOOF : Histogram of Oriented Optical Flow

Deep Learning Solutions :

- CNN + LSTM
- 3D-CNN: 3D Spatiotemporal CNN
- LEARNet : Lateral Accretive Hybrid Network
- CapsuleNet

Hybrid Solutions :

- ELRCN : Enriched Long-term Recurrent CNN
- Off-ApexNet : Optical Flow Features from Apex frame Network
- STSTNet : Shallow Triple Stream Three-dimensional CNN
- STRCN : Spatiotemporal Recurrent Convolution Network

Region based Solutions :

- NMPs: Necessary Morphological Patches
- Improved version of NMPs
- MicroExpFuseNet

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III. Proposed solution
   I. Idea and added value
   II. Overview
   III. CNN
   IV. LSTM

IV. Experiments and results

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MiEs : Catch me If you can :p

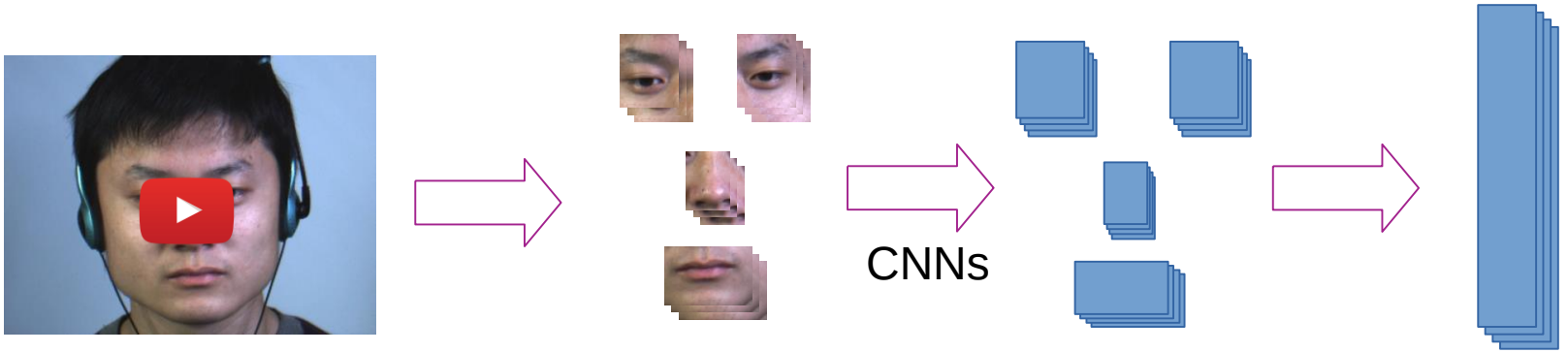
Me : Hey ! First of all, are you local or global reaction of the face

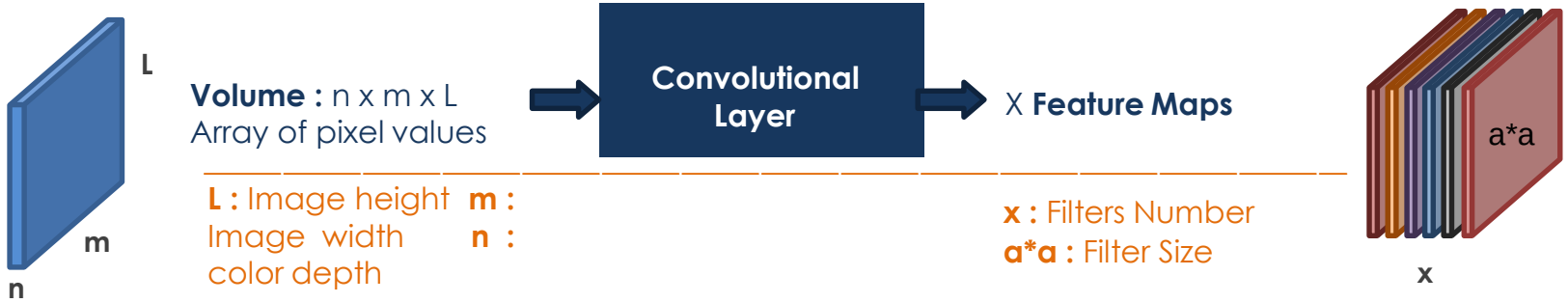
MiEs : Hmmmm I really don't know, but you can ask Paul Ekman

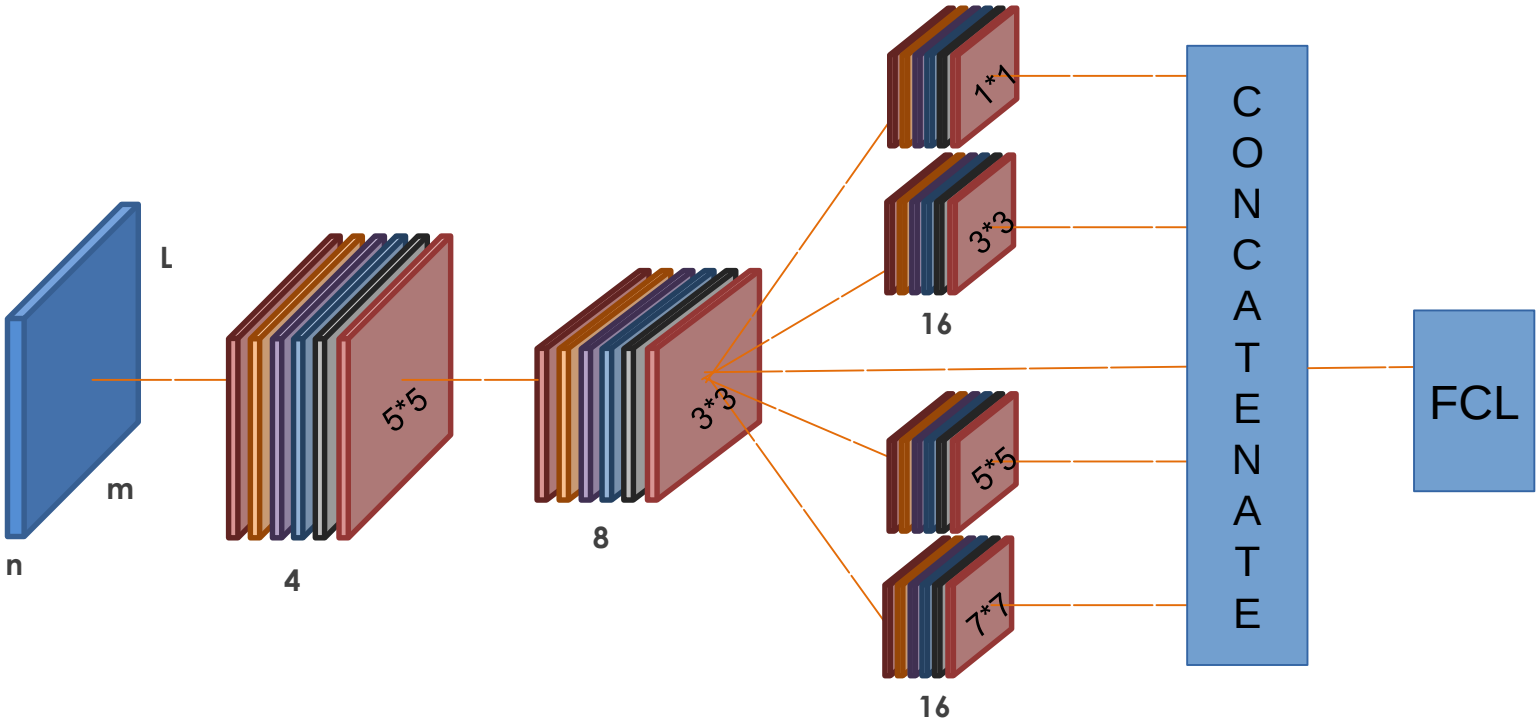
P. Ekman : yeah !! you can say that

Zaho et al. : we confirm, we recently did a research on that and guess what! we've got more than 20% precision higher with only traditional method. Get yourself ready MiEs :p :p

Me : Hmmmm OK, so the less parts I use the more relevant spatio-temporal features I got and with DL I expect to get a better result ….. good, thanks


CNNs
LSTM
Spatio-temporal features
FCL
MiE Recognition
Happy
Sad
Angry
Surprise
Disgust


L
m
n
Volume : n x m x L
Array of pixel values
Convolutional Layer
X Feature Maps
L : Image height m : Image width n : color depth
x : Filters Number
a*a : Filter Size
a*a
x


L
m
n
5*5
4
3*3
8
1*1
3*3
16
5*5
7*7
16
CONCATENATE
FCL

LSTM: Long Short Term Memory

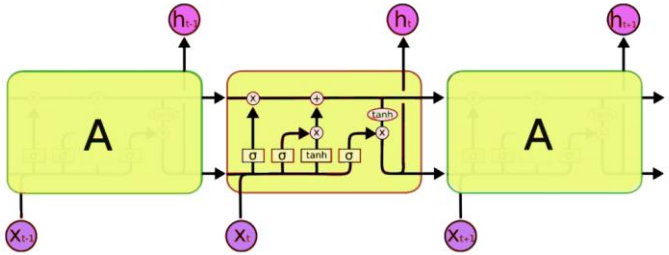
RNN: Recurrent Neural Network

Sequences

Evoloution of Filters through Time

Words in paragraph

Video etc ...



LSTM architecture

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IV. Experiments and results
   I. Data
   II. Experimental Setup
   III. Evaluation Metric
   IV. Results & Discussion

V. Conclusion and perspectives

Provided Database : Spontaneous Micro-Expressions

		SMIC	CASME II	SAMM
Participants		16	24	28
Frame rate (*fps*)		100	200	200
Avg. frame number		34	68	74
Avg. video duration (*s*)		0.34	0.34	0.37
Ground-truth (index)	Onset	Yes	Yes	Yes
	Offset	Yes	Yes	Yes
	Apex	No	Yes	Yes
Number of classe		3	5	7
Number of samples		164	255	159

- CASME I
- **CASME II**
- CAS(ME)^2
- **SAMM**
- SMIC-SUB
- **SMIC**
- Polikovsky's
- USF-HD
- MEVIEW
- YorkDDT
- ...

Provided Database :

3 Classes : Emotions : - / + / s

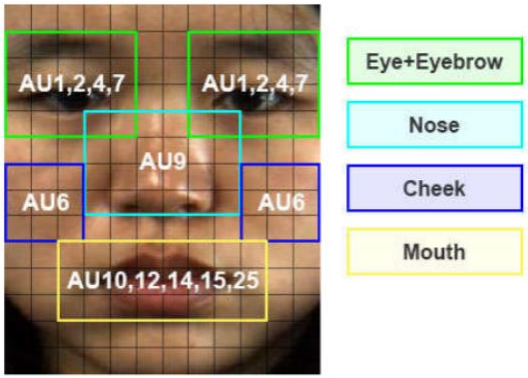
Emotion Class	SMIC	CASME II	SAMM	3DB-combined
Negative	70	88†	92‡	250
Positive	51	32	26	109
Surprise	43	25	15	83
TOTAL	164	145	133	442

MEGC 2019

- Negative class of CASMEII consists of samples from its original emotions class of Disgust and Repression
- Negative class of SAMM consists of samples from original emotions class of Anger, Contempt, Disgust, Fear and Sadness

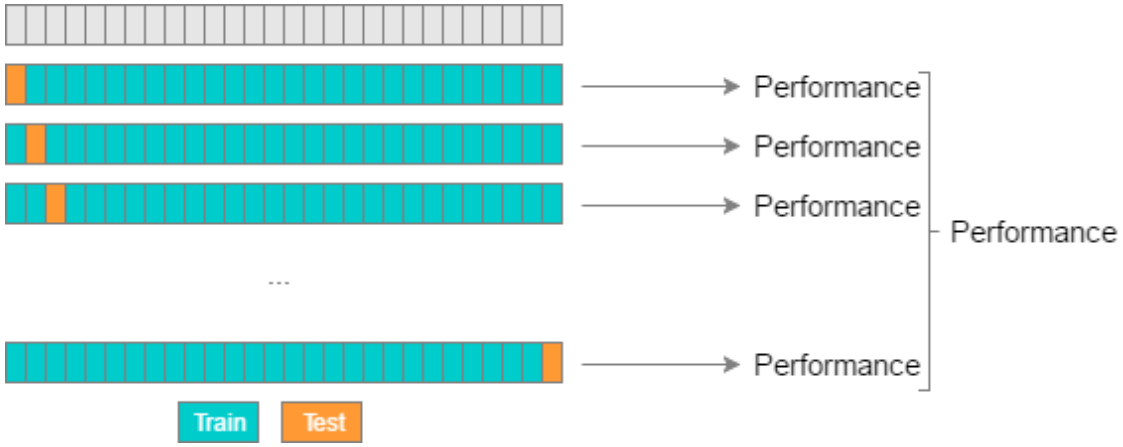
Network Settings :

- **Regions crop : Dlib library , 68 landmarks**
- **Different regions, different labels**
- CNNs trained with 64 batch size & 100 epochs
- LSTM+FCL Network trained with 244 batch size and 60 epoch
- Ubuntu 18.04.2 LTS, python3.6, keras-gpu2.2.4, tensorflow-gpu1.12.0, Geforce GTX 1080Ti GPU (32 GB memory) and Intel Xeon Processor



Training Protocol :

LOSO-CV Protocole



UF1 score

$$F1_c = \frac{2TP_c}{2TP_c + FP_c + FN_c},$$

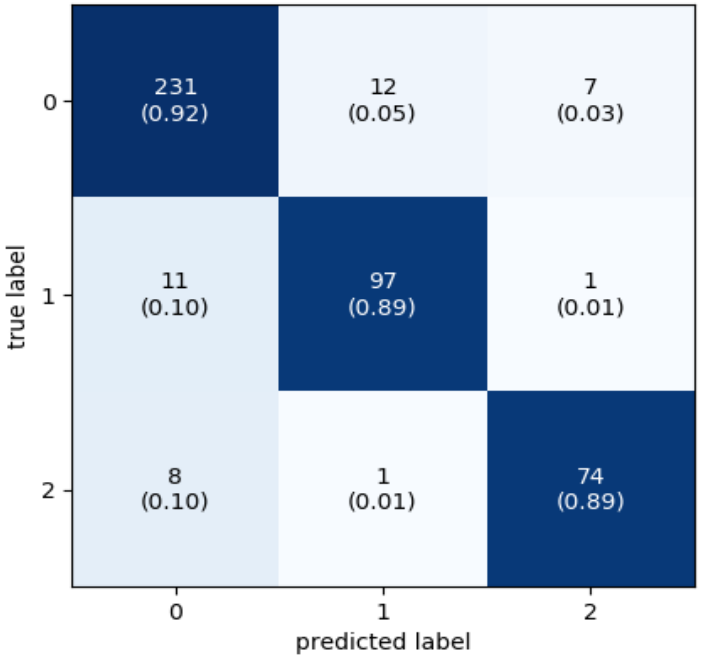
$$UF1 = \frac{F1_c}{C},$$

UAR score

$$UAR = \frac{1}{C}\sum_{c=1}^{C} ACC_c$$

$$ACC_c = \frac{TP_c}{N_c}$$

Results :



Confusion Matrix , FULL Database (CASMEII, SAMM, SMIc) ,MEGC 2019 Conditions, (0 : Negative, 1:Positive, 2 : Surprise)

Accuracy : 0.9095

UAR : 0.9018

UF1 : 0.9022

MEGC 2019

Comparison :

Models	FULL		SMIC		CASAME II		SAMM	
	UF1	UAR	UF1	UAR	UF1	UAR	UF1	UAR
LBP-TOP [22]$^{\diamond}$	0.5882	0.5785	0.2000	0.5280	0.7026	0.7429	0.3954	0.4102
Bi-WOOF [5]$^{\diamond}$	0.6296	0.6227	0.5727	0.5829	0.7805	0.8026	0.5211	0.5139
OFF-ApexNet [7]†	0.7196	0.7096	0.6817	0.6695	0.8764	0.8681	0.5409	0.5392
Micro-Attention [13]$^{\oplus}$	0.5080	0.4930	0.4730	0.4660	0.5390	0.5170	0.4030	0.3400
ATNet *(Fusion)* [26]$^{\oplus}$	0.6310	0.6130	0.5530	0.5430	0.7980	0.7750	0.4960	0.4820
Quang *et al.* [12]$^{*\oplus}$	0.6520	0.6506	0.5820	0.5877	0.7068	0.7018	0.5882	0.5989
Zhou *et al.* [27]*†	0.7322	0.7278	0.6645	0.6726	0.8621	0.8560	0.5868	0.5663
Liong *et al.* [8]*†	0.7353	0.7605	0.6801	0.7013	0.8382	0.8686	0.6588	0.6810
Liu e*et al.* [28]*†	0.7885	0.7824	0.7461	0.7530	0.8293	0.8209	0.7754	0.7152
Our proposed method $^{\oplus}$	**0.9022**	**0.9018**	**0.8886**	**0.8828**	**0.9857**	**0.9857**	**0.7855**	**0.8103**

$^{\diamond}$ handcrafted approach, † hybrid approach, $^{\oplus}$ deep learning approach.

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I. Conclusion
II. Perspectives

- Less is More
- Deep Learning : CNN (inception block) + LSTM

Accuracy :
More than 90 %

- Data Augmentation
- Adaptive analysis of MiE for Medical use case
- Complexe Micro-Expressions

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