MELAB
Micro-Expression LABoratory

Tutorial

ACCV 2020

Recent Advances and Challenges in Facial Micro-Expression Analysis

Spotting ME Sequences

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MMU MULTIMEDIA UNIVERSITY

Manchester Metropolitan University

Outline

- Related Works
- Main Directional Maximal Difference Analysis
- Spatio-temporal Fusion for Macro- and Micro-expression Spotting in Long Video Sequences
- Local Temporal Pattern and Data Augmentation for Micro-Expression Spotting
- Result Evaluation Method per Interval

Outline

- **Related Works**
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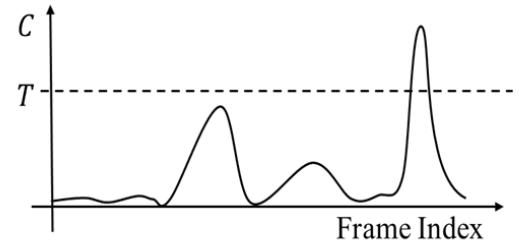
Related works

Feature Extraction
LBP-χ^2
HOG-χ^2
HOOF
MDMD
Etc.

→ Early Fusion → Global feature for entire face

→ Feature Difference in **temporal interval based on ME duration**



Spot Movements with maximal magnitude

Feature Extraction

- LBP-TOP, HOG-TOP and HIGO-TOP (Spatial and Short temporal duration)
- Movement magnitude (Spatial)
- Image intensity (Spatial)

→ An early fusion → Global feature for entire face

Classification

- SVM
- Adaboost model
- CNN

Small data size

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Main Directional Maximal Difference (MDMD) Analysis

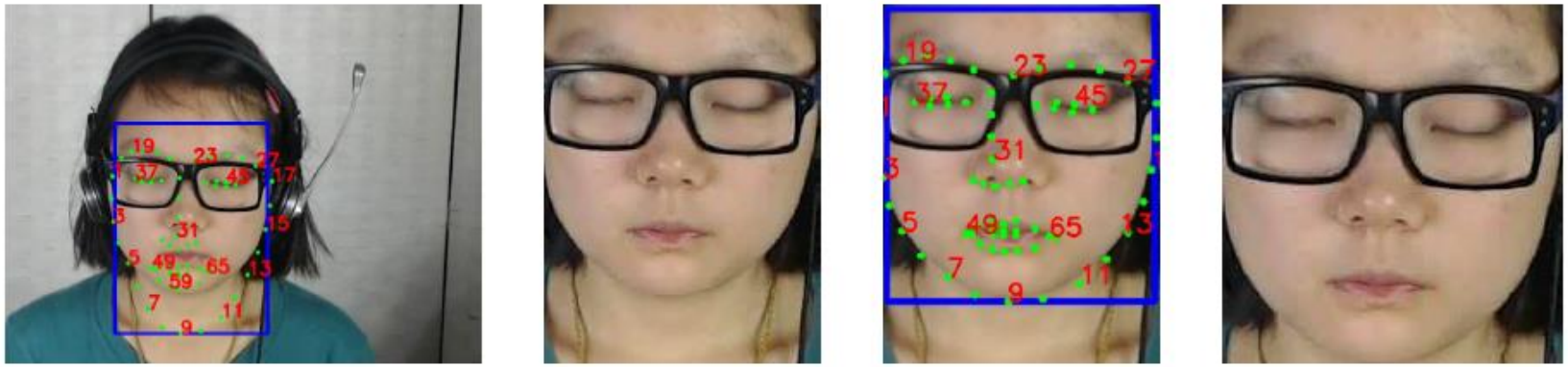
Contribution:

- MDMD uses the magnitude of maximal difference in the main direction of optical flow as a feature.
- Based on block-structured facial regions, MDMD obtains more accurate features of the movement of expressions.
- This method obtains both the temporal and spatial locations of facial movements.
- Baseline method for Micro-expression Grand Challenge (MEGC) 2020 - spotting micro-expressions and macro-expressions on long videos.

He, Ying, et al. "Spotting macro-and micro-expression intervals in long video sequences." *2020 15th IEEE international conference on automatic face & gesture recognition (FG 2020)*. IEEE, 2020.
Wang, Su-Jing, et al. "A main directional maximal difference analysis for spotting facial movements from long-term videos." *Neurocomputing* 230 (2017): 382-389.

Main Directional Maximal Difference (MDMD) Analysis

- **Pre-process**



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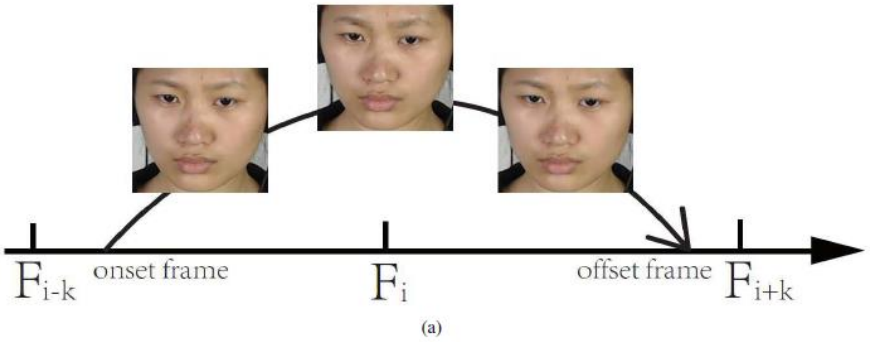
Main Directional Maximal Difference (MDMD) Analysis

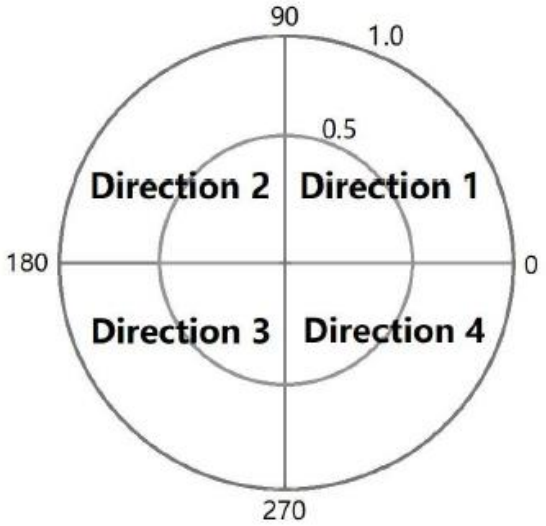
- **Feature Extraction**



$$\{(\rho_M^{HC}, \theta_M^{HC})\} = \{(\rho^{HC}, \theta^{HC}) | \theta^{HC} \in \Theta\}$$

$$\{(\rho_M^{HT}, \theta_M^{HT})\} = \{(\rho^{HT}, \theta^{HT}) | (\rho^{HT}, \theta^{HT}) \text{ and } (\rho_M^{HC}, \theta_M^{HC}) \text{ are two different vectors of the same point in } F_{i-k}\}$$

$$d = \frac{3}{g} \sum \max_{\frac{g}{3}} \{\rho_M^{HC} - \rho_M^{HT}\}$$



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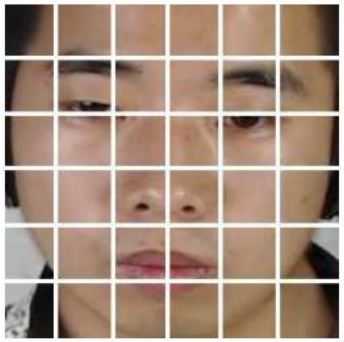
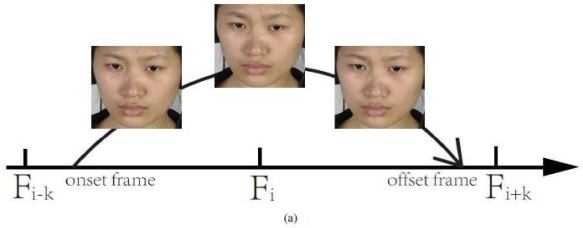
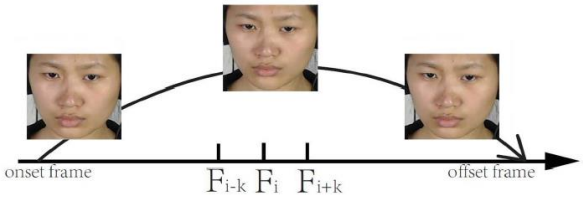
Main Directional Maximal Difference (MDMD) Analysis

- **Block-structured analysis**







$$\bar{d}^i = \frac{1}{s}\sum \max_s \{d_j^i\}$$

$$r^i = \bar{d}^i - \frac{1}{2}\left(\bar{d}^{i-k+1} + \bar{d}^{i+k-1}\right)$$

$$threshold = r_{mean} + p \times (r_{max} - r_{mean})$$

where

$$nean = \frac{1}{n-2k}\sum_{n-k}^{i=k+1} r^i$$

and

$$r_{max} = \max_{n-k}^{i=k+1} r^i.$$

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Spatio-Temporal fusion for Macro- and Micro-expression Spotting in Long Video Sequences

Contribution:

- We address the head motion problem in a simple way. We select the nose region as a standard global vector that contains only head motion. The local optical flow field is obtained by performing the operator of difference between superposition of optical field and standard global movement vector.
- Second, we propose a Spatio-temporal feature fusion matrix which describes spatial and temporal information by row and column relationship. A specific pattern related to magnitude and angle is extracted from the matrix. We denoted it as SP-pattern, which contains all the information from a micro-expression interval. We can obtain onset, apex, and offset according to the SP-pattern.
- Third, we use a multi-scale filter to remove high frequency noise and preserve crests of different intensities. In order to achieve good performance on both macro-expression and micro-expression, we comprehensively analyze information at different scales.
- Won the first place of MEGC2020

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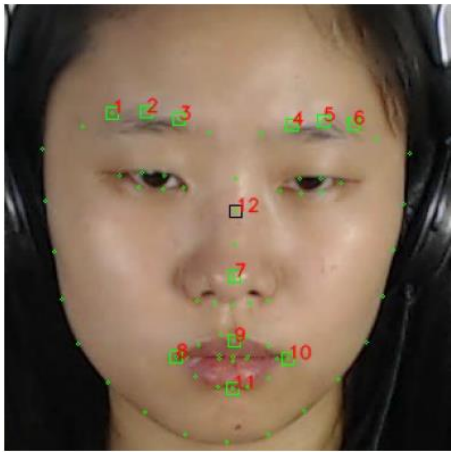
Spatio-Temporal fusion for Macro- and Micro-expression Spotting in Long Video Sequences

Preprocessing | Feature extraction | Spotting process



Facial region	ROI	AU
Eyebrows	1, 2, 3, 4, 5, 6	1, 2, 4, 5, 6, 7, 9
Nose	7, 12	11
Mouth	8, 9, 10, 11	10 12 14 15 17 20 23 24

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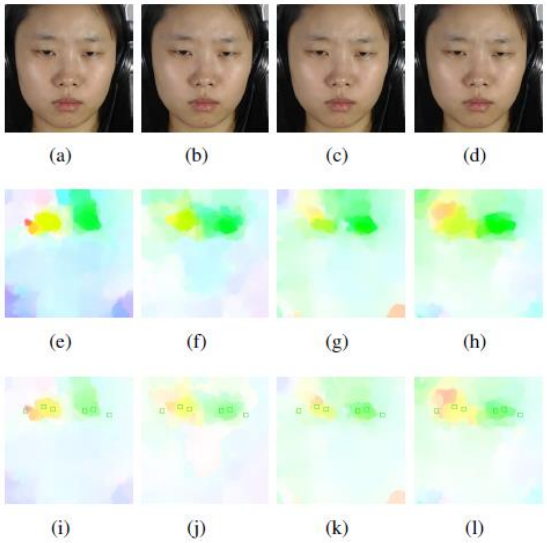
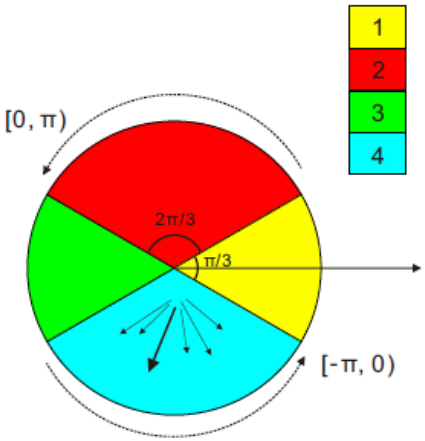
Preprocessing | **Feature extraction** | Spotting process





$$\mathbf{F} = \begin{bmatrix} L_1 \\ L_2 \\ \vdots \\ L_{N-1} \end{bmatrix} = \begin{bmatrix} \eta_1^1 & \eta_1^2 & \cdots & \eta_1^{11} \\ \eta_2^1 & \eta_2^2 & \cdots & \eta_2^{11} \\ \vdots & \vdots & \ddots & \vdots \\ \eta_{N-1}^1 & \eta_{N-1}^2 & \cdots & \eta_{N-1}^{11} \end{bmatrix}$$

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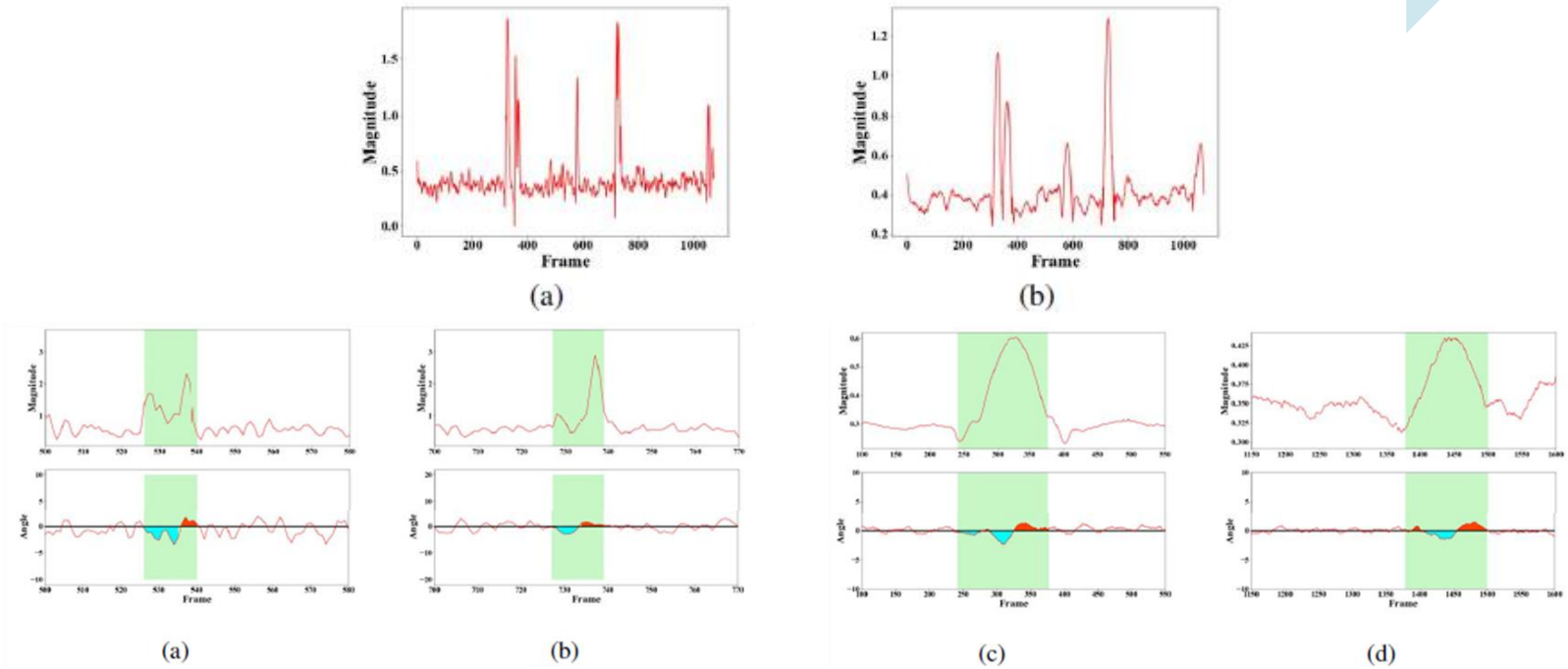
Spatio-Temporal fusion for Macro- and Micro-expression Spotting in Long Video Sequences

Preprocessing | Feature extraction | **Spotting process**



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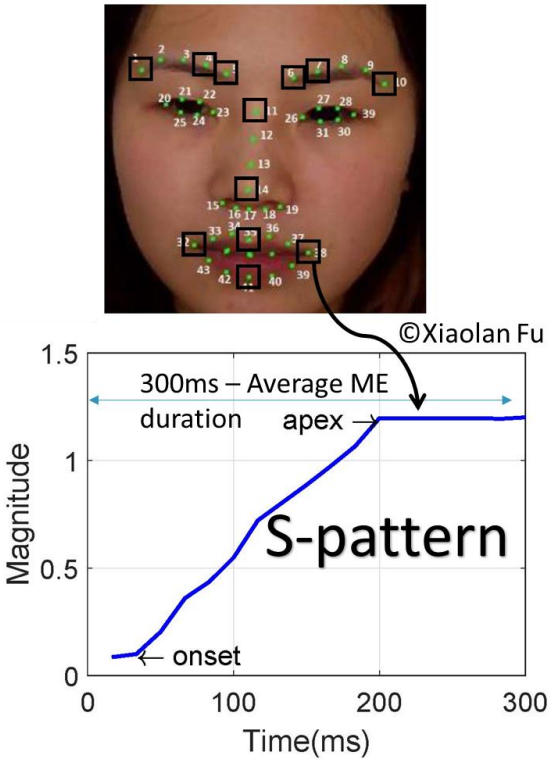
Local Temporal Pattern and Data Augmentation for Micro-Expression Spotting

Contribution:

- Local Temporal Pattern (LTP)
- A late spatial-and-temporal fusion
- Data augmentation by Hammerstein Model
- A novel result evaluation method and metric



Li, Jingting, Catherine Soladie, and Renaud Seguier. "Ltp-ml: Micro-expression detection by recognition of local temporal pattern of facial movements." 2018 13th IEEE international conference on automatic face & gesture recognition (FG 2018). IEEE, 2018.

Li, Jingting, et al. "Spotting micro-expressions on long videos sequences." 2019 14th IEEE International Conference on Automatic Face & Gesture Recognition (FG 2019). IEEE, 2019.

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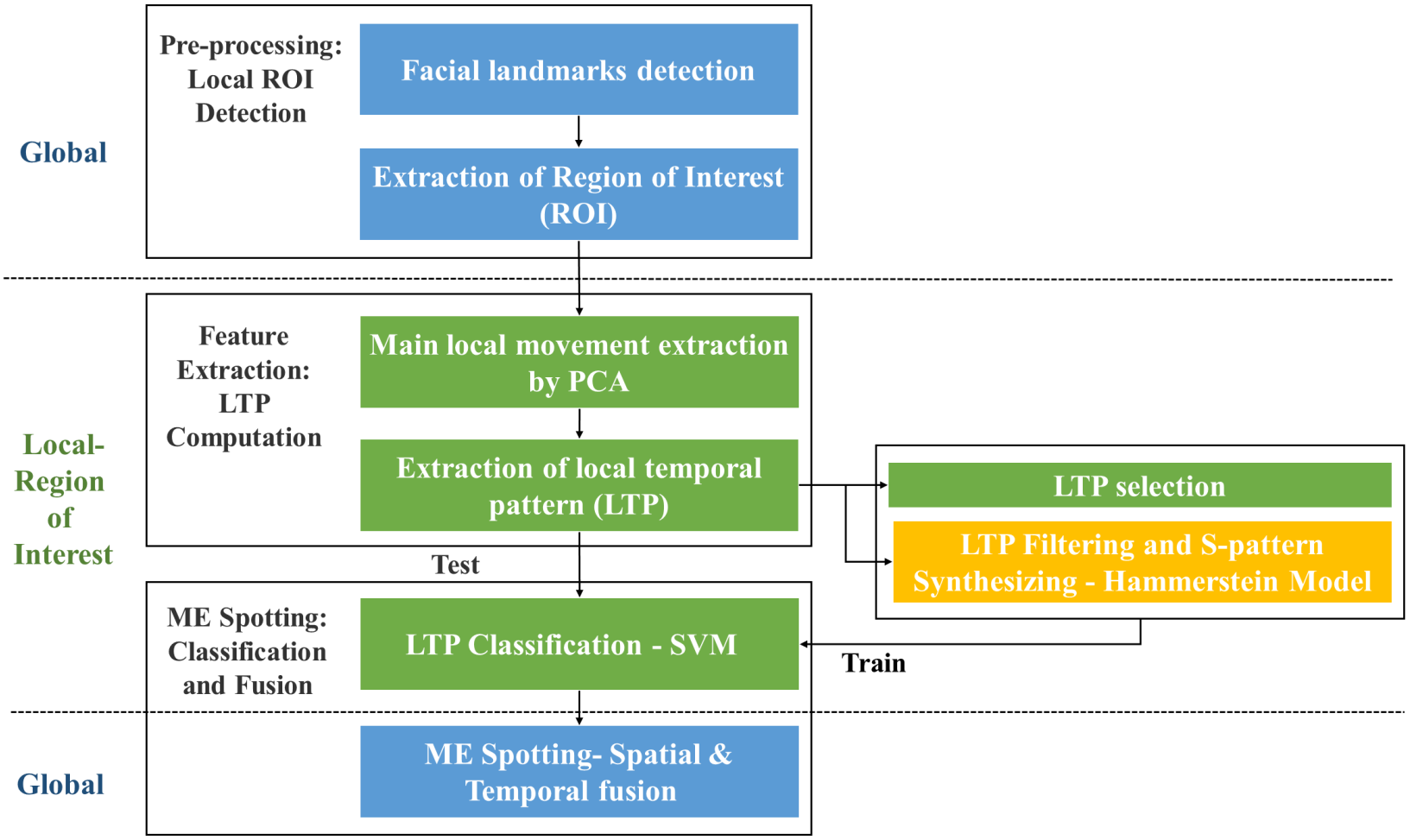
Local Temporal Pattern and Data Augmentation for Micro-Expression Spotting



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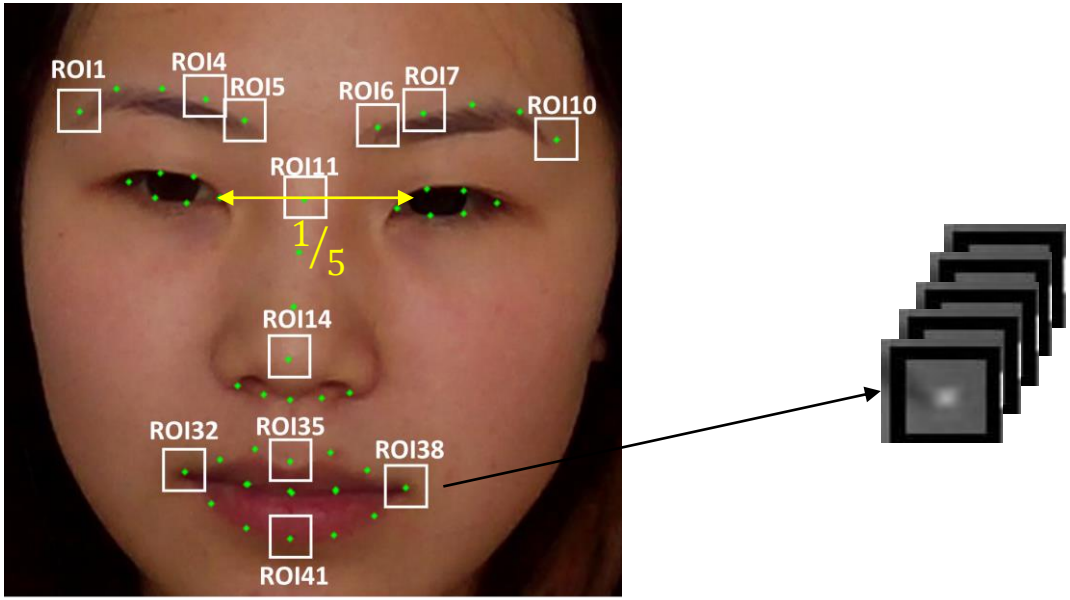
Local Temporal Pattern and Data Augmentation for Micro-Expression Spotting

- **Region of Interest selection**

Facial region	Related AU	12 ROI index
Eyebrows	1, 2, 4	1, 4, 5, 6, 7, 10
Nose	NaN	11, 14
Mouth	10, 12, 14, 15, 17, 25	32, 35, 38, 41



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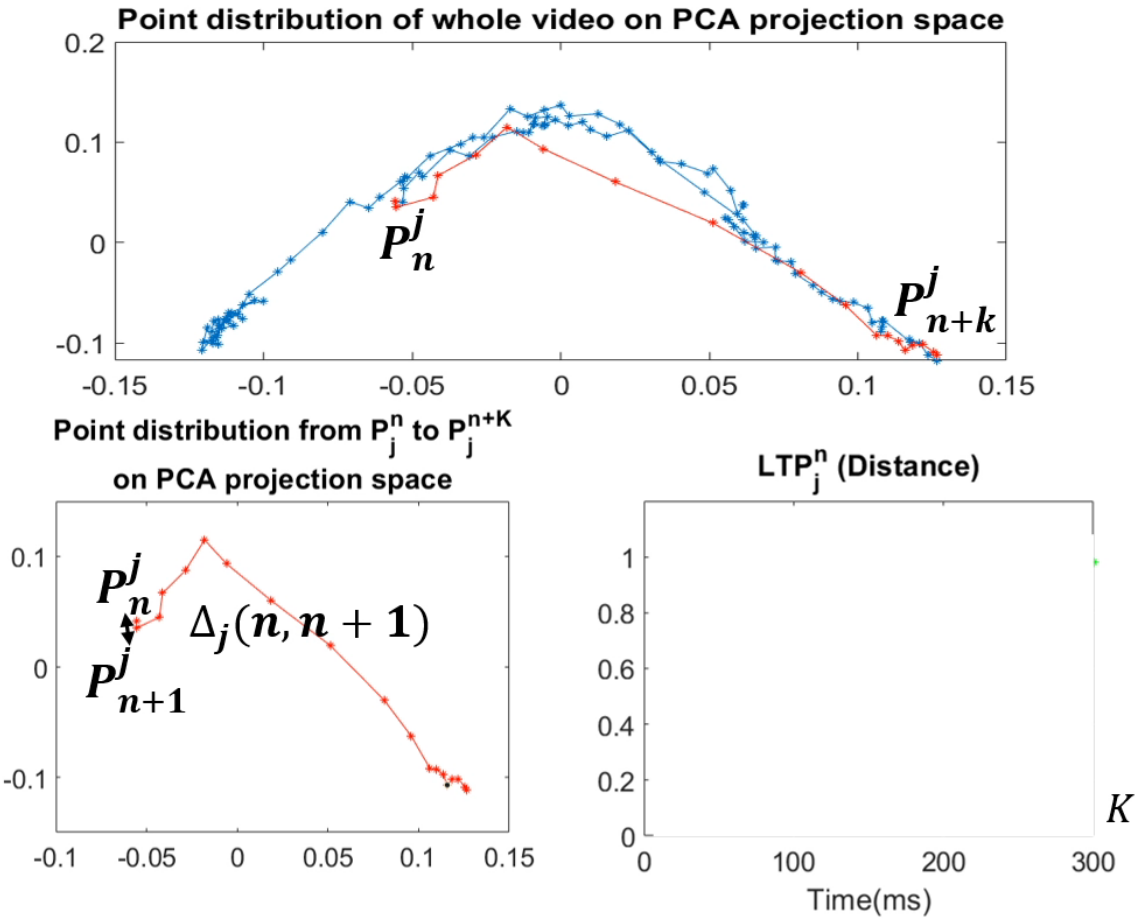
Local Temporal Pattern and Data Augmentation for Micro-Expression Spotting

Local temporal pattern calculation:



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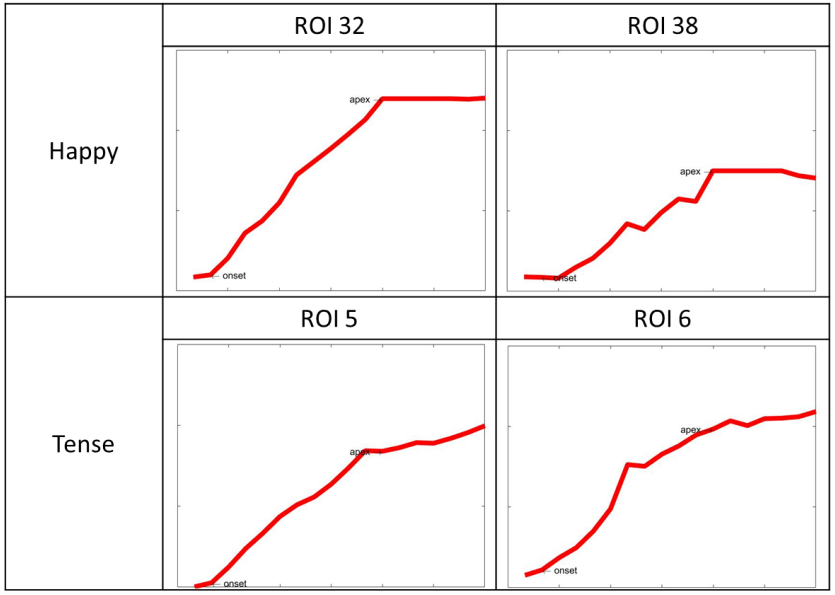
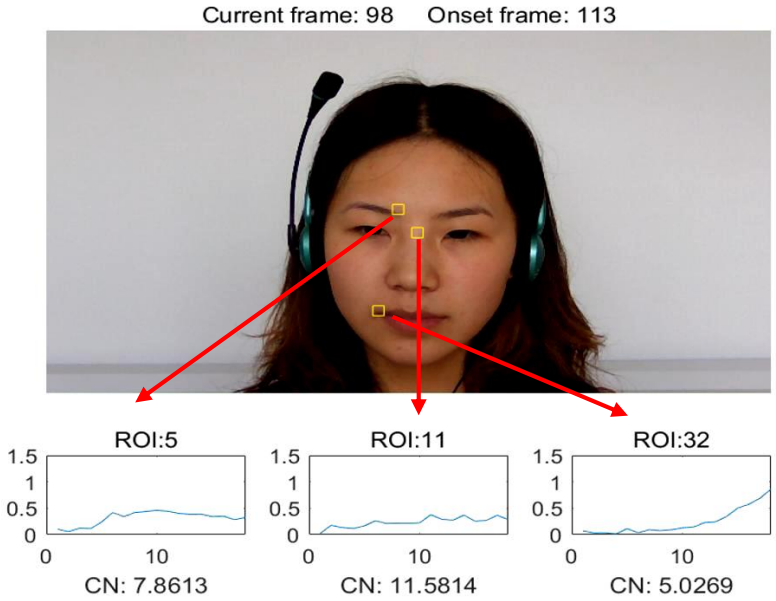
Local Temporal Pattern and Data Augmentation for Micro-Expression Spotting

Why S-pattern can be used for classification?

Same S-pattern for ME for different emotions and different ROIs



Different variations for ME (S-pattern) and non-ME region (Other LTPs)



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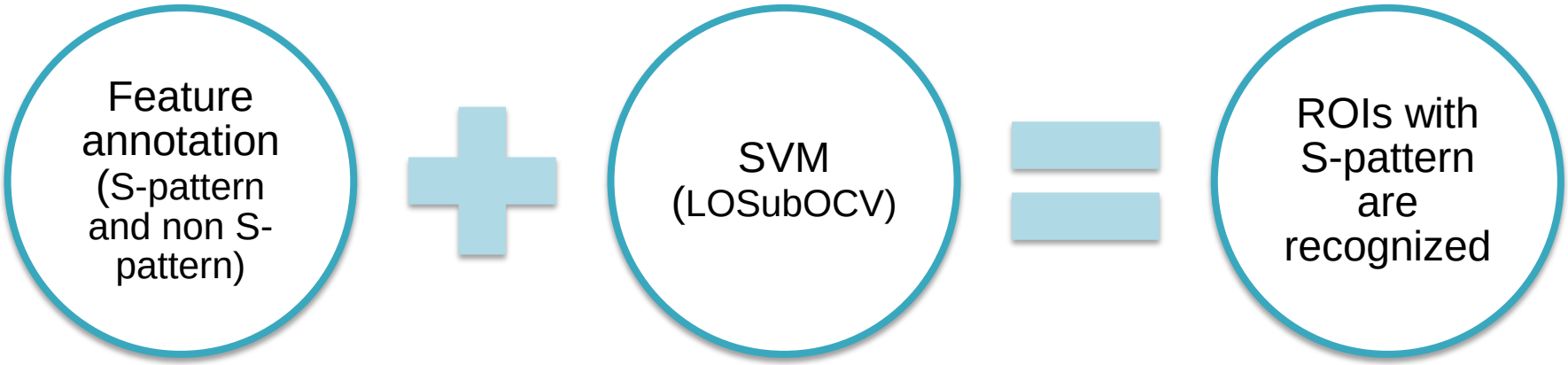

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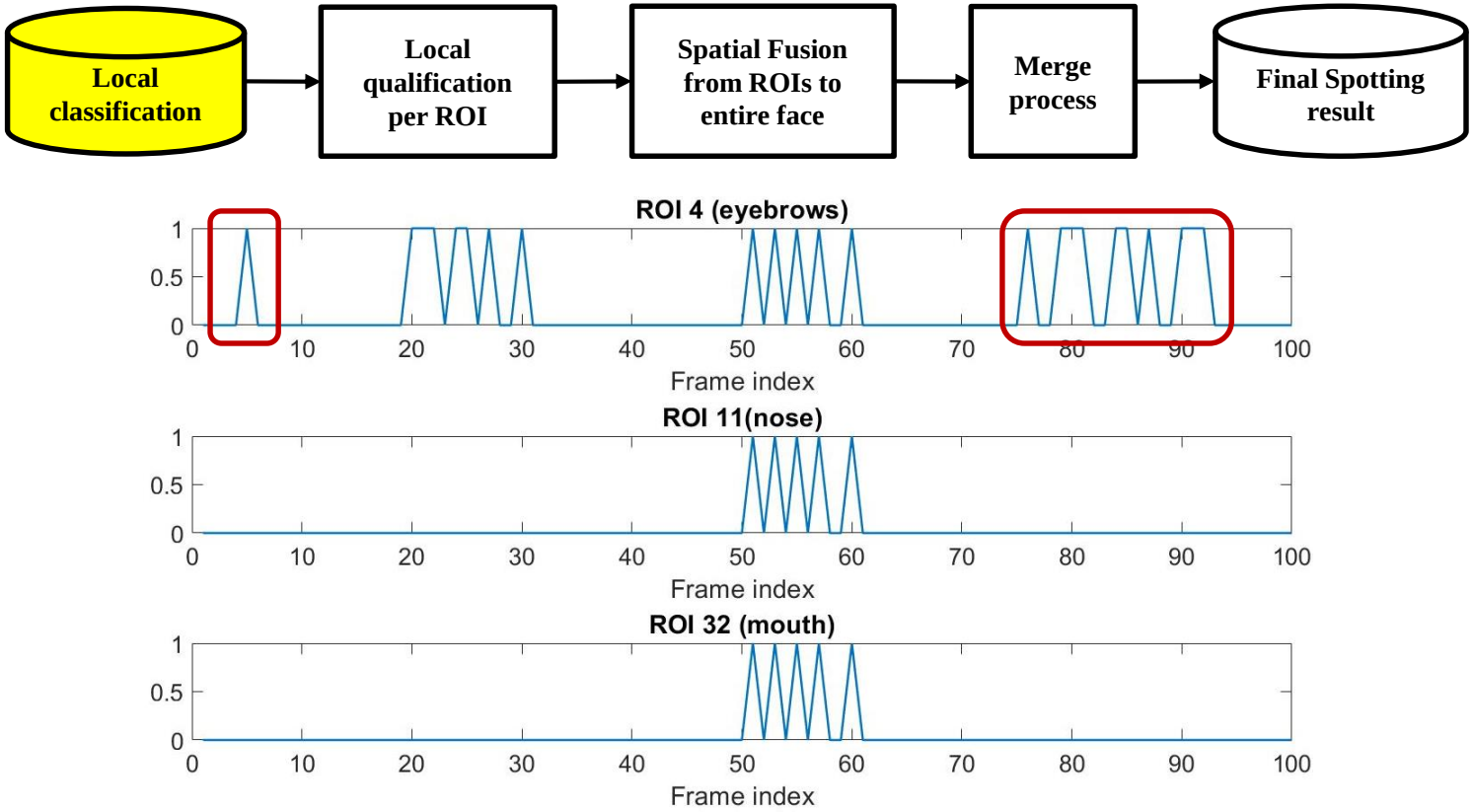
Local Temporal Pattern and Data Augmentation for Micro-Expression Spotting

Late spatial and temporal fusion



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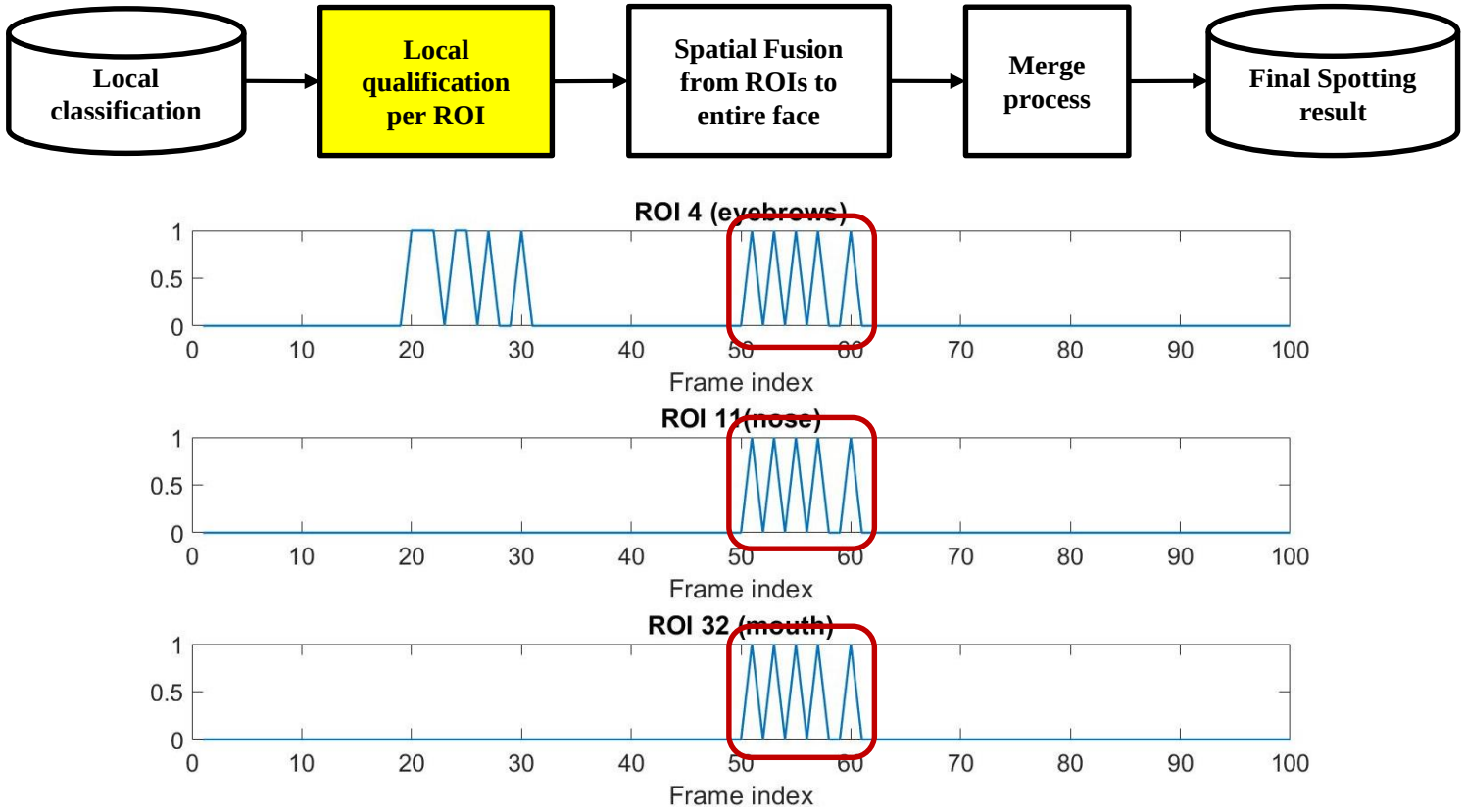

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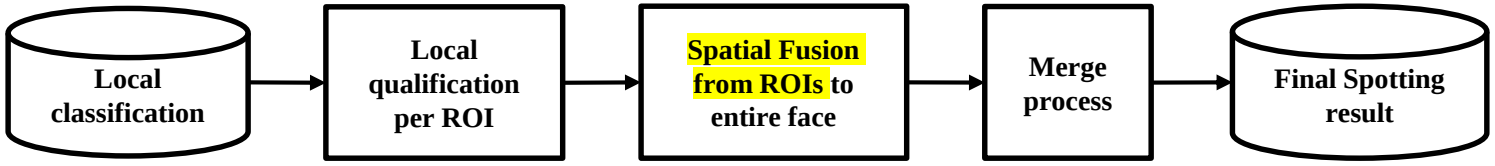

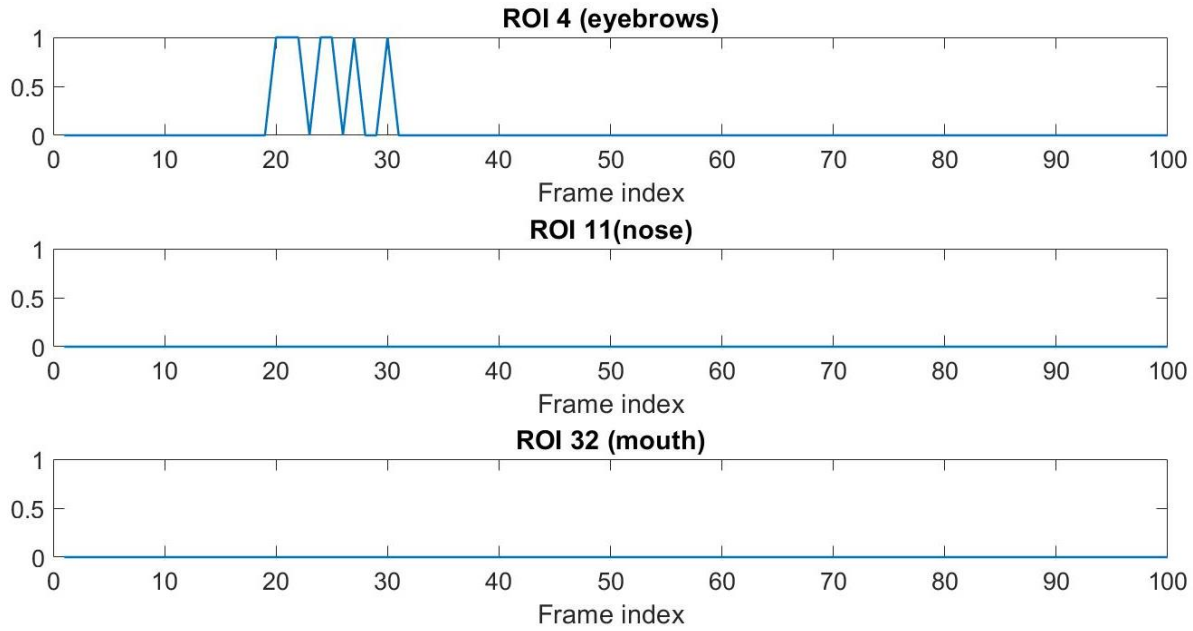

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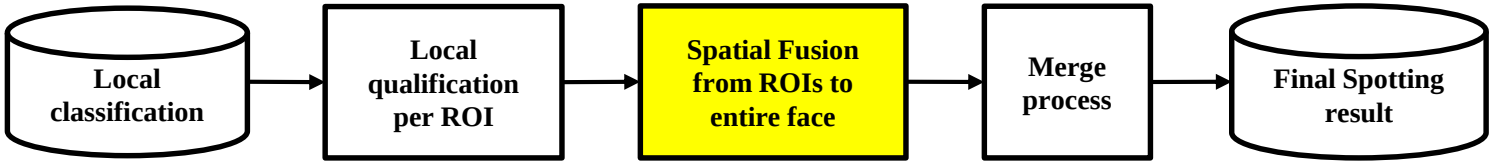

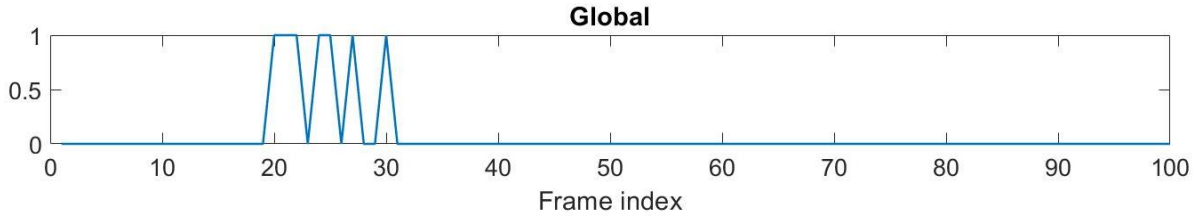

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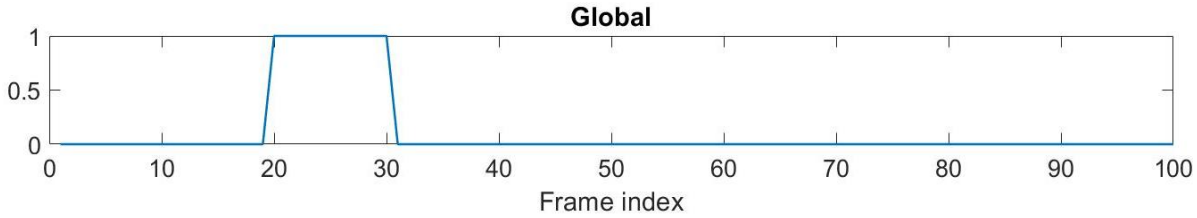

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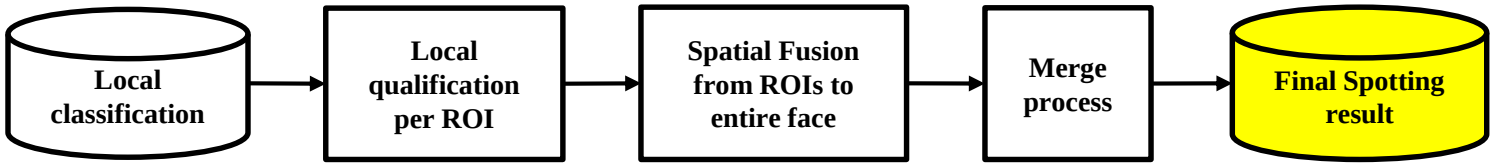

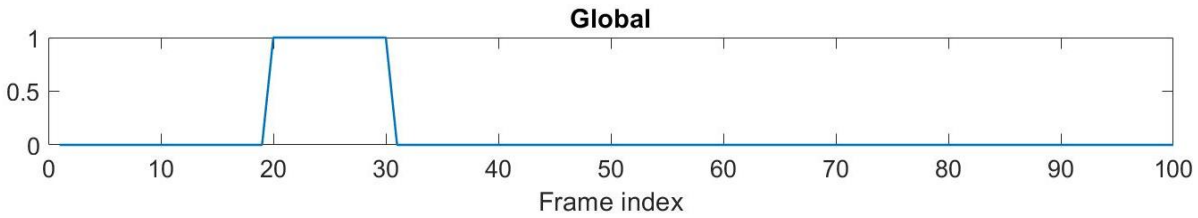

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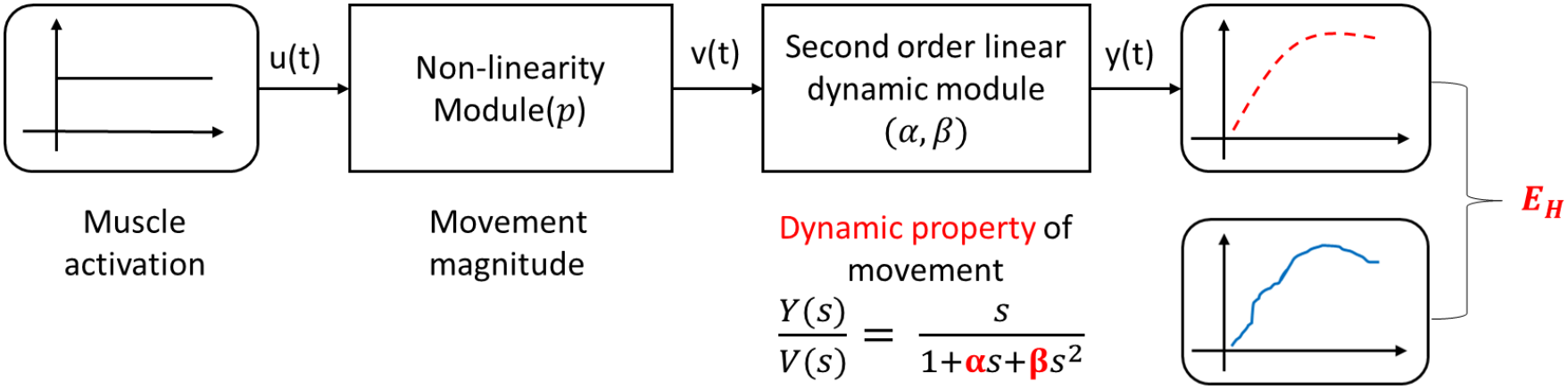
Local Temporal Pattern and Data Augmentation for Micro-Expression Spotting

- **Hammerstein Model**
  - A discrete-Time Model of Electrically Stimulated Muscle.
  - Response to the physique explanation of pattern synthetize.



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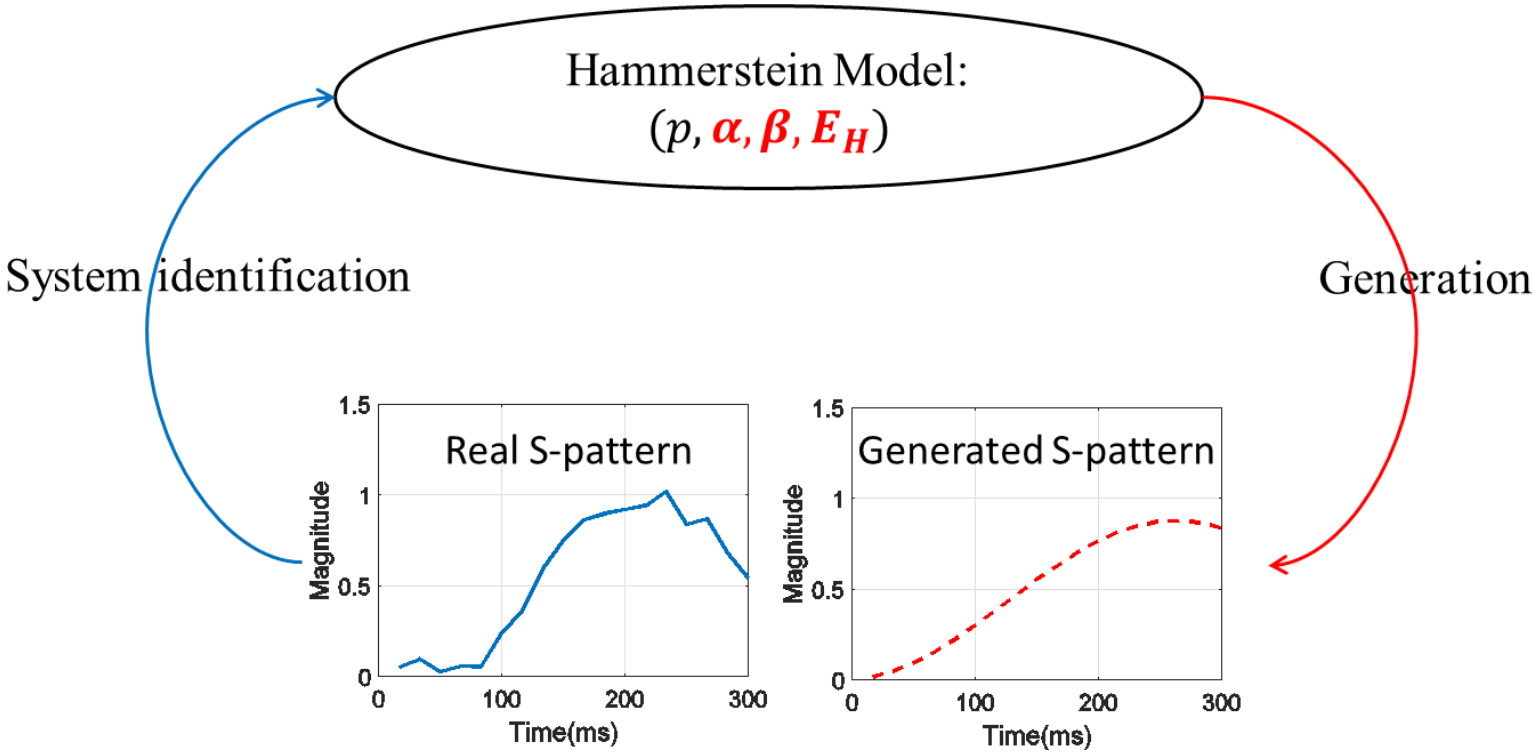
Data Augmentation by Hammerstein Model



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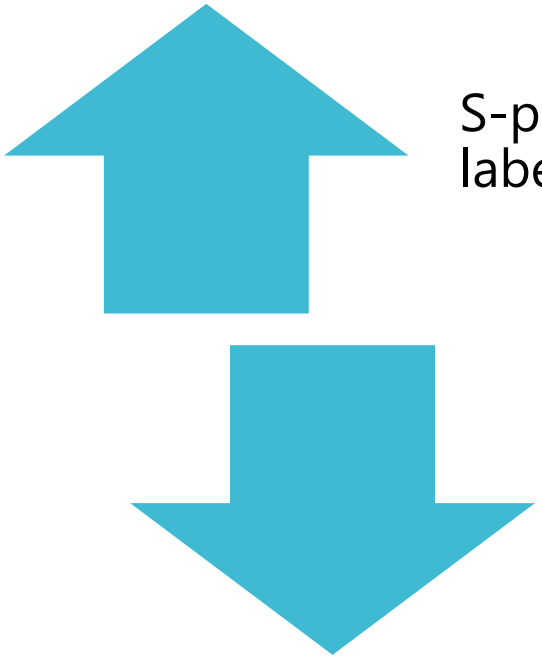
Local Temporal Pattern and Data Augmentation for Micro-Expression Spotting

Configurations for LTP Filtering and S-pattern Synthesis



S-patterns, which are wrongly labeled, can be filtered by $\boldsymbol{E_H}$

The (α, β) distribution allows to define the (α, β) value range for synthesizing reliable S-patterns by Hammerstein model.

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Local Temporal Pattern and Data Augmentation for Micro-Expression Spotting

Data augmentation using Hammerstein model

→ Better classification performance

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- **Result Evaluation Method per Interval**

Result Evaluation Method per Interval

- **MEGC 2019, 2020 spotting task**

What we want:

- Avoid the inaccuracy of annotation
- Less the true negatives

Per interval

True positive in one video:

- $\frac{W_{spotted} \cap W_{groundTruth}}{W_{spotted} \cup W_{groundTruth}} \geq k$
  - where k =0,5

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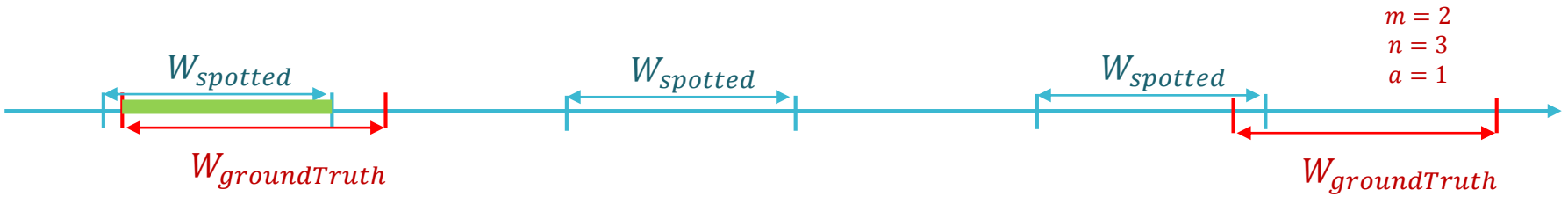
Result Evaluation Method per Interval

- Suppose that in one video
  - # of Ground truth (ME) interval : m
  - # of Spotted interval : n
  - # of TP interval: a



- Evaluation for entire database
  - $recall, TPR = \frac{\sum_{i=1}^{V} a_i}{\sum_{i=1}^{V} m_i} = \frac{A}{M}$, $precison = \frac{\sum_{i=1}^{V} a_i}{\sum_{i=1}^{V} n_i} = \frac{A}{N}$,
  - Imbalanced sample distribution: $F1\text{-}score = \frac{2*(recall*precison)}{recall+precison}$
  - Where a_i is the true positive, m_i and n_i are ME amount and spotted interval in i_{th} video respectively.

Li, Jingting, et al. "Spotting micro-expressions on long videos sequences." 2019 14th IEEE International Conference on Automatic Face & Gesture Recognition (FG 2019). IEEE, 2019.

He, Ying, et al. "Spotting macro-and micro-expression intervals in long video sequences." *2020 15th IEEE international conference on automatic face & gesture recognition (FG 2020)*. IEEE, 2020.

Conclusion

- Main Directional Maximal Difference Analysis
- Spatio-temporal Fusion for Macro- and Micro-expression Spotting in Long Video Sequences
- Local Temporal Pattern and Data Augmentation for Micro-Expression Spotting
- Result Evaluation Method per Interval

Perspectives

Data augmentation for micro-expression spotting

- More micro-expression databases
- Synthesizing ME samples or features

Consistency of metric and comparison

- F1-score and per interval
- Participating into challenges

Micro-expression spotting applications

- Spotting in-the-wild
- Spotting in real time
- Combination with real application
- Fusion of macro- and micro-expression spotting

Thanks for your attention☺

Any questions?

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