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INTRINSIC TWO-DIMENSIONAL LOCAL STRUCTURES FOR MICRO-EXPRESSION RECOGNITION

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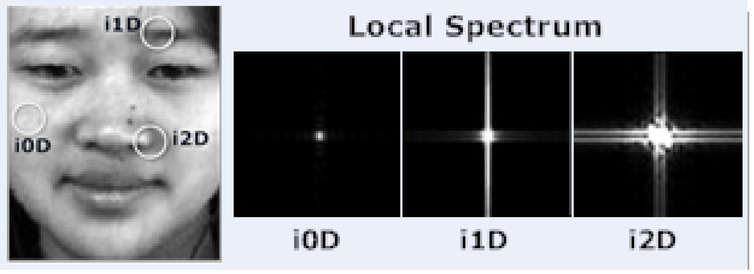
Idea: Complex patterns (i2D) such as corners around the facial components could be effective for emotion recognition.
Implementation: Retrieving and encoding i2D structures as the features for micro-expression recognition.

Intrinsic Dimensions with Spectrums



Monogenic Curvature [1]

The monogenic curvature is built on 2nd and 3rd order Riesz transform and it has two parts:

- The even part, T_{even}

$$T_{even} = \begin{bmatrix} R_{xx} & R_{xy} \\ R_{xy} & R_{yy} \end{bmatrix}$$

- The odd part, T_{odd}

$$T_{odd} = \begin{bmatrix} R_{xxx} + e_{12}R_{xxy} & R_{xyy} - e_{12}R_{xxy} \\ e_{12}R_{xxy} - R_{xyy} & R_{xyy} + e_{12}R_{yyy} \end{bmatrix}$$

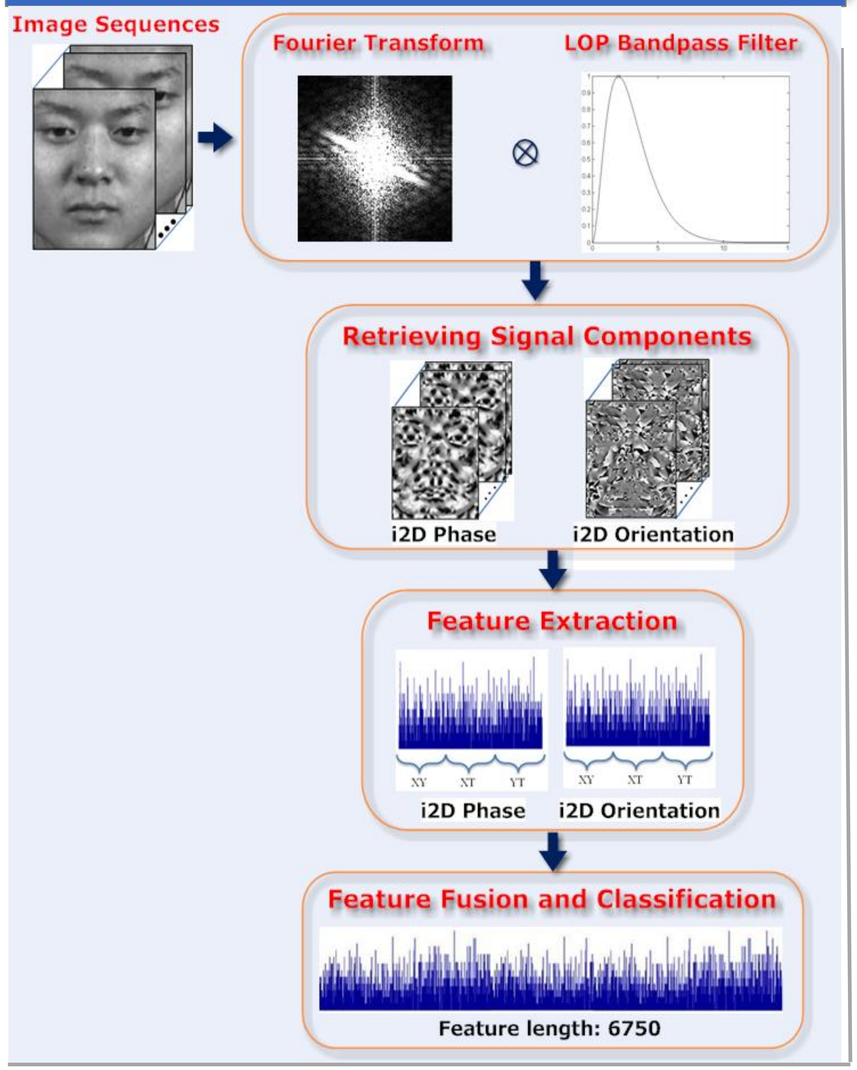
- $T_{odd} = T_{oddx} + e_{12}T_{oddy}$

The signal components such as i2D phase Φ and orientation θ can be retrieved by

$$\phi_{i2D} = atan2\left(\frac{|det(T_{odd})|}{det(T_{even})}\right)$$

$$\theta_{i2D} = atan\left(\frac{det(T_{oddx})}{det(T_{oddy})}\right)$$

Proposed Approach



*Feature Extraction

Feature Extraction involves 2 parts:

- Quantification
- Encoding

Quantification

✓ To quantize orientation and phase angles into few levels for further encoding

✓ The quantification formula that is applied:

phase: $mod([\frac{\phi(x,y)}{\frac{2\pi}{\varphi}}], \varphi)$

orientation: $sign(\theta(x,y))mod([\frac{\theta(x,y)}{\frac{\pi/2}{\vartheta}}], \vartheta)$

Encoding

✓ The encoding method is similar to LBP-TOP, expect discrete levels are used to compare and convert into binary patterns

$$Q = \begin{cases} 0, & q_{x_c,y_c} = q_{x_p,y_p} \\ 1, & q_{x_c,y_c} \neq q_{x_p,y_p} \end{cases} \qquad H = \sum_{p=0}^{P-1} Q2^p$$

Results

Local Structures	CASME II [2] F1	P	R	SMIC [3] F1	P	R
Baseline	0.35	0.36	0.34	0.43	0.43	0.44
i1D	0.32	0.37	0.28	0.34	0.33	0.36
i2D	**0.41**	**0.46**	**0.37**	**0.44**	**0.44**	**0.45**

[1] A. Sedlazeck, "Local feature detection by higher order riesz transforms on images," Ph.D. dissertation, Citeseer, 2008.
[2] W.-J. Yan, S.-J. Wang, G. Zhao, X. Li, Y.-J. Liu, Y.-H. Chen, and X. Fu, "CASME II: An improvoed spontaneous micro-expression database and the baseline evaluation," PLoS ONE, vol. 9, p. e86041, 2014.
[3] X. Li, T. Pfister, X. Huang, G. Zhao, and M. Pietikainen, "A spontaneous micro-expression database: Inducement, collection and baseline," in Automatic Face and Gesture Recognition (FG), IEEE, pp. 1-6, 2013.