

RBF

(FFP⁽¹⁾)

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Feature-Based Facial Expression Recognition from Image Sequences Using RBF Neural Networks and Fuzzy Inference System

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Abstract

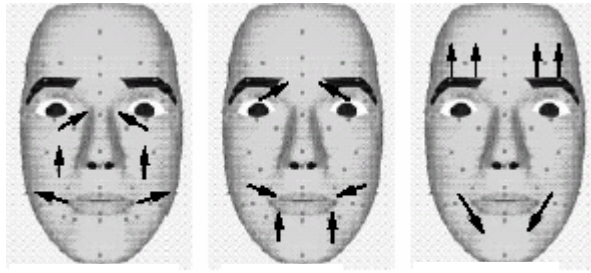
In this Paper a facial expression recognition system based on facial characteristic points and facial features extracted from them in frontal image sequences is presented. In the first digitized frame, 21 key feature points were manually marked with a computer-mouse around facial landmarks. Selected facial feature points were automatically tracked using a cross-correlation based optical flow. At first a Radial Basis Function (RBF) neural network were used to classify four facial expressions using feature vector extracted from position of Facial Feature Points (FFP) in the first and the last frame. Then 7 features were extracted from FFP's movement and were used to classify six basic facial emotions using RBF neural networks and Fuzzy Inference System (FIS). The recognition results from proposed classifiers showed that comparing with static image classifier, using image sequences gives higher recognition rate. Comparing RBF neural networks and FIS classifier systems shows that RBF classifier acts better than FIS classifier and gives higher recognition rate but it takes more processing time and for the real time implementation FIS classifier is preferred .

Key words: Facial expressions recognition, Facial feature points, RBF neural networks, Fuzzy inference system.

1-Facial Feature Points

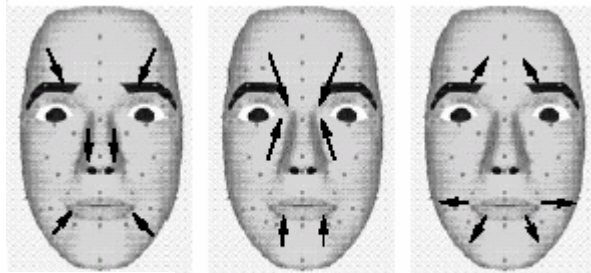
2- Optical Flow

3-Radial Basis Function



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Tsapatsoulis Piat
FFP FFP Hara Kobayashi
% %
[] CFS⁽¹⁾ Ushida
FIS % %) FFP
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RBF % /
[] Nakamura Ebine
RBF % /
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RBF
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AU
RBF
(FFP)
FFP ()

$$x_{org} = x_0 - BASE \times \sin\theta$$

$$y_{org} = y_0 - BASE \times \cos\theta \quad ()$$

(x_b, y_b)

FFP

BASE

: []

$$x_a = x_b - x_{org}$$

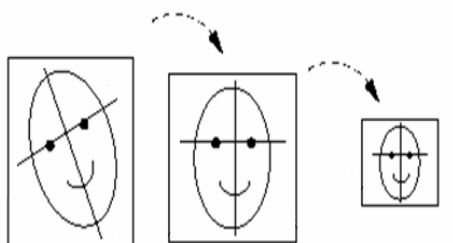
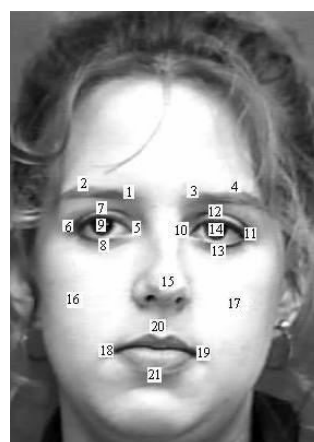
$$y_a = y_b - y_{org} \quad ()$$

$$BASE = \sqrt{(x_5 - x_{10})^2 + (y_5 - y_{10})^2} \quad ()$$

BASE

$$x'_a = x_a / BASE \quad ()$$

$$y'_a = y_a / BASE \quad ()$$



BASE

$$\theta = \text{Arc tan} \left(\frac{y_5 - y_{10}}{x_5 - x_{10}} \right) \quad ()$$

FFP

(x_{org}, y_{org})

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FFP

BASE

(x_0, y_0)

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$$x_0 = \frac{x_5 + x_{10}}{2}$$

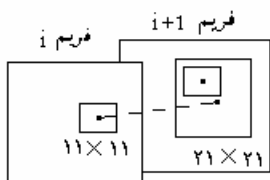
$$y_0 = \frac{y_5 + y_{10}}{2} \quad ()$$

Cohn-Kanade

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: (x_{org}, y_{org})

pixel/frame



Cohn-Kanade

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%	-
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×	(Grayscale)

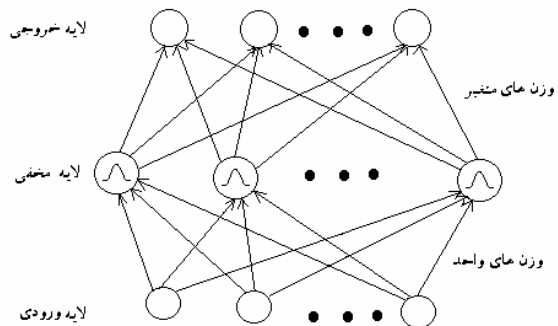


Cohn-Kanade

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RBF



RBF

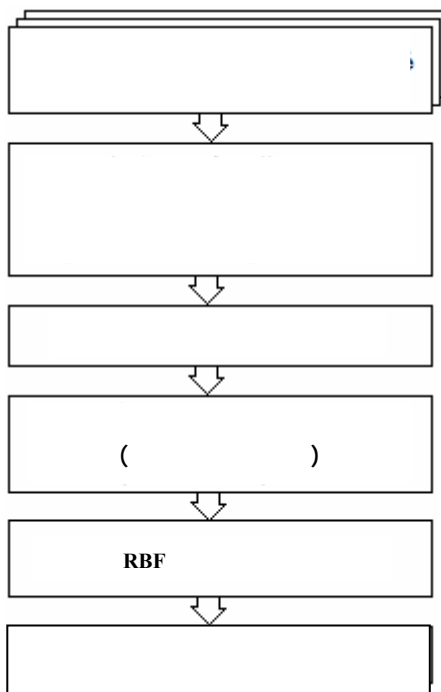
Radial Basis

N

Radial Basis

RBF

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$$RBF(c_i) = \exp(-(\|c_i - p\| b)^2) \quad ()$$

$\| \cdot \|$ b p RBF c_i

Moody Darken RBF ()

p RBF

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RBF

p

Radial Basis

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$$b = \frac{0.8326}{\sigma} \quad ()$$

RBF

$\pm\sigma$ RBF

RBF

$\frac{1}{2}$

RBF

σ $\sigma = 1$

σ

RBF

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Cohn-Kanade

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$$we = \frac{(x_{11} - x_{10}) + (x_5 - x_6)}{2}$$

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Pentium IV 2.4

Matlab 6.5

MB RAM

$$he1 = \frac{(y_{15} - y_4) + (y_{15} - y_2)}{2}$$

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$$he2 = \frac{(y_{15} - y_3) + (y_{15} - y_1)}{2}$$

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$$wm = x_{19} - x_{18}$$

()

RBF

-

				(%)

: () $om = y_{21} - y_{20}$ ()

[] $nl = \frac{(y_{18} - y_{15}) + (y_{19} - y_{15})}{2}$ ()

$ec = \frac{(y_{16} - y_9) + (y_{17} - y_{14})}{2}$ ()

(FIS)

(x_i, y_i)

FIS ()

() **RBF** - -
RBF

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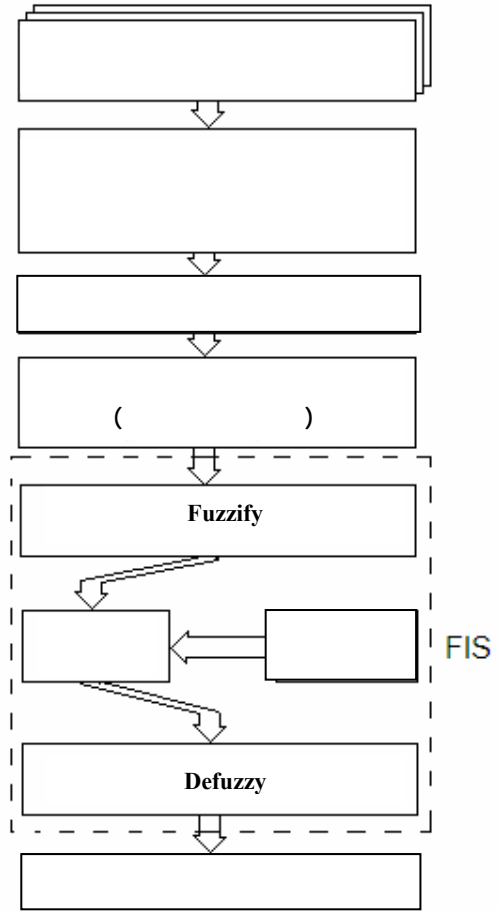
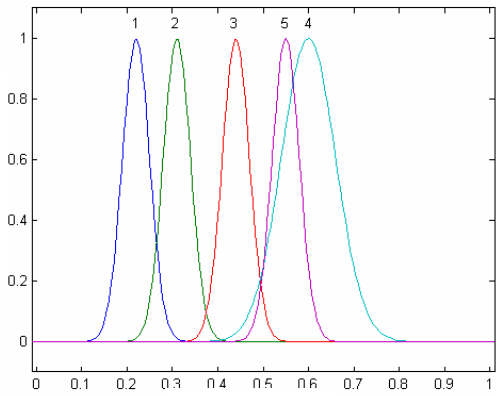
RBF

						(%)
/				/	/	
			/		/	
	/	/				
	/		/		/	
/			/			

VS: very small, **S:** small, **M:** medium
L: large, **VL:** very large

WE	HE1	HE2	WM	OM	NL	EC	
M	M	M	VL	S	S	S	
VL	VL	L	M	VL	VL	L	
S	M	L	M	VS	M	M	
M	M	S	S	S	M	S	
M	VS	S	M	S	S	S	
L	L	L	S	M	M	M	

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AND

						(%)
				/	/	
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(MVIP 2003)

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(ICEE2004)

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RBF

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FIS

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