Chapter-5

NEW METHOD FOR CLASSIFICATION OF AGE GROUPS BASED ON TEXTURE SHAPE FEATURES

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5.1 BRIEF OUTLINE OF THE CHAPTER

The Previous chapter derived GLCM features on FIDRSP and focused on statistical, structural and shape primitive properties for face recognition. The present chapter extends this concept, by deriving Texture Shape Features (TSF) on the proposed FIDRSP model and found that these features drastically affect the age classification system of humans. The present chapter developed an innovative technique that classifies human age into five different groups i.e 0 to 12, 13 to 25, 26 to 45, 46 to 60 and above 60 based on the TSF's on the facial skin. To distinguish these age groups the present study assumes that bone structural changes do not occur after the person is fully grown i.e. the geometric relationships of primary features do not vary. Hence, secondary features need to be identified and explored. The secondary features that are exploited in the present study are TSF on the proposed FIDRSP model of the facial skin. The other major advantage of the proposed method of this chapter is, it evaluated TSF on only two parts of the facial skin namely chin and forehead instead of entire face. Most of the previous algorithms on age classification considered entire facial image which is a complex task. The present research observed the fact

that the facial skin of a person tends to more changes with growing age. These rapid topological changes in the skin are exploited by TSF's. The TSF's are derived from the patterns formed by Bezier curve (BC), and U, V and T patterns on the facial skin. The patterns are measured on a 5×5 mask, because most of the curve and complex shape primitives properties do not fit into 3×3 mask.

5.2 AGE CLASSIFICATION BASED ON TEXTURE SHAPE FEATURES (TSF) ON FIDRSP OF FACIAL SKIN

Recently Vijaya Kumar V, Chandra Mohan et al. developed a new direction for the child and adulthood classification using facial feature parameters derived from geometric properties of human face. The feature parameters of the these approach are computed from facial distance features [9, 10].The adulthood classification methods [9,10] can be effectively used for persons with folded eye, blind, wearing spectacles, and face images with closed eyes. Further they developed an innovative age classification technique that classifies adult images further with age spans for every ten years based on the topological texture features (TTF) in the facial skin [12]. The present thesis extended the above methodology on the proposed FIDRSP model and found that the classification rate is much better by reducing overall complexity, dimensionality and gray level range without any loss of significant texture features. The present study based on TSF's on FIDRSP model of facial skin attempted the tedious and complex task of classification of

age into five group's i.e. 0 to 12, 13 to 25, 26 to 45, 46 to 60 and above 60 as young boys, young adults, middle aged adults, old aged adults and senior citizens respectively.

The present chapter initially converts each facial image into compressed model with grey levels ranging from 0 to 4 by the "Fuzzy based Image Dimensionality Reduction using shape Primitives (FIDRSP) model" of previous chapter, and classifies the age into five different groups by using TSF's.

The Bezier curves with twelve different control points are estimated by the proposed FIDRSP model on each 5x5 mask as shown in Fig.5.1. The TSF i.e. U, V and T patterns on a 5x5 mask are shown in Fig.5.2. The entire process of age classification on FIDRSP model using TSF is given in Algorithm 5.1.

1	1	0	0	0
0	1	0	0	0
0	1	1	0	0
0	0	1	1	0
0	0	0	0	1
CP (1, 2),(2,1)				

1	1	0	0	0
0	1	0	0	0
0	1	1	0	0
0	0	1	1	0
0	0	0	1	1
CP (1,3), (3,1)				

1	1	0	0	0
0	1	1	0	0
0	0	1	0	0
0	0	1	1	0
0	0	0	1	1
CP (1,4), (4,1)				

1	1	1	0	0
0	0	1	0	0
0	0	1	0	0
0	0	1	0	0
0	0	1	1	1
CP (1,5),(5,1)				

1	0	0	0	0
1	1	1	0	0
0	0	1	0	0
0	0	1	1	0
0	0	0	1	1
CP (2,1), (1,2)				

1	0	0	0	0
0	1	0	0	0
0	0	1	0	0
0	0	0	1	0
0	0	0	0	1
CP (1,1), (1,1)				

1	0	0	0	0
1	1	1	0	0
0	0	1	1	0
0	0	0	1	1
0	0	0	0	1
CP (3,1), (1,3)				

1	0	0	0	0
1	1	0	0	0
0	1	1	1	0
0	0	0	1	1
0	0	0	0	1
CP (3,2),(2,3)				

1	1	0	0	0
0	1	1	0	0
0	0	1	1	0
0	0	0	1	0
0	0	0	1	1
CP (3,5), (5,3)				

1	0	0	0	0
0	1	1	0	0
0	0	1	1	0
0	0	0	1	0
0	0	0	1	1
CP (4,5), (5,4)				

1	0	0	0	0
1	0	0	0	0
1	1	1	1	1
0	0	0	0	1
0	0	0	0	1
CP (5,1), (1,5)				

1	0	0	0	0
1	1	0	0	0
0	1	1	0	0
0	0	1	1	1
0	0	0	0	1
CP (5,3),(3,5)				

Fig.5.1: The TSF's of Bezier curves on a 5x5 mask with different control points.

1	0	0	0	1
1	0	0	0	1
1	0	0	0	1
1	0	0	0	1
1	1	1	1	1
(a)				

1	0	0	0	1
1	0	0	0	1
1	0	0	0	1
0	1	0	1	0
0	0	1	0	0
(b)				

1	1	1	1	1
0	0	1	0	0
0	0	1	0	0
0	0	1	0	0
0	0	1	0	0
(c)				

Fig.5.2: The TSF's on a 5×5 mask (a) U-pattern (b) V-pattern (c) T-pattern.

Algorithm 5.1: Computation of Frequency of occurrences of TSF's on the proposed FIDRSP model of a Facial Image.

Begin

Step 1: Input Facial image.

Step 2: Consider the forehead and chin parts of the input facial image and with a size of 130×35 and 100 x 25 respectively.

Step 3: Convert the RGB facial parts into Grey scale Image by using HSV Color model.

Step 4: Generate the Local Grey level magnitude matrix (LMM) of each 3×3 window of two parts of the facial image.

Step 5: Reduce the LMM of a 3×3 neighbourhood into a 2×2 neighbourhood by using Horizontal and Vertical Line Shape Primitives (HVLSP).

Step 6: Apply Fuzzy principles to convert each 2×2 window with fuzzy values ranging from 0, 1, 2, 3 and 4.

Step 7: Find the frequency occurrences on each fuzzy grey level separately for the fore head and chin separately using TSF's - Bezier curves U pattern, V pattern and T pattern.

Step 8: Based on the frequency occurrences of above TSF's on the FIDRSP model on chin and forehead area of the facial image the image is classified as child(0-12), young adults(13-25), middle-aged adults(26-45), and old adults(46-60) and senior adults(above 60).

End

5.3 EXPERIMENTAL RESULTS

These TSF's are most prominently visible on forehead, and chin parts. For this, the proposed method divides face into two parts, forehead, and chin with a cropped size of 130×35 and 100 x 25 respectively. The proposed scheme established a database from the 1002 face images collected from FG-NET database and 500 face images collected from Google database. This leads a total of 1502 sample facial images. Sample images of each group images are shown in Fig.1.4. The proposed scheme is given in Algorithm 5.1.

The FIDRSP model reduces the grey level range from 0 to 4. The novelty of the proposed method is it counts the frequency occurrences of all the above mentioned patterns using fuzzy grey levels 0, 1, 2, 3, and 4 separately. That is B0, B1, B2, B3 and B4 deals the frequency occurrence of Bezier curve with different control points as shown in Fig.5.1 with fuzzy grey level value 0, 1, 2, 3 and 4 respectively. The same notation is used for all other patterns. This gives an idea about in which fuzzy grey level value the considered patterns are dominating. Tables 5.1 and 5.2 represents the frequency occurrences of TSF of Bezier, U patterns and V, T patterns of chin area of FG-NET ageing database. The Tables 5.3 and 5.4 represents the same patterns on forehead.

Table 5.1: Frequency occurrences of TSF of Bezier and U patterns on chin area of FG-NET ageing database based on FIDRSP model (chin area size 100×25).

S.No.	Image Name	B0	B1	B2	B3	B4	U0	U1	U2	U3	U4
1	001A02	0	0	7	0	0	0	0	1	0	0
2	001A08	0	0	12	0	0	0	0	3	0	0
3	002A12	0	0	4	0	0	0	0	1	0	0
4	008A13	0	0	1	0	0	0	0	0	0	0
5	002A16	0	0	9	0	0	0	0	2	0	0
6	002A23	0	0	16	0	0	0	0	0	0	0
7	001A28	0	0	15	0	0	0	0	0	0	0
8	001A40	0	0	10	0	0	0	0	0	0	0

9	005A45	0	0	12	0	0	0	0	0	0	0
10	004A48	0	0	14	0	0	0	0	0	0	0
11	004A53	0	0	9	0	0	0	0	0	0	0
12	006A59	0	0	7	0	0	0	0	0	0	0
13	006A61	0	0	6	0	0	0	0	0	0	0
14	006A67	0	0	2	0	0	0	0	3	0	0
15	006A69	0	0	0	0	0	0	0	0	0	0

Table 5.2: Frequency occurrences of TSF of V and T patterns on chin area of FG-NET ageing database based on FIDRSP model (chin area size 100×25).

S.NO	Image Name	V0	V1	V2	V3	V4	T0	T1	T2	T3	T4
1	001A02	0	0	0	0	0	0	0	1	0	0
2	001A08	0	0	3	0	0	0	0	3	0	0
3	002A12	0	0	1	0	0	0	0	2	0	0
4	008A13	0	0	0	0	0	0	0	1	0	0
5	002A16	0	0	2	0	0	0	0	0	0	0
6	002A23	0	0	0	0	0	0	0	0	0	0
7	001A28	0	0	1	0	0	0	0	1	0	0
8	001A40	0	0	1	0	0	0	0	0	0	0
9	005A45	0	0	2	0	0	0	0	2	0	0
10	004A48	0	0	2	0	0	0	0	1	0	0

11	004A53	0	0	0	0	0	0	0	1	0	0
12	006A59	0	0	1	0	0	0	0	1	0	0
13	006A61	0	0	1	0	0	0	0	0	0	0
14	006A67	0	0	2	0	0	0	0	1	0	0
15	006A69	0	0	0	0	0	0	0	1	0	0

Table 5.3: Frequency occurrences of TSF of Bezier and U patterns on forehead area of FG-NET ageing database based on FIDRSP model (forehead area size 130x35).

S.No.	Image Name	B0	B1	B2	B3	B4	U0	U1	U2	U3	U4
1	001A02	0	0	98	0	0	0	0	11	0	0
2	001A08	0	0	89	0	0	0	0	9	0	0
3	002A12	0	0	99	0	0	0	0	7	0	0
4	008A13	0	0	84	0	0	0	0	18	0	0
5	002A16	0	0	90	0	0	0	0	6	0	0
6	002A23	0	0	85	0	0	0	0	7	0	0
7	001A28	0	0	64	0	0	0	0	5	0	0
8	001A40	0	0	44	0	0	0	0	4	0	0
9	005A45	0	0	43	0	0	0	0	1	0	0
10	004A48	0	0	28	0	0	0	0	1	0	0
11	004A53	0	0	38	0	0	0	0	1	0	0
12	006A59	0	0	31	0	0	0	0	4	0	0

13	006A61	0	0	13	0	0	0	0	2	0	0
14	006A67	0	0	14	0	0	0	0	0	0	0
15	006A69	0	0	17	0	0	0	0	0	0	0

Table 5.4: Frequency occurrences of TSF of V and T patterns on forehead area of FG-NET ageing database based on FIDRSP model (forehead area size 130x35).

S.No.	Image Name	V0	V1	V2	V3	V4	T0	T1	T2	T3	T4
1	001A02	0	0	12	0	0	0	0	11	0	0
2	001A08	0	0	7	0	0	0	0	9	0	0
3	002A12	0	0	6	0	0	0	0	5	0	0
4	008A13	0	0	0	0	0	0	0	0	0	0
5	002A16	0	0	0	0	0	0	0	5	0	0
6	002A23	0	0	4	0	0	0	0	4	0	0
7	001A28	0	0	8	0	0	0	0	4	0	0
8	001A40	0	0	9	0	0	0	0	6	0	0
9	005A45	0	0	4	0	0	0	0	3	0	0
10	004A48	0	0	1	0	0	0	0	2	0	0
11	004A53	0	0	1	0	0	0	0	1	0	0
12	006A59	0	0	1	0	0	0	0	2	0	0
13	006A61	0	0	2	0	0	0	0	1	0	0
14	006A67	0	0	2	0	0	0	0	0	0	0
15	006A69	0	0	3	0	0	0	0	0	0	0

From the Tables 5.1, 5.2, 5.3 and 5.4 it is observed that fuzzy grey level value 2 only formed TSF on the proposed FIDRSP model. Therefore for classification purpose only the TSF with fuzzy value 2 is considered. The present work counted sum of all frequencies of TSF's (STSF) on FIDRSP with fuzzy value 2 only on both forehead and chin and listed in Table 5.5. The present work classified the age groups into five categories based on algorithm.5.2 derived from Table 5.5.

Table 5.5: Sum of Frequency occurrences of TSF on chin and forehead area in FG-NET ageing database.

S.NO	Image Name	CHIN				FOREHEAD				CHIN + FOREHEAD
		B2	U2	V2	T2	B2	U2	V2	T2	
1	001A02	7	1	0	1	98	11	12	11	141
2	001A08	12	3	3	3	89	9	7	9	135
3	002A12	4	1	1	2	99	7	6	5	125
4	008A03	6	1	3	3	93	10	7	6	129
5	001A05	8	2	2	2	87	7	8	7	123
6	002A12	11	2	1	1	91	6	7	7	126
7	002A07	9	1	1	1	96	6	6	5	125
8	002A05	10	3	0	1	101	5	6	4	130
9	008A06	8	1	2	2	105	8	6	9	141
10	001A10	6	1	1	3	95	7	5	10	128
11	008A13	1	0	0	1	84	18	0	0	104
12	002A16	9	2	2	0	90	6	0	5	114
13	002A23	16	0	0	0	85	7	4	4	116
14	001A19	11	0	1	0	82	12	3	0	109
15	001A22	14	2	0	1	83	5	3	2	110
16	002A15	8	0	1	0	89	9	3	4	114
17	001A14	11	2	2	0	78	7	5	7	112
18	002A16	7	2	0	1	84	8	3	6	111
19	001A18	12	1	1	1	82	14	2	3	116
20	002A20	10	2	2	0	75	7	4	5	105
21	001A28	15	0	1	1	64	5	8	4	98
22	001A40	10	0	1	0	44	4	9	6	74

23	005A45	12	0	2	2	43	1	4	3	67
24	002A26	11	0	2	1	49	3	4	2	72
25	002A31	13	0	1	2	55	3	2	1	77
26	002A29	14	1	1	2	46	2	3	4	73
27	002A36	12	0	2	1	53	4	5	2	79
28	002A38	15	0	1	2	47	3	2	3	73
29	003A35	16	0	2	1	41	1	2	4	67
30	003A38	12	0	2	0	61	5	3	1	84
31	004A48	14	0	2	1	28	1	1	2	49
32	004A53	9	0	0	1	38	1	1	1	51
33	006A59	7	0	1	1	31	4	1	2	47
34	003A47	8	1	1	1	29	1	1	2	44
35	003A49	10	1	0	1	30	2	0	1	45
36	003A51	12	0	2	1	32	3	1	2	53
37	003A58	13	0	2	0	29	2	0	1	47
38	003A60	12	0	0	1	32	2	1	2	50
39	004A51	11	0	0	1	33	3	0	2	50
40	006A46	9	0	1	1	33	2	1	2	49
41	006A61	6	0	1	0	13	2	2	1	25
42	006A67	2	3	2	1	14	0	2	0	24
43	006A69	0	0	0	1	17	0	3	0	21
44	004A62	0	0	1	0	15	1	1	2	20
45	004A63	1	1	3	1	18	1	3	1	29
46	005A61	3	2	0	0	16	0	3	0	24
47	004A69	5	0	2	1	19	0	1	0	28
48	005A63	2	2	0	0	12	4	2	1	23
49	004A65	3	1	1	1	13	1	0	1	21
50	004A66	5	0	2	1	13	1	2	1	25

The classification algorithm to classify the facial image is given in Algorithm 5.2.

Algorithm 5.2: Age Group Classification using Frequency Occurrences of TSF on FIDRSP model of Forehead and Chin parts of the Facial image.

Begin

Let STSF denotes the sum of the frequency occurrences TSF on both chin and forehead parts of the facial image.

```
if (STSF < 25 ) then
                print “facial image age is senior adults ( > 60)”
    else if (STSF < 60 ) then
                print “facial image age is old adults(46-60)”
    else if (STSF < 100 ) then
                print “facial image age is middle-aged adults(26-45)”
    else if (STSF < 120 ) then
                print “facial image age is young adults ( 13-25)”
    else
                print “facial image age is child(0-12)”
end
```

Table 5.6: Comparison of the proposed TSF on FIDRSP model with other methods.

S.No	Authors	Name of the Method	% of Classification Rate	Type of Age Classification
1	TSF on FIDRSP	Classification Of Age Groups Based On Texture Shape Features	96	0-12 13-26 26-45 46-60 60 above
2	Chandra sekhar et al.[24]	Shape features on IT-LBP(previous method)	95	Child and Adulthood
3	Chandra Mohan et al,[10]	Novel Method for Child and Adulthood Classification Using Linear Wavelet Transforms	95.32	Child and Adulthood
4	Chandra Mohan et al,[9]	Age Classification of Adults Based on Topological Texture Features	92.33	16-25, 26-35, 36-45, 46-55, 56-65, 66-75 and 76-85
5	Chandra Mohan et al,[12]	Novel Method of Adult Age Classification Using(2-level) Linear Wavelet Transforms	93.8	16-25, 26-35, 36-45, 46-55, 56-65, 66-75 and 76-85
6	Young H. K won et al,[41]	Age Classification from Facial Images	78	Babies, adults, and Senior adults.

7	Tsuneo KANNO et al,[81]	Classification of Age Group Based on Facial Images of Young Males by Using Neural Networks	80	Only young males are age groups considered for classifications are 12,15,18 and 22 years
8	Wen-Bing Horng Cheng-et al,[85]	Classification of Age Groups Based on Facial Features	90.52	Classified age groups are babies, young adults, middle-aged adults, and old adults

Table 5.6 gives the comparison of the proposed method with various other existing methods. The results clearly indicate the efficiency of the proposed method.

SUMMARY

Most of the existing age classification algorithms in the literature classified age into either 2 or 3 groups and also they estimated this by experimenting on entire facial image. The other important feature of the present method is out of these TSF's Bezier curve estimates, the rapid topological changes in the skin at a higher rate, which is the reason an exhaustive number of Bezier curves with twelve different control points are estimated on each 5 x 5 mask by proposed method. The Fuzzy logic on FIDRSP model derived five fuzzy grey levels. The experimental setup clearly indicates that shape features are detected only with fuzzy grey

level value 2 i.e. the pixel values equal to average of the considered 3x3 neighborhood. This clearly indicates the proposed method works well without fuzzy logic. The major advantage of the proposed model is, it classified the human age into five age groups by experimenting on only forehead and chin parts of the facial image. The above facts greatly reduce most of the burden. The proposed FIDRSP model is easy to implement and accurate when compares to the existing age classification methods which is evident from Table 5.6.