AGE CLASSIFICATION BASED ON SIMPLE LBP TRANSITIONS

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***Abstract*- The research related to age estimation using face images has become increasingly important, due to the fact that it has a variety of potentially useful applications. An age estimation system is generally composed of aging feature extraction and feature classification; both of which are important in order to improve the performance. The present paper derived "Transition based Fuzzy LBP" (TFLBP) method for the classification of facial image into five age groups as child (0-12), young adults (13-25), middle-aged adults (26-45), senior adults (46-60) and Senior citizens (> 60) .The proposed TFLBP used the concept of Fuzzy texture unit on LBP and derived two different LBP unit values with four pixels. The first one is from four-connected pixels of cross diagonal representation of Fuzzy LBP (FLBP) and the second one is from four-non connected corner pixels of FLBP. On this distinct FLBP the transitions are counted and age classification is derived from this. Age classification performance is compared with the various fuzzy based texture classification methods. The results demonstrate that superior performance is achieved by the proposed method.**

Key Words: Corner Pixels, Diagonal Pixels, Transitions, connected, non-connected

1. INTRODUCTION

Human facial image processing has been an active and interesting research issue for years. Since human faces provide a lot of information, many topics have drawn lots of attentions and thus have been studied intensively**.** Less research work has been reported on the aspects of age information in images of human faces. However, it is appropriate to review research on facial image analysis. Nagamine, Uemerra, and Masuda [2 have developed methods to match features in range images of faces. In an attempt at recognizing facial expressions, Matsuno, Lee, and Tsuji [1] use potential nets, which undergo structural deformations at features such as the eyebrows, nose, and mouth. As another embodiment of this approach, O'Toole, Abdi, Deffenbacher, and Bartlett [3] used auto associative memory techniques, and this proved useful in classifying faces by gender and race in recognition. The works in this area involve methods based on age prototypes [9], statistical models [7, 4], support vector machines (SVM) and distance-based techniques [6]. They can work on usual two-dimensional face images or 3D scans of faces [8, 10]. Moreover, age estimation methods can also be used as the basis for age-progression algorithms [5].

The Paper is organized as follows. The 2 and 3 unit represents the methodology and result and discussion. The fourth unit gives overall conclusions.

2. PROPOSED TRANSITION BASED FUZZY LBP (TFLBP)

In order to overcome the shortcomings of Uniform and Non-uniform transitions on LBP, the present paper considered a u value of 2 and 4 for "Non-connected corners of FLBP" (NCFLBP) and "Cross Diagonal of FLBP" (CDFLBP) that is exactly 2 and 4, 0/1 or 1/0 transitions in the bitwise representation. That is the present paper derived transitions on LBP by eliminating 0 transitions of uniform patterns and by only considering 4-transitions of non uniform patterns.

The LBP gives the texture information using eight neighbouring pixels around the central pixel. The level of this information depends on ordering of the neighbouring pixels. Further, a little work is reported [11, 12, 13] in literature to produce strong texture information of an image by separating the neighbouring pixels into groups and form a relationship between them. In the cross diagonal approach [14]**,** texture information of the image is evaluated by separating the neighbourhood pixels into diagonal and corner pixels. The cross diagonal approach is evaluated with original texture unit but not with the FTU information. In the cross diagonal approach the classification is not based on transitions of LBP units. To overcome this, the present paper proposed TFLBP method as given below. The proposed TFLBP method consists of five steps, which are explained below.

STEP1: Convert the RGB image into Grey scale Image by using HSV colour model.

STEP 2: Generation of Fuzzy LBP (FLBP) on each 3 x 3 sub matrix by using the following fuzzy rules (fuzzy values are 0, 1, 2, 3 and 4) represented by Fig.2 and Eqn. 2. The 3 x 3 sub image is represented as shown in Fig.1.

P_1	P_2	P_3
P_4	P_5	P_6
P_7	P_8	P_9

Fig.1:3x3 Sub Image.

In Fig. 1, P_i represents the grey level value of the 3 x 3 sub image. To convert in to FLBP, a threshold has taken as mean (denoted as V_0) on the 3 x 3 neighbourhood instead of central pixel. The threshold value i.e V_0 of the 3 x 3 neighbourhood is compared with the 8-neighboring pixels using the fuzzy concept, and this generates the five different fuzzy values i.e 0, 1, 2, 3, 4 as given in Fig. 2 and represented in Eqn. 1

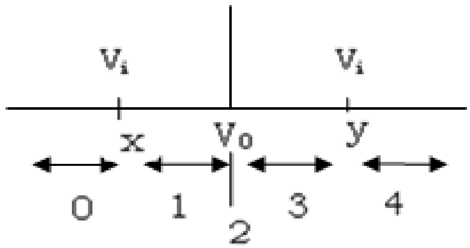

Fig. 2: Fuzzy representation of LBP.

$$\mathbf{FP_i} = \begin{cases} \mathbf{0} & \mathbf{if} \quad \mathbf{P_i < V_0} \quad \mathbf{and} \quad \mathbf{P_i < (V_0 - 5)} \\ \mathbf{1} & \mathbf{if} \quad \mathbf{P_i < V_0} \quad \mathbf{and} \quad \mathbf{P_i \geq (V_0 - 5)} \\ \mathbf{2} & \mathbf{if} \quad \mathbf{P_i = V_0} \\ \mathbf{3} & \mathbf{if} \quad \mathbf{P_i > V_0} \quad \mathbf{and} \quad \mathbf{P_i \leq (V_0 + 5)} \\ \mathbf{4} & \mathbf{if} \quad \mathbf{P_i > V_0} \quad \mathbf{and} \quad \mathbf{P_i > (V_0 + 5)} \end{cases} \quad \mathbf{for\ i = 1, 2 \ldots 9} \qquad (1)$$

Where $\mathbf{V_0}$ is mean of the 3×3 sub matrix.

STEP 3: Derivation of two distinct FLBP units: The FLBP is divided into two distinct FLBP's. Each FLBP contains four pixels only. The first one contains the four pixels of "Cross Diagonal of FLBP" (CDFLBP) i.e the set of pixels FP_2, FP_4, FP_8 and FP_6. The next one contains the four pixels of "Non-connected corners of FLBP" (NCFLBP) i.e: the set of pixels FP_1, FP_3, FP_7 and FP_9. The representation of CDFLBP and NCFLBP are shown in Fig.3 with blue and red shades respectively.

FP_1	FP_2	FP_3
FP_4		FP_6
FP_7	FP_8	FP_9

Fig.3: Two distinct FLBP.

Each of the two NCFLBP and CDFLBP element has one of the five possible values {0, 1, 2, 3 and 4}. But they can only have four values because each of them contains only four pixels.

STEP 4: Evaluation of FLBP units: The NCFLBP and CDFLBP units are evaluated as represented in Equations (2) & (3)

$$\mathbf{NCFLBPu} = \sum_{\mathbf{i=1}}^{\mathbf{4}} \mathbf{E_{L_i}} * \mathbf{5^{(i-1/2)}} \qquad (2)$$

$$\mathbf{CDFLBPu} = \sum_{\mathbf{i=1}}^{\mathbf{4}} \mathbf{E_{R_i}} * \mathbf{5^{(i-1/2)}} \qquad (3)$$

The NCFLBP and CDFLBP units will have a maximum value of 38.

STEP 5: Transitions on NCFLBP and CDFLBP: To represent these NCFLBP and CDFLBP units, 6 bits are required. On these 6-bit binary values, the present TFLBP method considered a u value of 2 and 4 that is exactly 2 and 4, 0/1 or 1/0 transitions.This TFLBP method further reduces the FTU from 2020 to 38. This reduction is useful for a good classification by reducing computational complexity.

3. RESULTS AND DISCUSSIONS

The proposed TFLBP scheme established a database from the 1002 face images collected from FG-NET database and other 600 images collected from the scanned photographs. This leads a total of 1602 sample facial images. In the proposed TFLBP scheme, the sample images are grouped into five age groups of 0 to 12, 13 to 25, 26 to 45, 46 to 60, and > 60. The frequency occurrence of 2 and 4 transitions of NCFLBP and CDFLBP of the facial image are calculated. The frequency occurrence of 2 and 4 transitions of NCFLBP and CDFLBP of facial images of FG-NET ageing database is shown in Tables 1,2,3,4 and 5 respectively as per the age groups. The proposed method also evaluated the sum of frequency occurrences of 2 and 4 transitions of NCFLBP and CDFLBP and denoted as STFLBP in all tables

Table 1: Frequency Occurrences of Transitions on CDFLBP and NCFLBP for the age group between 0 to 12

S.No	Img Name	CDFLBP Transition Frequencies		NCFLBP Transition Frequencies		STFLBP
		2	4	2	4	
1	001A05	37718	45504	40012	44848	168082
2	001A08	39016	47069	49433	48995	184513
3	008A12	39150	44568	41507	49079	174304
4	001A02	36578	48521	43528	46789	175416
5	002A07	38867	46543	45324	47654	178388
6	001A10	36971	45623	40045	45345	167984
7	002A04	37654	44997	42165	46754	171570
8	002A05	37656	44876	41342	47654	171528
9	009A00	38654	45291	42657	46342	172944
10	009A01	38435	48004	42789	48765	177993
11	009A03	37465	47684	45478	48752	179379
12	009A05	35999	47613	44675	48763	177050
13	009A09	36550	46465	43572	46739	173326
14	009A11	37353	45675	43278	47902	174208
15	010A01	36785	45734	41768	46732	171019
16	010A04	37135	46785	41546	45345	170811
17	010A05	38235	48672	41763	45326	173996
18	010A06	39767	49765	42367	44378	176277
19	010A07a	38246	48452	43376	42367	172441
20	010A07b	37563	46742	44785	40567	169657

Table 2: Frequency Occurrences of Transitions on CDFLBP and NCFLBP for the age group between 13-25.

S.No	Img Name	CDFLBP Transition Frequencies		NCFLBP Transition Frequencies		STFLBP
		2	4	2	4	
1	002A18	42353	52345	45345	54376	194419
2	002A20	43561	54678	46786	53897	198922
3	002A21	44738	53675	47895	54786	201094
4	002A23	45345	45687	45326	55674	192032
5	008A17	41342	49789	44673	56435	192239
6	001A14	42884	43314	46375	53391	185964
7	001A18	43506	51302	44586	56192	195586
8	001A22	43657	65452	46522	56519	212150
9	001A19	43878	64351	45378	57643	211250
10	002A23	44989	58675	46754	55678	206096
11	001A16	43765	52768	45674	56413	198620
12	004A19	42462	50078	44327	56743	193610
13	004A21	41379	51456	46123	55734	194692
14	002A16	42784	52347	45978	57859	198968
15	005A18	42884	53458	44970	56908	198220
16	001A22	44987	58767	45098	56423	205275
17	005A24	45890	57980	43568	55789	203227
18	010A15	45782	56784	44567	56743	203876
19	009A13	43289	55897	45328	54325	198839
20	009A14	43765	54980	45864	56436	201045

Table 3: Frequency Occurrences of Transitions on CDFLBP and NCFLBP for the age group between 26-45.

S.No	Img Name	CDFLBP Transition Frequencies		NCFLBP Transition Frequencies		STFLBP
		2	4	2	4	
1	002A26	45627	78657	54628	59468	238380
2	002A29	44542	86743	57685	54763	243733
3	005A30	43565	95463	56452	55643	251123
4	004A26	44513	99786	55629	57430	257358
5	004A28	45162	98745	55392	53438	252737
6	004A30	46782	88564	58792	58470	252608
7	008A41	47563	87563	59027	52790	246943
8	008A43	43512	92365	58282	58546	252705
9	008A45	44558	92451	56453	57459	250921
10	003A38	49567	98793	59786	51248	259394
11	001A28	44563	68592	60954	58096	232205
12	001A33	46131	68246	58976	61803	235156
13	001A40	51579	100895	55953	64996	273423
14	002A31	53651	98769	54674	60789	267883
15	002A36	52895	96756	55784	59784	265219
16	001A43a	50782	98342	55643	62563	267330

17	002A31	51732	94562	54636	63457	264387
18	002A38	48756	96757	51345	65789	262647
19	003A35	46815	90123	55673	61365	253976
20	001A29	45672	92345	56825	60347	255189

Table 4: Frequency Occurrences of Transitions on CDFLBP and NCFLBP for the age group between 46-60.

S.No	**Img Name**	**CDFLBP Transition Frequencies**		**NCFLBP Transition Frequencies**		**STFLBP**
		2	**4**	**2**	**4**	
1	006A48	54637	73567	88957	73453	290614
2	006A50	55663	74563	89764	68945	288935
3	003A51	54250	76574	88954	69056	288834
4	003A53	53254	75896	87946	70765	287861
5	003A58	57438	71237	87568	74580	290823
6	003A60	56436	72363	88795	73452	291046
7	004A51	57744	75346	89065	71785	293940
8	004A53	52335	76459	89436	70896	289126
9	004A55	52990	73896	84527	71235	282648
10	004A57	53646	74632	87463	72437	288178
11	003A57	55758	72352	88321	68567	284998
12	004A55	54370	72896	90234	69869	287369
13	004A57	58438	73568	91437	68536	291979
14	004A59	59789	71245	90768	68424	290226
15	006A51	58342	75694	88673	65438	288147
16	003A47	53263	74553	89499	69063	286378
17	006A55	61188	74566	90125	69342	295221
18	004A48	54368	73541	89657	70564	288130
19	003A58	60537	88765	66745	84368	300415
20	003A51	58531	85361	63456	74562	281910

Table 5: Frequency Occurrences of Transitions on CDFLBP and NCFLBP for the age > 60.

S.No.	Img Name	CDFLBP Transition Frequencies		NCFLBP Transition Frequencies		STFLBP
		2	4	2	4	
1	004A63	79678	75784	65747	89657	310866
2	004A65	74647	67479	78546	94635	315307
3	004A67	70795	56376	84537	89675	301383
4	004A69	84359	58456	64437	99087	306339
5	004A63	90546	95646	79553	96647	362392
6	006A61	88345	90463	74784	95656	349248
7	006A69	84259	89469	79564	94525	347817
8	006A63	86725	74562	85635	95632	342554
9	006A66	79573	78423	85368	98765	342129
10	004A61	90341	77489	97856	89046	354732
11	001A61	94567	81436	86655	88657	351315
12	001A63	96766	82475	84563	92135	355939
13	006A65	96793	88569	83425	95647	364434
14	006A67	95674	95353	86647	94646	372320
15	006A61	68009	104320	84819	88794	345942
16	004A63	85165	66317	79975	105419	336876
17	006A69	104475	45572	33605	132400	316052
18	004A62	98675	46573	43643	123464	312355
19	006A67	89675	49521	78542	98675	316413
20	006A63	88564	48965	79563	97479	314571

Based on the above tables, classification algorithms for five age groups w.r.to various combinations are derived. The Algorithms 1 & 2; 3 and 4 derives age classification based on frequency occurrences of 2 and 4 transitions on CDFLBP and NFCLBP respectively. The Algorithm 5 is derived based on the STFLBP i.e sum of the frequencies of 2 and 4 transitions on the proposed NCFLBP and CDFLBP units.

Algorithm 1: Age group classification based on CDFLBP on frequency occurrence of transition 2.

```
Begin
If ((CDFLBP-2T >= 35000) && (CDFLBP-2T <=40000)
        Print (“Facial Image age is Child (0-12)”)
    Else if ((CDFLBP-2T >= 41000) && (CDFLBP-2T <=46000))
        Print (“Facial Image age is Young Adult (13-26)”)
    Else if ((CDFLBP-2T >= 46100) && (CDFLBP-2T <=53800))
        Print (“Facial Image age is Middle Aged Adult (26-45)”)
    Else if ((CDFLBP-2T >= 54000) && (CDFLBP-2T <=62000))
        Print (“Facial Image age is Senior Adult (46-60)”)
    Else
        Print (“Facial Image age is Senior Citizens (>60)”)
    End
End.
```

Algorithm 2: Age group classification based on CDFLBP on frequency occurrence of transition 4.

```
Begin
If ((CDFLBP-4T >= 44000) && (CDFLBP-4T<=50000))
    Print (“Facial Image age is Child (0-12)”)
```

```
Else if ((CDFLBP-4T >= 51000) && (CDFLBP-4T <=66000))
    Print ("Facial Image age is Young Adult (13-26)")
    Else if ((CDFLBP-4T >= 66500) && (CDFLBP-4T <=110000))
        Print ("Facial Image age is Middle Aged Adult (26-45)")
    Else if ((CDFLBP-4T >= 110500) && (CDFLBP-4T <=130000))
    Print ("Facial Image age is Senior Adult (46-60)")
          Else
Print ("Facial Image age is Senior Citizens (>60)")
         End
    End
```

Algorithm 3: Age group classification based on NCFLBP on frequency occurrence of transition 2.

```
        Begin
If ((NCFLBP-2T >= 40000) && (NCFLBP-2T <=46000))
    Print ("Facial Image age is Child (0-12)")
     Else if ((NCFLBP-2T >= 46500) && (NCFLBP-2T <=48000))
        Print ("Facial Image age is Young Adult (13-26)")
     Else if ((NCFLBP-2T >= 50000) && (NCFLBP-2T <=61000))
            Print ("Facial Image age is Middle Aged Adult (26-45)")
     Else if ((NCFLBP-2T >= 63000) && (NCFLBP-2T <=92000))
        Print ("Facial Image age is Senior Adult (46-60)")
             Else
        Print ("Facial Image age is Senior Citizens (>60)")
             End.
        End
```

Algorithm 4: Age group classification based on NCFLBP on frequency occurrence of transition 4.

```
         Begin
  If ((NCFLBP-4T >= 40000) && (NCFLBP-4T <=50000))
    Print ("Facial Image age is Child (0-12)")
     Else if ((NCFLBP-4T >= 53000) && (NCFLBP-4T <=58000))
        Print ("Facial Image age is Young Adult (13-26)")
     Else if ((NCFLBP-4T >= 59000) && (NCFLBP-4T <=66000))
            Print ("Facial Image age is Middle Aged Adult (26-45)")
     Else if ((NCFLBP-4T >= 67000) && (NCFLBP-4T <=85000))
        Print ("Facial Image age is Senior Adult (46-60)")
             Else
        Print ("Facial Image age is Senior Citizens (>60)")
             End.
        End.
```

Algorithm 5: Age group classification based on STFLBP.

```
            Begin
                If (STFLBP < 180000)
        Print (facial image age is Child (0 -12))
                Else if (STFLBP < 215000)
            Print (facial image age is young adults (13-26))
                Else if (STFLBP < 275000)
                Print (facial image age is middle-aged adults (26-45))
                Else if (STFLBP < 305000)
            Print (facial image age is senior adults (46-60))
```

Else
Print (facial image age is Senior citizens (> 60))
End.
End.

Based on the above algorithms 1 to 5 and tables 1 to 5, the success rate of classification of age groups using frequencies of 2 and 4 transitions of CDFLBP, NCFLBP and STFLBP are shown in Table 6 and Fig.4.

Table 6: Success Rate of Age Group Classification Algorithms.

Age	CDFLBP-2T	CDFLBP-4T	NCFLBP-2T	NCFLBP-4T	STFLBP
0-12	100	100	100	100	95
13-25	100	85	20	100	100
26-45	60	100	100	65	100
46-60	80	0	100	95	100
>60	100	0	5	100	95

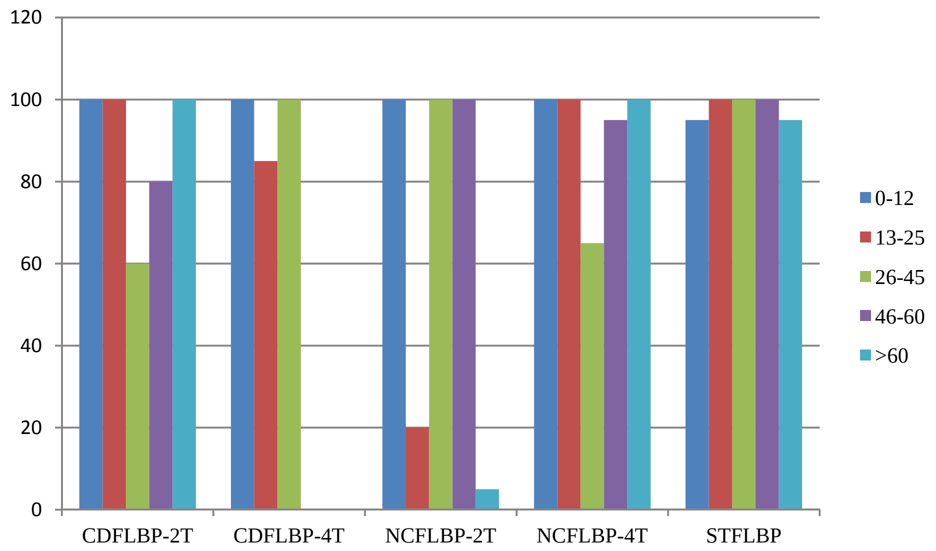

Fig 4: classification graph of facial images based on different combinations of transitions.

4. CONCLUSIONS

The Present Paper derived TFLBP, which divided the Fuzzy LBP into two distinct FLBP's named as CDFLBP and LCFLBP. The derived FLBPs reduced the LBP unit values to 38 only, thus it overcomes the complexities involved in other LBP units which ranges up to 0-255. The proposed method considered only that 2 and 4 bit wise transitions for effective age classification. The results clearly indicate that STFLBP has shown a significant accuracy in classifying the age groups into five categories.

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