Classification of Facial Expressions based on Transitions Derived from Third Order Neighborhood LBP

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Abstract

The present paper extended the LBP transitions derived from second-order neighbourhood on to third order neighbourhood LBP (TN-LBP) and derived transitions on Trapezoid patterns for facial expression classification. The TN-LBP forms four Trapezoid Patterns (TP) i.e. top left, bottom right and top right, bottom left. So far no researcher carried out work on classification problem based on transitions on third-order neighborhood LBP. The present paper derived transitions on the two reciprocal ?Trapezoids of TN-LBP (T-TN-LBP) i.e. top left vs. bottom right. Each of these Trapezoids on TN-LBP will have five pixies and each of them will have 25 i.e 32 patterns. The present paper derived transitions on two symmetric T-TN-LBP. Based on this, facial expression recognition algorithm is built. The proposed approach is compared with the existing methods.

Index terms— classification, facial expression recognition, lbp transitions, third order neighborhood lbp, trapezoid patterns.

1 Introduction

maging understanding is one of the most important tasks involving a classification system. Its primary purpose is to extract information from the images to allow the discrimination among different objects of interest. The classification process is usually based on grey level intensity, color, shape or texture. Image classification is of great interest in a variety of applications. Most of the image analysis problems are related to the neighborhood properties. Each pixel in a neighborhood or image is considered as a random variable, x r , which can assume values x r ? {0, 1?G-1}, where G is the number of grey levels of the image. The probability P (x r = x r | r), where r is the neighbor set for the element x r . The Fig. 1 illustrates different orders of neighborhood for a central pixel. Most of the research involved in image processing is mostly revolved around second order neighborhood only. This is because all the 8-neighboring pixels are well connected with central central pixels and the methods based on second order neighborhood are given extraordinary results in various issues. The present paper considering the difficulties and complexities involved in the third order neighborhood and derived a new, simple and efficient model for image analysis.

2 Derivations of Transitions on Trapezoids of tn-lbp

The proposed method evaluated transitions on "Trapezoids of Third Order Neighborhood of LBP (T-TN-LBP)" and based on this, derived various algorithms for the recognition of facial expressions. The proposed transition based T-TN-LBP consists of 7 steps as described below.

Step 1: Take facial image as Input Image (Img).

3 II.

Step 3 : Crop the grey scale image.

Step 4: The present research evaluated TN-LBP on each 5 x 5 sub image. The TN contains only 13 pixels of 25 pixels of 5x5 neighborhood as shown in Fig. 1. The TN-LBP grey level sub image is converted into binary sub image by comparing the each pixel of TN grey level sub image with the mean value of TN grey sub image. The following Equation.1 is used for grey level to binary conversion.TN-Pi= ? 0 if P i < V 0 1 if P i ? V 0 ? for i = 1,2,3**(1)**

Where V 0 is the mean of the TN sub matrix

Step 5: The present research for classification purpose considered the two reciprocal trapezoids i.e. Top Left (TL) and Bottom Right (BR) trapezoids of TN-LBP. The Fig. 2 shows TL and BR trapezoids of TN-LBP. The each trapezoid pattern consists of 5 pixels. The pixels P 1, P Step 6 : Each trapezoid of TN-LBP consists of five bit patterns. The present research computed the transitions from 0 to 1 and 1 to 0. Generally in 5 bit patterns, 3 types of 0 to 1 and 1 to 0 transitions occur i.e. zero, two and four transitions. The proposed method, considers two and four transitions only, which accounts for 87.5% of patterns.

Step 7 : Based on frequency occurrences of two and four transitions, the facial image is classified as one of the category (Neutral, Happiness, Sadness, Surprise, Anger, Disgust and Fear).

4 Results and Discussions

The proposed transition based T-TN-LBP method is experimented on a database contains 213 images of female facial expressions collected by Kamachi and Gyoba at Kyushu University, Japan In the proposed "Transitions based on T-TN-LBP method", the sample images are grouped into seven categories of expression (neutral, happiness, sadness, surprise, anger, disgust and fear). Each T-TN-LBP consists of 5 bit pattern. It results a total of 32 bit patterns. This forms two-zero transitions i.e. the decimal value 0 and 31. The decimal values 5,9,10,11,13,18,20,21,22,26 results for 0 to 1 or 1 to 0 four transitions.The rest of the binary equivalent decimal values1,2,3,4,6,7,8,12,14,15,16,17,19,23,24,25,27,28,29, 30 results two transitions. The beauty of the proposed transitions on T-TN-LBP method is it evaluated the frequency occurrences of 2 and 4 transitions. This accounts a total of 87.5% of transitions.

The proposed method not considered the zero transitions which accounts for 12.5% of patterns. Further the proposed method evaluated the frequency occurrence of 2 and 4 transitions separately. The proposed method further evaluated sum of frequency occurrences two and four transitions of both TL and BR T-TN-LBP for the different facial expressions separately and listed in tables 1, 2, 3, 4, 5, 6 and 7 respectively. In the tables, STLT denotes sum of transitions (both 2 and 4) of Top Left Trapezoid and SBRT denotes sum of transitions (both 2 and 4) of Bottom Right Trapezoid. Further, the table also gives Total number of (2 and 4) transitions of both Trapezoids denoted as TBT in the above tables. Comparison of The Proposed t-tn-lbp with Other Existing Methods

Table 9 shows the classification rate for various groups of facial expression by the proposed T-TN-LBP method with other existing methods like feature-based facial expression recognition within an architecture based on a two-layer perception of Zhengyou Zhang [2], Facial expression analysis by Dela Torre et.al [3] and Facial Expression Recognition Based on Distinct LBP and GLCM by Gorti SatyanarayanaMurthy et.al [4]. These methods are implemented on Kamachi and Gyoba [5] at Kyushu University-data set and compared with the proposed method. From table 9, it is clearly evident that, the proposed method exhibits a high classification rate than the existing methods. The graphical representation of this is also shown in Fig. 5. [1] [2]

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Figure 1: Figure 1 :

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Figure 2: Step 2 :

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Figure 3: Figure 2 :

Figure 4:

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Figure 5: Figure 3 :

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Figure 6: Figure 4 :

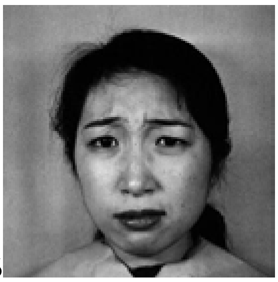
5 

Figure 7: Figure 5 :

		P 1		
			P 4	
	P 2	P 3		
P 5	P 6	P 7	P 8	P 9
	P 10	P 11	P 12	
		P 13		

Figure 8:

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								Year D D D D D D D D) F (
		Transitions on Top-Left			Transitions on Bottom-Right			
			T-TN-LBP			T-TN-LBP		
S.No	Image Name	2	4	STLT	2	4	SBRT	TBT
1	KA.AN1.39	737	137	874	741	152	893	1767
2	KA.AN2.40	723	170	893	708	189	897	1790
3	KA.AN3.41	711	177	888	709	183	892	1780
4	KL.AN1.167	723	170	893	699	179	878	1771
5	KL.AN2.168	729	182	911	726	187	913	1824
6	KL.AN3.169	748	159	907	716	187	903	1810
7	KM.AN1.17	727	152	879	721	153	874	1753
8	KM.AN2.18	696	167	863	698	169	867	1730
9	KM.AN3.19	699	167	866	732	159	891	1757
10	KR.AN1.83	727	158	885	693	193	886	1771
11	KR.AN2.84	759	160	919	723	169	892	1811
12	KR.AN3.85	730	161	891	730	161	891	1782
13	MK.AN1.125	708	173	881	742	162	904	1785
14	MK.AN2.126	678	184	862	733	162	895	1757
15	MK.AN3.127	704	153	857	738	151	889	1746

Figure 9: Table 1 :

2

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Year

			Transitions on Top-Left			Transitions on Bottom-Right			
				T-TN-LBP			T-TN-LBP		
	S.No	Image Name	2	4	STLT	2	4	SBRT	TBT
(D D D D) F	1 2	KA.DI1.42 KA.DI2.43	831 788	158 186	989 974	770 784	163 175	933 959	
	3	KA.DI3.44	795	150	945	795	175	970	
	4	KL.DI1.170	820	167	987	749	203	952	
	5	KL.DI2.171	807	184	991	735	192	927	
	6	KL.DI3.172	742	178	920	785	173	958	
	7	KL.DI4.173	758	148	906	775	186	961	
	8	KM.DI1.20	822	169	991	756	171	927	
	9	KM.DI3.22	820	150	970	745	184	929	
	10	KR.DI1.86	819	171	990	763	145	908	
	11	KR.DI2.87	843	166	1009	726	172	898	
	12	KR.DI3.88	792	156	948	778	179	957	
	13	MK.DI1.128	833	144	977	794	151	945	
	14	MK.DI2.129	837	132	969	789	163	952	
	15	MK.DI3.130	806	160	966	764	183	947	
	16	NA.DI1.214	798	182	980	767	186	953	
	17	NA.DI2.215	834	168	1002	765	160	925	
	18	NA.DI3.216	834	164	998	773	167	940	
	19	NM.DI1.107	818	180	998	726	170	896	
	20	NM.DI3.109	821	177	998	737	189	926	
	21	TM.DI1.193	754	215	969	753	212	965	

Figure 10: Table 2 :

3

								Year
		Transitions on Top-Left			Transitions on Bottom-Right			
			T-TN-LBP			T-TN-LBP		
S.No	Image Name	2	4	STLT	2	4	SBRT	TBT
1	KA.FE1.45	796	195	991	844	194	1038	
2	KA.FE2.46	811	178	989	820	183	1003	
3	KA.FE3.47	783	192	975	815	189	1004	
4	KA.FE4.48	778	206	984	826	210	1036	
5	KL.FE1.174	778	197	975	832	192	1024	
6	KL.FE2.175	784	205	989	851	173	1024	
7 8	KL.FE3.176 KM.FE1.23	796 778	197 198	993 976	843 782	199 201	1042 983	(D D D D D D D D) F
9	KM.FE2.24	783	195	978	774	201	975	
10	KM.FE3.25	787	181	968	809	185	994	
11	KR.FE1.89	769	196	965	832	186	1018	
12	KR.FE2.90	792	186	978	818	183	1001	
13	KR.FE3.91	801	200	1001	830	197	1027	
14	MK.FE2.131	795	184	979	844	165	1009	
15	MK.FE3.132	802	180	982	832	174	1006	
16	MK.FE4.133	793	165	958	812	193	1005	
17	NA.FE1.217	793	188	981	801	190	991	
18	NA.FE2.218	783	188	971	824	181	1005	
19	NA.FE3.219	797	209	1006	856	173	1029	
20	NM.FE1.110	773	200	973	867	162	1029	
21	NM.FE2.111	783	186	969	820	177	997	
22	NM.FE3.112	798	184	982	825	164	989	
23	TM.FE1.196	796	208	1004	833	186	1019	
24	TM.FE2.197	814	199	1013	807	208	1015	
25	TM.FE3.198	793	189	982	823	200	1023	
26	UY.FE1.152	792	199	991	842	172	1014	

Figure 11: Table 3 :

4

			Transitions on Top-Left T-TN-LBP			Transitions on Bottom-Right T-TN -LBP			
	S.No	Image Name	2	4	STLT	2	4	SBRT	TBT
Year	1	KA.HA1.29	847	207	1054	865	220	1085	2139
	2	KA.HA2.30	847	193	1040	857	204	1061	2101
	3	KA.HA3.31	823	210	1033	887	193	1080	2113
	4	KA.HA4.32	832	221	1053	874	211	1085	2138
	5	KL.HA1.158	809	251	1060	878	208	1086	2146
	6	KL.HA2.159	844	208	1052	864	209	1073	2125
	7	KL.HA3.160	839	204	1043	859	209	1068	2111
	8	KM.HA1.4	839	217	1056	829	201	1030	2086
	9	KM.HA2.5	849	185	1034	865	177	1042	2076
	10	KM.HA3.6	782	238	1020	810	232	1042	2062
	11	KM.HA4.7	831	215	1046	842	198	1040	2086
D	12	KR.HA1.74	823	217	1040	893	211	1104	2144
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(	13	KR.HA2.75	831	204	1035	879	210	1089	2124
	14	KR.HA3.76	819	199	1018	864	203	1067	2085
	15	MK.HA2.117	827	211	1038	855	200	1055	2093
	16	MK.HA3.118	831	185	1016	847	188	1035	2051
	17	NA.HA1.202	835	208	1043	835	199	1034	2077
	18	NA.HA2.203	833	205	1038	859	208	1067	2105
	19	NA.HA3.204	863	196	1059	832	186	1018	2077
	20	NM.HA1.95	836	211	1047	851	215	1066	2113
	21	NM.HA2.96	842	202	1044	869	197	1066	2110
	22	NM.HA3.97	857	186	1043	858	201	1059	2102
	23	TM.HA1.180	826	208	1034	852	232	1084	2118
	24	TM.HA2.181	817	236	1053	826	262	1088	2141
	25	TM.HA3.182	823	223	1046	848	238	1086	2132
	26	UY.HA1.137	846	222	1068	860	213	1073	2141
	27	UY.HA2.138	861	212	1073	840	228	1068	2141
	28	UY.HA3.139	824	213	1037	871	200	1071	2108
	29	YM.HA1.52	833	220	1053	864	206	1070	2123
	30	YM.HA2.53	826	214	1040	845	216	1061	2101

Figure 12: Table 4 :

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S.No	Image Name	Transitions on Top-Left T-TN-LBP 2	4	STLT	Transitions on Bottom-Right T-TN-LBP 2	4	SBRT	TBT
1	KA.NE1.26	871	214	1085	876	227	1103	2188
2	KA.NE2.27	868	195	1063	898	211	1109	2172
3	KA.NE3.28	863	199	1062	892	223	1115	2177
4	KL.NE1.155	861	227	1088	864	222	1086	2174
5	KL.NE2.156	871	220	1091	857	233	1090	2181
6	KL.NE3.157	873	226	1099	887	220	1107	2206
7	KM.NE1.1	844	221	1065	898	195	1093	2158
8	KM.NE2.2	843	242	1085	861	215	1076	2161
9	KM.NE3.3	877	208	1085	866	225	1091	2176
10	KR.NE1.71	858	207	1065	872	223	1095	2160
11	KR.NE2.72	862	224	1086	876	217	1093	2179
12	KR.NE3.73	871	233	1104	878	211	1089	2193
13	MK.NE1.113	894	185	1079	854	219	1073	2152
14	MK.NE2.114	886	203	1089	870	221	1091	2180
15	MK.NE3.115	861	201	1062	926	173	1099	2161
16	NA.NE1.199	888	214	1102	856	202	1058	2160
17	NA.NE2.200	873	237	1110	857	233	1090	2200
18	NA.NE3.201	900	188	1088	886	204	1090	2178
19	NM.NE1.92	860	191	1051	878	230	1108	2159
20	NM.NE2.93	876	202	1078	878	213	1091	2169
21	NM.NE3.94	930	210	1140	856	205	1061	2201
22	TM.NE1.177	855	228	1083	865	237	1102	2185
23	TM.NE2.178	849	245	1094	833	289	1122	2216
24	TM.NE3.179	834	239	1073	882	240	1122	2195
25	UY.NE1.134	873	204	1077	879	213	1092	2169
26	UY.NE2.135	874	214	1088	854	231	1085	2173
27	UY.NE3.136	881	210	1091	873	212	1085	2176
28	YM.NE1.49	851	215	1066	904	194	1098	2164
29	YM.NE2.50	888	186	1074	872	212	1084	2158
30	YM.NE3.51	887	214	1101	863	223	1086	2187

Figure 13: Table 5 :

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S.No	Image Name	Transitions on Top-Left T-TN-LBP 2	4	STLT	Transitions on Bottom-Right T-TN-LBP 2	4	SBRT	TBT

Figure 14: Table 6 :

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		Transitions on Top-Left T-TN-LBP			Transitions on Bottom-Right T-TN-LBP			
S.No	Image Name	2	4	STLT	2	4	SBRT	TBT
1	KA.SU1.36	1005	231	1236	981	235	1216	2452
2	KA.SU2.37	973	234	1207	974	233	1207	2414
3	KA.SU3.38	1006	225	1231	983	237	1220	2451
4	KL.SU1.164	946	265	1211	988	238	1226	2437
5	KL.SU2.165	975	236	1211	991	226	1217	2428

Figure 15: Table 7 :

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Image Dataset	Architecture based on a two-layer perception	Facial expression analysis	GLCM on DLBP of FCI Method	Proposed Method (T-TN-LBP)
Kamachi and Gyoba at Kyushu University, Japan-data set	80.29	91.79	96.67	100

Figure 16: Table 9 :

.1 Conclusions

The present paper derived new direction for various problems of image processing by deriving LBP on the third order neighborhood. The third order neighborhood consists of 12 pixels excluding centre pixel. This may lead to huge number of patters i.e. 2 12 . The U-LBP on third order neighborhood leads to a negligible percentage of patterns. To overcome this, the present paper proposed transitions on T-TN-LBP. The T-TN-LBP considered 87.5% of transitions thus overcoming the disadvantage of U-LBP of third order neighborhood. The STLT, SBRT and TBT results of Table **??** clearly indicates an average facial expression classification result of 58%, 66% and 100% respectively.

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