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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.

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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 2^5 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.

Keywords: classification, facial expression recognition, lbp transitions, third order neighborhood lbp, trapezoid patterns.

I. Introduction

Imaging 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.

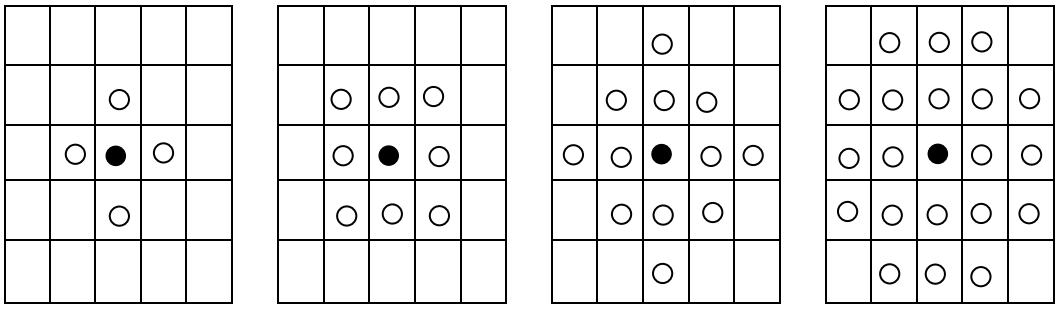

Figure 1 : Neighborhood for a central pixel: (a) First Order (b) Second Order (c) Third Order (d) Fourth Order

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 $x_r \in \{0, 1 \ldots G-1\}$, where G is the number of grey levels of the image. The probability $P(x_r = x_r \mid r)$, 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 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.

II. 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).

Step 2: Convert the RGB image into Grey scale Image by using HSV color model.

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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.

$$\text{TN-Pi} = \begin{cases} 0 & \text{if} \quad P_i < V_0 \\ 1 & \text{if} \quad P_i \geq V_0 \end{cases} \quad \text{for i} = 1,2,3 \qquad (1)$$

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_2, P_5, P_6 and P_3 form the TL trapezoid. The Pixels P_8, P_{11}, P_{13}, P_{12} and P_9 form the BR trapezoid.

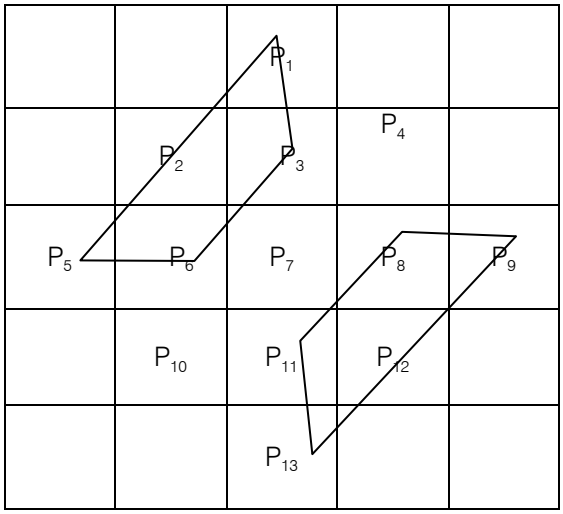

Figure 2 : The TL and BR trapezoids of TN-LBP

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).

III. 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 [1]. A few of them are shown in Fig. 3.

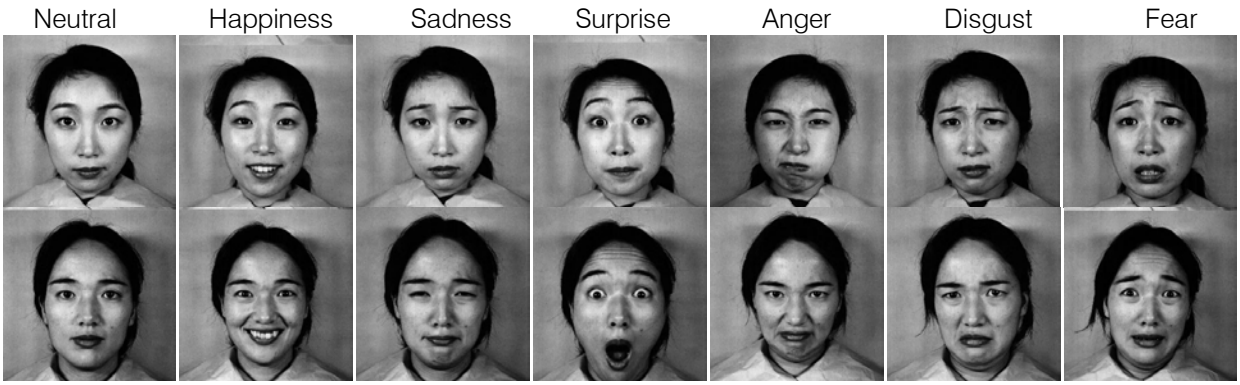

Figure 3 : Facial expression database (Kamachi and Gyoba at Kyushu University, Japan).

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.

Table 1 : Frequency occurrence of transitions of T-TN-LBP method on Anger expression database.

		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.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

16	NA.AN1.211	716	141	857	735	128	863	1720
17	NA.AN2.212	770	136	906	739	161	900	1806
18	NA.AN3.213	695	171	866	722	198	920	1786
19	NM.AN1.104	734	158	892	750	154	904	1796
20	NM.AN2.105	730	149	879	762	144	906	1785
21	NM.AN3.106	769	123	892	755	141	896	1788
22	TM.AN1.190	704	189	893	711	208	919	1812
23	TM.AN2.191	740	172	912	742	178	920	1832
24	TM.AN3.192	678	192	870	711	164	875	1745
25	UY.AN1.146	721	192	913	679	214	893	1806
26	UY.AN2.147	713	202	915	688	222	910	1825
27	UY.AN3.148	754	166	920	722	180	902	1822
28	YM.AN1.61	725	171	896	796	122	918	1814
29	YM.AN2.62	698	182	880	727	183	910	1790
30	YM.AN3.63	698	191	889	709	196	905	1794

Table 2 : Frequency occurrences of transitions of T-TN-LBP method on Disgust expression database.

		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.DI1.42	831	158	989	770	163	933	1922
2	KA.DI2.43	788	186	974	784	175	959	1933
3	KA.DI3.44	795	150	945	795	175	970	1915
4	KL.DI1.170	820	167	987	749	203	952	1939
5	KL.DI2.171	807	184	991	735	192	927	1918
6	KL.DI3.172	742	178	920	785	173	958	1878
7	KL.DI4.173	758	148	906	775	186	961	1867
8	KM.DI1.20	822	169	991	756	171	927	1918
9	KM.DI3.22	820	150	970	745	184	929	1899
10	KR.DI1.86	819	171	990	763	145	908	1898
11	KR.DI2.87	843	166	1009	726	172	898	1907
12	KR.DI3.88	792	156	948	778	179	957	1905
13	MK.DI1.128	833	144	977	794	151	945	1922
14	MK.DI2.129	837	132	969	789	163	952	1921
15	MK.DI3.130	806	160	966	764	183	947	1913
16	NA.DI1.214	798	182	980	767	186	953	1933
17	NA.DI2.215	834	168	1002	765	160	925	1927
18	NA.DI3.216	834	164	998	773	167	940	1938
19	NM.DI1.107	818	180	998	726	170	896	1894
20	NM.DI3.109	821	177	998	737	189	926	1924
21	TM.DI1.193	754	215	969	753	212	965	1934

22	TM.DI2.194	766	163	929	783	211	994	1923
23	TM.DI3.195	759	204	963	811	170	981	1944
24	UY.DI1.149	809	177	986	733	194	927	1913
25	UY.DI2.150	741	183	924	795	180	975	1899
26	UY.DI3.151	807	188	995	751	181	932	1927
27	YM.DI1.64	800	193	993	751	191	942	1935
28	YM.DI2.65	779	185	964	748	200	948	1912
29	YM.DI3.66	814	201	1015	758	155	913	1928
30	YM.DI4.67	847	195	1042	734	145	879	1921

Table 3 : Frequency occurrences of transitions of T-TN-LBP method on Fear expression database.

		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.FE1.45	796	195	991	844	194	1038	2029
2	KA.FE2.46	811	178	989	820	183	1003	1992
3	KA.FE3.47	783	192	975	815	189	1004	1979
4	KA.FE4.48	778	206	984	826	210	1036	2020
5	KL.FE1.174	778	197	975	832	192	1024	1999
6	KL.FE2.175	784	205	989	851	173	1024	2013
7	KL.FE3.176	796	197	993	843	199	1042	2035
8	KM.FE1.23	778	198	976	782	201	983	1959
9	KM.FE2.24	783	195	978	774	201	975	1953
10	KM.FE3.25	787	181	968	809	185	994	1962
11	KR.FE1.89	769	196	965	832	186	1018	1983
12	KR.FE2.90	792	186	978	818	183	1001	1979
13	KR.FE3.91	801	200	1001	830	197	1027	2028
14	MK.FE2.131	795	184	979	844	165	1009	1988
15	MK.FE3.132	802	180	982	832	174	1006	1988
16	MK.FE4.133	793	165	958	812	193	1005	1963
17	NA.FE1.217	793	188	981	801	190	991	1972
18	NA.FE2.218	783	188	971	824	181	1005	1976
19	NA.FE3.219	797	209	1006	856	173	1029	2035
20	NM.FE1.110	773	200	973	867	162	1029	2002
21	NM.FE2.111	783	186	969	820	177	997	1966
22	NM.FE3.112	798	184	982	825	164	989	1971
23	TM.FE1.196	796	208	1004	833	186	1019	2023
24	TM.FE2.197	814	199	1013	807	208	1015	2028
25	TM.FE3.198	793	189	982	823	200	1023	2005
26	UY.FE1.152	792	199	991	842	172	1014	2005

27	UY.FE2.153	819	194	1013	818	172	990	2003
28	UY.FE3.154	807	185	992	861	173	1034	2026
29	YM.FE1.67	803	196	999	826	177	1003	2002
30	YM.FE2.68	805	192	997	814	201	1015	2012

Table 4 : Frequency occurrences of transitions of T-TN-LBP method on Happiness expression database.

		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.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
12	KR.HA1.74	823	217	1040	893	211	1104	2144
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

Table 5 : Frequency occurrences of transitions of T-TN-LBP method on Neutral expression database.

		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.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

Table 6 : Frequency occurrences of transitions of T-TN-LBP method on Sadness expression database.

		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.SA1.33	846	236	1082	972	255	1227	2309

2	KA.SA2.34	882	213	1095	970	243	1213	2308
3	KA.SA3.35	886	205	1091	982	195	1177	2268
4	KL.SA1.161	883	210	1093	959	232	1191	2284
5	KL.SA2.162	878	222	1100	967	239	1206	2306
6	KL.SA3.163	873	224	1097	987	221	1208	2305
7	KM.SA1.9	949	203	1152	993	165	1158	2310
8	KM.SA2.10	873	213	1086	962	206	1168	2254
9	KM.SA3.11	920	197	1117	948	223	1171	2288
10	KM.SA5.13	847	221	1068	975	217	1192	2260
11	KR.SA1.77	866	203	1069	992	213	1205	2274
12	KR.SA2.78	851	230	1081	978	217	1195	2276
13	KR.SA3.79	867	213	1080	986	205	1191	2271
14	MK.SA1.119	829	222	1051	993	231	1224	2275
15	MK.SA2.120	882	171	1053	1021	188	1209	2262
16	MK.SA3.121	867	212	1079	982	206	1188	2267
17	NA.SA1.205	871	231	1102	983	201	1184	2286
18	NA.SA2.206	848	243	1091	974	251	1225	2316
19	NA.SA3.207	869	220	1089	980	215	1195	2284
20	NM.SA1.98	872	207	1079	973	209	1182	2261
21	NM.SA2.99	873	206	1079	955	226	1181	2260
22	NM.SA3.100	861	205	1066	980	217	1197	2263
23	TM.SA1.184	846	221	1067	980	225	1205	2272
24	TM.SA2.185	849	250	1099	995	224	1219	2318
25	TM.SA3.186	874	235	1109	959	253	1212	2321
26	UY.SA1.140	873	229	1102	975	232	1207	2309
27	UY.SA2.141	882	221	1103	1006	197	1203	2306
28	UY.SA3.142	885	232	1117	988	217	1205	2322
29	YM.SA1.55	846	225	1071	981	217	1198	2269
30	YM.SA2.56	871	232	1103	962	228	1190	2293

Table 7: Frequency occurrences of transitions of T-TN-LBP method on Surprise expression database.

		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

6	KL.SU3.166	1007	227	1234	963	252	1215	2449
7	KM.SU1.14	967	211	1178	963	235	1198	2376
8	KM.SU2.15	928	241	1169	988	201	1189	2358
9	KM.SU3.16	957	216	1173	923	258	1181	2354
10	KR.SU1.80	956	233	1189	965	236	1201	2390
11	KR.SU2.81	949	262	1211	952	255	1207	2418
12	KR.SU3.82	959	228	1187	960	232	1192	2379
13	MK.SU1.122	977	215	1192	988	211	1199	2391
14	MK.SU2.123	963	214	1177	993	195	1188	2365
15	MK.SU3.124	964	220	1184	995	202	1197	2381
16	NA.SU1.208	962	228	1190	951	228	1179	2369
17	NA.SU2.209	956	250	1206	985	252	1237	2443
18	NA.SU3.210	1003	225	1228	989	228	1217	2445
19	NM.SU1.101	989	212	1201	963	221	1184	2385
20	NM.SU2.102	974	215	1189	997	216	1213	2402
21	NM.SU3.103	978	217	1195	941	228	1169	2364
22	TM.SU1.187	989	225	1214	990	240	1230	2444
23	TM.SU2.188	961	247	1208	950	256	1206	2414
24	TM.SU3.189	935	267	1202	976	235	1211	2413
25	UY.SU1.143	976	246	1222	954	270	1224	2446
26	UY.SU2.144	1004	238	1242	991	231	1222	2464
27	UY.SU3.145	979	246	1225	1001	234	1235	2460
28	YM.SU1.58	953	265	1218	996	216	1212	2430
29	YM.SU2.59	983	264	1247	986	210	1196	2443
30	YM.SU3.60	967	287	1254	974	235	1209	2463

Based on the above tables, classification algorithms for facial expressions are derived. The Algorithms 1, 2 derives facial expression classification based on frequency occurrences of 2, 4 transitions on STLT, SBRT respectively. The Algorithm 3 is derived based on the

TBT i.e Total number of transitions on both trapezoids of TN-LBP.

Algorithm 1: Facial Expression Recognition algorithm based on Frequency occurrences of STLT.
(STLT denotes Sum of Transitions on Top Left Trapezoid of TN-LBP includes sum of 2T and 4T)

```
Begin
if (STLT <= 920 )
print (“Facial Image is Anger Expression”)
else if ((STLT > 920) and (STLT<= 1045 ))
print (“Facial Image is Disgust Expression”)
else if ((STLT > 1045) and (STLT<= 1050))
print (“Facial Image is Fear Expression”)
else if ((STLT > 1050) and (STLT <=1075))
print (“Facial Image is Happy Expression”)
else if ((STLT > 1075) and (STLT <= 1110))
print (“Facial Image is Neutral Expression”)
else if ((STLT > 1110) and (STLT <=1170))
print (“Facial Image is Sadness Expression”)
else if (STLT> 1170)
print (“Facial Image is Surprise Expression”)
End.
```

Algorithm 2: Facial Expression Recognition algorithm based on Frequency occurrences of SBRT.
(SBRT denotes sum of transitions of Bottom Right Trapezoid of TN-LBP includes 2T and 4T)

```
Begin
        if (SBRT <= 920)
print ("Facial Image is Anger Expression")
else if ((SBRT > 920) and (SBRT <= 995))
print ("Facial Image is Disgust Expression")
else if ((SBRT > 995) and (SBRT < =1035))
print ("Facial Image is Fear Expression")
else if ((SBRT > 1035) and (SBRT <= 1105))
print ("Facial Image is Happiness Expression")
else if ((SBRT> 1105) and (SBRT <= 1125))
print ("Facial Image is Neutral Expression")
else if ((SBRT > 1125)  and (SBRT< =1230))
print ("Facial Image is Sadness Expression")
else if (SBRT > 1230)
print ("Facial Image is Surprise Expression")
End.
```

Algorithm 3: Facial Expression Recognition algorithm based on Frequency occurrences of TBT.
(TBT denotes the total number of Transitions on Both Trapezoids of TN-LBP)

```
Begin
if (TBT < 1835)
print ("Facial Image is Anger Expression")
else if ((TBT > 1835) and (TBT <= 1945 ))
print ("Facial Image is Disgust Expression")
else if ((TBT > 1945) and (TBT <= 2035))
print ("Facial Image is Fear Expression")
else if ((TBT > 2035) and (TBT <= 2150))
print ("Facial Image is Happiness Expression")
else if ((TBT> 2150) and (TBT <= 2220))
print ("Facial Image is Neutral Expression")
else if ((TBT > 2220) and (TBT<= 2325 ))
print ("Facial Image is Sadness Expression")
else if (TBT > 2325)
print ("Facial Image is Surprise Expression")
End.
```

Based on the above algorithms 1, 2 and 3, the present study evaluated success rate of classification of the facial expressions and results are shown in table 8 and corresponding graph is shown in Fig.4. From table 8, it is clearly evident that algorithm based on TBT has high classification rate than other two algorithms. The table 8 clearly indicates the algorithm based on STLT has low classification rate in recognizing the expressions like fear, happy and sadness. And also the algorithm based on SBRT failed in recognizing neutral and surprise facial expressions. The TBT has given high classification rate because where ever the STLT has failed; the SBRT performed well and vice versa is also true.

Table 8 : % of Facial Expression Classification based on proposed algorithms.

Facial Expression	STLT	SBRT	TBT
Anger	100	100	100
Disgust	96	83	100
Fear	0	70	100
Happy	33	86	100
Neutral	73	20	100
Sadness	10	93	100
Surprise	96	10	100

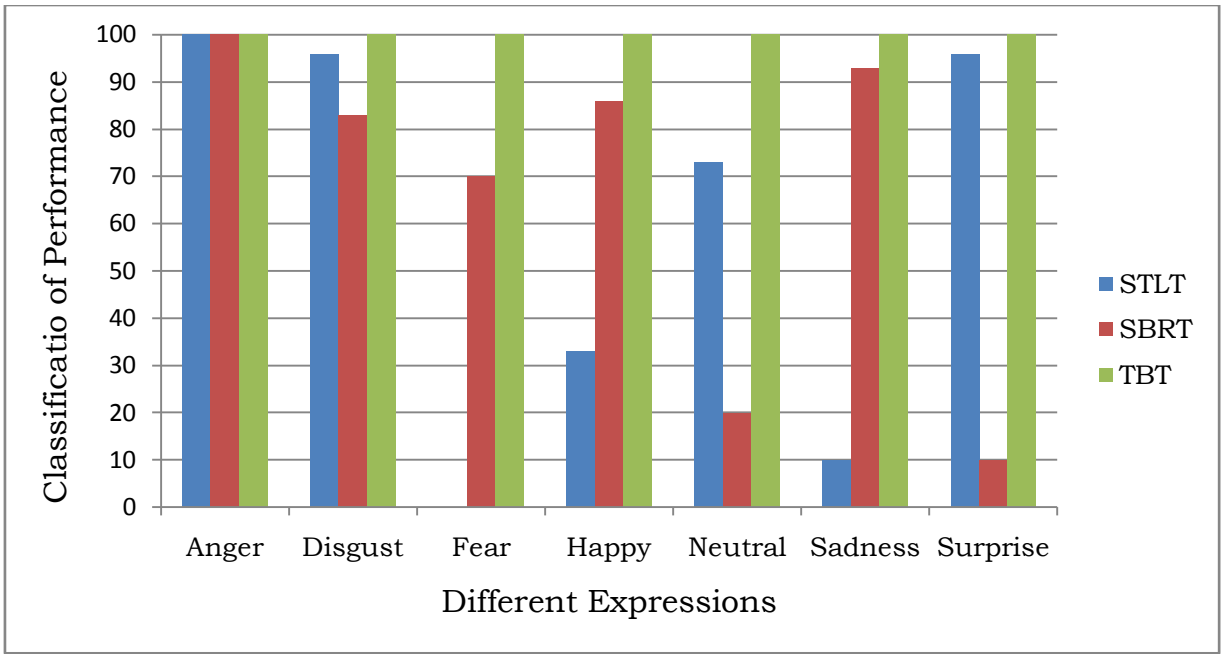

Figure 4 : Classification Performance of various algorithms.

IV. 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.

Table 9 : Classification rate of the proposed T-TN-LBP method with other existing methods

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

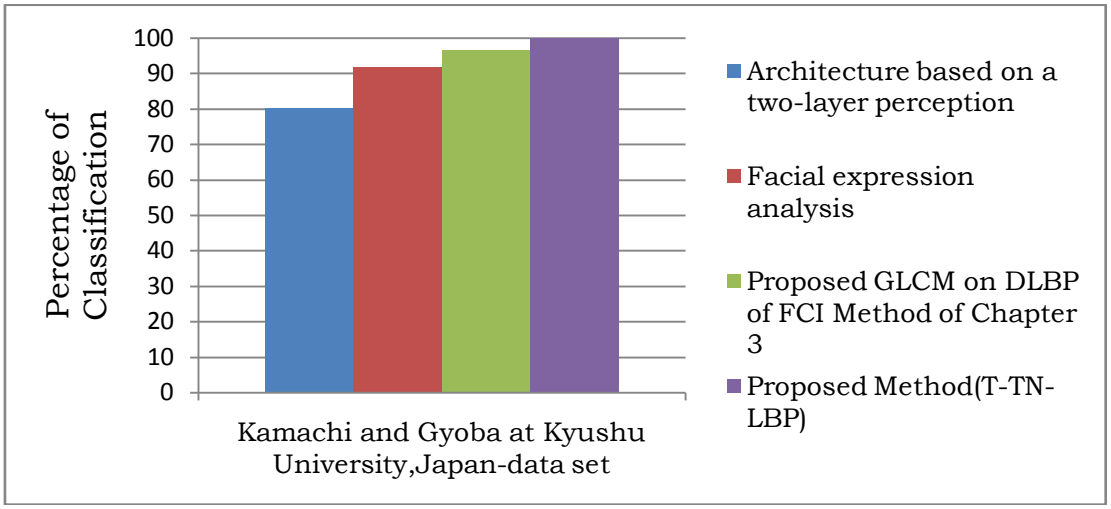

Figure 5 : Classification chart of proposed T-TN-LBP method with other existing methods.

V. 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 8 clearly indicates an average facial expression classification result of 58%, 66% and 100% respectively.

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