International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878 (Online), Volume-8 Issue-4, November 2019

Age Group Estimation Based on the Transition Count of 3rd Order Neighborhood using V and Inverted V Patterns

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Abstract: ***Age Classification is used in so many applications like crime detection, face detection and so on. . The age leads to significant variation in human face. The variation depends on many factors like gender, exposure to sunlight, drinking, weight loss or weight gain. In our paper the performance of face aging is established based on v pattern and Inverted v pattern by using the transition count of third order neighborhood. In our proposed method the age of the person is divided into 5 categories 1.Childhood (0-12years) 2.Young Adults (13-25years) 3.Middle Age Adults (26-40years) 4.Senior Adults (40-60years) 5.Senior Citizens (more than 60 years).The quantative evaluation and analysis is performed in our proposed method when compared to other existing methods after applying on 4 different facial image databases.***

Keywords: V pattern, Inverted V pattern, transition count, age estimation, third order neighborhood

I. INTRODUCTION

The Age is very important for the human appearance. Age classification becomes challenging due to anatomical changes. Aging is divided into two types. i) Intrinsic aging ii) Extrinsic aging. Intrinsic aging is the natural aging process which can be identified by the skin lines, dryness of skin, furrows and laxity of the skin. Extrinsic aging is identified due to sleeping position, smoking, sun exposure and so on. The Age synthesis is important for identifying face after several years such as passport renewal and border security. Age estimation is also used to predict rejuvenating results. The remainder of the paper can be organized as follows. In section 2 related work in age estimation and in section 3 about proposed method and in section 4 about Results and Experiments and in section 5 we conclude.

II. RELATED WORK IN AGE ESTIMATION

A recent survey on automated age estimation can be found in [1].KwonandLobo[2] first worked on the age classification problem. They referred to cranio -facial research, the article makeup, plastic surgery. The publicly available FG-Net aging database is commonly used in many previous works for age estimation in order to evaluate performance[6, 7, 8, 9, 10].

Manuscript published on November 30, 2019.
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The recent texture based approaches [11, 12, 13, 14, 15, 16] for age classification and face recognition attained high accuracy and classification rate over the other existing methods.

To find out the success rate the proposed method used u Morph Data base [18] and the percentage of success is about 91.86. V V Kumar et al., [19] proposed Topological Texture Features (TTF). Based on the TTF facial image is classified into five categories those are: child, young-adults, middle-aged, senior aged and Senior citizens

SasiKiran et al.,[20] Proposed SICFRG model, which reduces the dimensionality of the image. The SICFRG was done in three steps. The 5×5 sub face is compressed into a 2×2 sub face without losing any substantial attributes.

V. Vijaya Kumar et al., [24] proposed a method called Fuzzy IDRSP (FIDRSP). It is used to estimate the facial images into five categories with Texture Shape Features (TSF). In the FIDRSP approach the percentage of success is 95.6%.

Pullela et al., [26] proposed a method for adult and child classification based on Morphological Pattern Representation Schemes. The proposed method is tested on three datasets: Google, Fgnet, and Scanned images.

U Ravi Babu et al., [27] proposed method for estimating the age group of a person based on the shape features. The proposed method mainly consists of 5 steps i.e. cropping, conversion in to grey level, finding features and so on.

III. PROPOSED METHOD

The present method contains 4 important steps. In Step 1, extract the skin region for a given image. In step2 Have to convert the color image into gray scale image. In Step 3, convert the TNP on 5×5 sub image into two valued matrix and find transition trends of 'v' and inverted 'v' patterns. Based on the trends of transition, derive the user defined Age estimation algorithm for estimate the age group of a person's facial image in step 4. The Block diagram of the Age Group Estimation system is shown in figure 1.

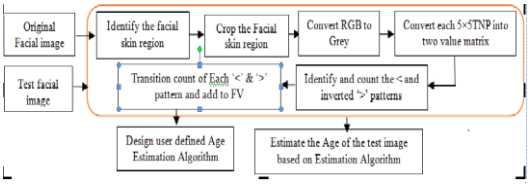

Figure 1: Block diagram of the Age estimation Approach

A. Detect the skin region of the face

By using Hue-Saturation-Value color model identify the skin region of a given image. This step plays key role in facial expression identification system. Skin region detection is sensitive to lighting conditions and background clutter. The proposed method also considers the lighting conditions and illumination changes. In HSV model, two parameters namely p and q are calculated based on the following equations (1) and (2).

p=0.148*H-0.291*S+0.439*V+128-----(1);q=0.439*H-0.368*S+0.071*V+128----(2)

The pixel is identified as a skin pixel based on the values of the p, q and H. The p value is in between the 140and 195, q value is in between 140 and 165, and H values is in between 0.002 and 0.1. The processed images in this step are shown in figure 2.

140 <q< 165 --- eq (3); 140 <p<195 ---eq (4); 0.02 < H < 0.1--- eq (5)

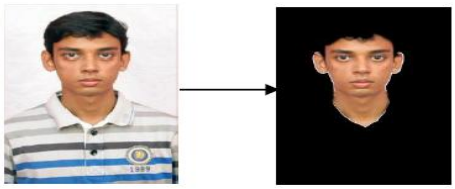

Figure 2: a) original image b) Detect the skin region of original image

B. Cropped skin region

After detecting skin region, crop the skin region from whole face by eliminating the unnecessary parts of the skin region such as neck, hair and so on. Once skin region is cropped, size of the image may changes. So the proposed approach can be identified irrespective of size of the image. Then convert the cropped facial image into grayscale image. The resultant images in this step are shown in figure 3.

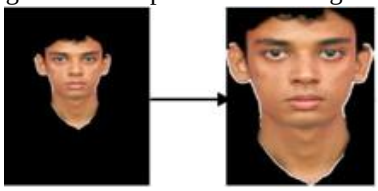

Figure 3: a) Skin Region identified image b) Resultant cropped image c) Gray scale image

2.3RGB image to Grey level facial mage:

The present paper utilizes HSV color model for changing over the facial color image into grey scale, in light of the fact that the present study is expected to assess the human age into five groups in light of the progressions on the facial skin as recognized on the grey scale image. HSV color space isolates the colors into three classifications i.e. Hue, Intensity, and Saturation. The changing over conditions for RGB to grey level transformation are given in the condition from 6 to 10

$V = max(R, G, B)$ … (6);S = $\frac{V - min(R,G,B)}{V}$ … (7);

$H = \frac{G-B}{6S} if \quad V = R$ … (8)

$H = \frac{1}{3} + \frac{B-R}{6S} if \quad V = G$ …(9);

$H = \frac{1}{3} + \frac{R-G}{6S} if \quad V = B$ … (10)

Where Hue (H) component range is from 0 to 255, range of S is from 0 to 1 and range of the V is from 0 to 255. The present work treats the H component as grey component.

C. Third order Neighborhood (TNP)

The most significant job in the classification system is Image analysis and image understanding. The main purpose of Image analysis and image understanding is to extract information from the images to allow the discrimination among different objects of interest. The classification process is mainly based on grey level intensity, color, shape or texture. Image classification is of great interest in a variety of applications, for instance analysis of aerial satellite multispectral and medical images.

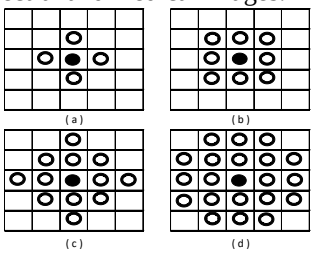

Figure 4: Neighborhood patterns with central pixel (a) 1st Order

Neighborhood pattern (b) 2ndorder Neighborhood pattern (c) TNP (d) 4thorder Neighborhood pattern

Most of the image analysis problems are related to the neighborhood properties i.e. edge detection, segmentation, dilation, closing, opening, LBP, Texture Unit (TU), etc. Each pixel in a neighborhood or image is considered as a random variable, xr, which can assume values xr € {0, 1…G 1}, where G is the number of grey levels of the image. The probability P (xr = xr| r), where r is the neighbor set for the element xr. The figure 4 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 approach considering the difficulties and complexities involved in the third order neighborhood and derived a new, simple and efficient model for image analysis based on transitions.The considered third order neighborhood is formed in 5×5 by window. The Third order Neighborhood (TN) has thirteen pixels of twenty five pixels of 5×5 neighborhood as shown in Figure 5.

		G1		
	G2	G3	G4	
G5	G6	G7	G8	G9
	G10	G11	G12	
		G13		

Figure 5: Third order neighborhood considered pixel positions.

D. Transition count on 'V' and inverted 'V' patterns of the facial image of TNP

In literature, the various patterns based methods on the third order neighborhood and integrated them with Grey Level Co-occurrence Matrix (GLCM) and derived features for efficient age classification. To overcome and address this on third order Neighborhood the present paper uses transition count of 'V' and inverted 'V' patterns in each TNP.

E. Identify 'V' and inverted 'V' patterns:

The each 5×5 sub image is converts to two valued image by comparing the each pixel of TN grey level sub image with the mean value of TN grey sub window. For converting grey level to two valued, the equation 11 is used.

TN-Pi

$$= \begin{Bmatrix} 0 & if & P_i < V_0 \\ 1 & if & P_i \geq V_0 \end{Bmatrix} \quad for\ i = 1, 2, ..13 \quad \ldots (11)$$

Where V_0 is the average value of the 13 considered pixels.On each 5×5 window, identify 'V' and inverted 'V' patterns. Both 'V' pattern and inverted 'V' pattern of TNP consists of five pixels. The considered 'V' pattern pixels of TNP are indicated by blue color and inverted 'V' pattern pixels of TNP are designated by green color and the corresponding patterns are shown in the Figure 6(a) and 6(b) respectively. The Positions at P5, P10, P13, P12, and P9 form 'V' pattern of TN and the positions at P5, P2, P1, P4 and P9 forms inverted 'V' pattern of TN. Figure 6: patterns on TN (a) considered 'V' Pattern b) Considered inverted 'V' Pattern In each 'V' and inverted 'V' patterns, count the number of transition in the pattern. The transition means value is changed either from one-to-zero or zero-to-one in pattern. The present paper considers the transitions in circularly. While considering the pattern circularly, three types of transitions are occurred i.e. 0, 2, and 4 transitions. For example, the considered pattern'00000'or'11111' has 0 transitions, while patterns 00001, 00010, and so on… have 2 one-to-zero or zero-to-one transitions. The patterns like 00101, 01001, 01011 and other circularly pivoted bitwise turned renditions have 4 one-to-zero or zero-to-one transitions. The present approach uses 5 bits to from 'V' and inverted 'V' patterns of TNP. So, totally forms 32 distinct patterns with one of the 3 transitions i.e. zero, two and four transitions. The present approach evaluated the frequency occurrences of transitions on 'V' and inverted 'V' of TNP on the facial images for estimating the age groups.

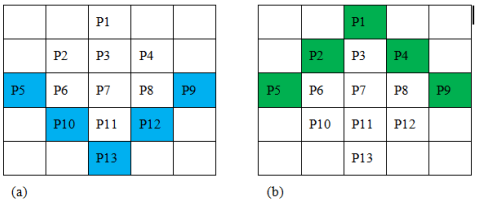

Figure 6: patterns on TN (a) considered 'V' Pattern b) Considered inverted 'V' Pattern

F. Derive a user defined Algorithm for estimate Age group of Facial image

From the data in FV tables, define a user defined algorithm for estimating the age group of the input facial test image. The algorithm classify the facial test input image into one of the pre-defined class group such as Childhood (0-12 years), Young Adults (13-25 years), Middle-aged Adults26-40 years), Senior Adults (40-60 years) and Senior Citizens (more than 60 years). The derived user defined algorithm is defined in algorithm1.

Algorithm 1: Age group estimation (image)
Input: facial test image for Age group estimation
Output: Age group
Start
Step 1: extract the skin region of the face using HIS model
Step 2: Crop the Skin region of the facial image.
Step 3: Convert the Crop color image into grey level image by using HIS color model
Step 4: Convert each 5×5 sub image of TNP into two valued matrix
Step 5: find transition trends of 'V' and inverted 'V' patterns in each 5×5 sub image of TNP.
Step 6: Based on the transition count, estimate the age group of the test image. Let VC be 'V' pattern count, IVC be the inverted 'V' pattern count, 0 be the zero transition count, 2 be the two transition count, 4 be the four transition count.

If ((VC (0)<= 815)and(IVC(0+4>1270 1410)&& (IVC (0+4 < 1410))
    Print ("Facial image is considered as Childhood aged group");
Else if ((VC (0) < 930) and (IVC (0+4 >1410) && (IVC (0+4 <1660))
    Print ("facial image is considered as Young adult aged group");
Else if ((VC (0) <1010) and (IVC (0+4 >1165) && (IVC (0+4 <1206))
    Print ("Facial image is considered as middle aged group");
Else if ((VC (0) <1125) and (IVC (0+4 < 1125))
    Print ("Facial image is considered as Senor aged Group ");
Else if ((VC (0) <1325) and (IVC (0+4 >1205) && (IVC (0+4 <1270))
Print ("Facial image is considered as Senior Citizen aged Group ");
Else
    Print ("Unknown age group");
End

IV. RESULTS AND DISCUSSIONS

Among the many available face databases around the world, four of them are considered which include substantial sets for aging individuals. The MORPH Database [18], FG-NET aging database [28]. 500 images of 50 individuals are collected from Google database (ages from 0 to 80), and 600 images are scanned photographs. Totally, it becomes 19102 face images. In the present method, the sample images are grouped into two databases i.e. training and test database. A few of them are shown in Figure7. The present paper utilizes 60% of the total images i.e. 11461 images are considered as training database.

Calculate the transition count of the each training database facial image and the values to Feature vector (FV) for developing user defined algorithm based on the transition count occurred of the each facial image. Due to cropping the facial skin area, the resultant image size varies so that the transition count of the each image is normalized to 255×255. The transition count of the 'V and inverted 'V' patterns on each 5×5 window of the sample database of the considered five groups are listed out in tables from 1 to 5. Based on the values in FV, an algorithm 1 is designed to estimate the age group of the person to one of the five pre-defined categories: Childhood (0-12 years), Young Adults (13-25 years), Middle-aged Adults26-40 years), Senior Adults (40-60 years) and Senior Citizens (more than 60 years).

Figure 7: Sample facial images used in the present approach

Table1: Frequency occurrences of transitions on 'V' and inverted 'V" pattern of TNP for childhood aged facial images.

Sno	Image Name	V pattern Count (VC)							inverted V pattern Count (IVC)						
		0	2	4	0+2	0+4	2+4	0+2+4	0	2	4	0+2	0+4	2+4	0+2+4
1	001A02	382	1666	553	2048	935	2219	2601	992	1328	281	2320	1273	1609	2601
2	001A05	413	1123	1065	1536	1478	2188	2601	1070	1325	206	2395	1276	1531	2601
3	001A08	473	1134	994	1607	1467	2128	2601	1066	1309	226	2375	1292	1535	2601
4	001A10	517	1423	661	1940	1178	2084	2601	1061	1277	263	2338	1324	1540	2601
5	002A03	584	1378	639	1962	1223	2017	2601	1137	1274	190	2411	1327	1464	2601
6	002A04	586	1671	344	2257	1530	2015	2601	1080	1271	250	2351	1330	1521	2601
7	002A07	589	1109	903	1698	1492	2012	2601	1136	1271	194	2407	1330	1465	2601
8	008A06	598	1661	342	2259	940	2003	2601	1161	1268	172	2429	1333	1440	2601
9	009A00	598	1661	342	2259	940	2003	2601	914	1259	428	2173	1342	1687	2601
10	010A01	617	1207	777	1824	1394	1984	2601	946	1258	397	2204	1343	1655	2601
11	gi008	626	1336	639	1962	1265	1975	2601	937	1257	407	2194	1344	1664	2601
12	gi003	634	963	1004	1597	1638	1967	2601	967	1256	378	2223	1345	1634	2601
13	gi002	649	1210	742	1859	1391	1952	2601	1180	1248	173	2428	1353	1421	2601
14	gi009	698	1691	212	2389	1269	1903	2601	1177	1245	179	2422	1356	1424	2601
15	gi007	704	1527	370	2231	1074	1897	2601	1102	1240	259	2342	1361	1499	2601
16	gi005	714	1689	198	2403	912	1887	2601	1102	1237	262	2339	1364	1499	2601
17	si001	743	1256	602	1999	1345	1858	2601	1141	1230	230	2371	1371	1460	2601
18	si003	759	1594	248	2353	1007	1842	2601	1249	1208	144	2457	1393	1352	2601
19	si005	776	1626	199	2402	975	1825	2601	1123	1198	280	2321	1403	1478	2601
20	si009	815	1584	202	2399	1017	1786	2601	1145	1194	262	2339	1407	1456	2601

Table2: Frequency occurrences of transitions on 'V' and inverted 'V" pattern of TNP for Young adult aged facial images.

Sno	Image	V pattern Count (VC)							inverted V pattern Count (IVC)						
		0	2	4	0+2	0+4	2+4	0+2+4	0	2	4	0+2	0+4	2+4	0+2+4
1	012A32	934	1403	264	2337	1198	1667	2601	1002	1433	166	2435	1168	1599	2601
2	013A34	935	1503	163	2438	1098	1666	2601	899	1427	275	2326	1174	1702	2601
3	018A34	935	1416	250	2351	1185	1666	2601	972	1422	207	2394	1179	1629	2601
4	019A37	936	1436	229	2372	1165	1665	2601	937	1421	243	2358	1180	1664	2601
5	020A36	939	1457	205	2396	1250	1662	2601	837	1418	346	2255	1183	1764	2601
6	021A39	947	1429	225	2376	1172	1654	2601	987	1417	197	2404	1184	1614	2601
7	025A34	947	1429	225	2376	1172	1654	2601	895	1416	290	2311	1185	1706	2601
8	001A43a	952	1419	230	2371	1182	1649	2601	998	1413	190	2411	1188	1603	2601
9	005A45	953	1447	201	2400	1154	1648	2601	1007	1408	186	2415	1193	1594	2601
10	006A42	967	1137	497	2104	1464	1634	2601	988	1407	206	2395	1194	1613	2601
11	gi026	969	1447	185	2416	1154	1632	2601	966	1405	230	2371	1196	1635	2601
12	gi028	975	1503	123	2478	1098	1626	2601	940	1404	257	2344	1197	1661	2601
13	gi040	981	1420	200	2401	1181	1620	2601	987	1404	210	2391	1197	1614	2601
14	gi042	982	1424	195	2601	1177	1619	2601	1010	1403	188	2413	1198	1591	2601
15	gi045	997	1315	289	2312	1286	1604	2601	995	1402	204	2397	1199	1606	2601
16	si039	998	1404	199	2402	1197	1603	2601	998	1402	201	2400	1199	1603	2601
17	si045	999	1407	195	2406	1194	1602	2601	1095	1401	105	2496	1200	1506	2601
18	si038	999	1348	254	2347	1253	1602	2601	962	1398	241	2360	1203	1639	2601
19	si041	1002	1363	236	2365	1238	1599	2601	1012	1398	191	2410	1203	1589	2601
20	si035	1008	1421	172	2429	1180	1593	2601	942	1396	263	2338	1205	1659	2601

Table 3: Frequency occurrences of transitions on 'V' and inverted 'V" pattern of TNP for Middle aged images

Sno	Imname	V pattern Count (VC)							inverted V pattern Count (IVC)						
		0	2	4	0+2	0+4	2+4	0+2+4	0	2	4	0+2	0+4	2+4	0+2+4
1	003A51	1014	1420	167	2434	1181	1587	2601	427	1626	548	2053	975	2174	2601
2	003A57	1016	1388	197	2404	1213	1585	2601	631	1600	370	2231	1001	1970	2601
3	003A58	1018	1445	138	2463	1156	1583	2601	631	1600	370	2231	1001	1970	2601
4	003A59	1023	1421	157	2444	1180	1578	2601	815	1588	198	2403	1013	1786	2601
5	003A60	1024	1473	104	2497	1016	1577	2601	855	1548	198	2403	1053	1746	2601
6	004A53	1024	1388	189	2412	1213	1577	2601	814	1533	254	2347	1068	1787	2601
7	006A54	1026	1254	321	2280	1347	1575	2601	925	1531	145	2456	1070	1676	2601
8	006A55	1028	1339	234	2367	1262	1573	2601	806	1510	285	2316	1091	1795	2601
9	039A50	1046	1359	196	2405	1242	1555	2601	904	1504	193	2408	1097	1697	2601
10	003A47	1049	1347	205	2396	1254	1552	2601	879	1492	230	2371	1109	1722	2601
11	003A49	1058	1269	274	2327	1332	1543	2601	877	1479	245	2356	1122	1724	2601
12	004A48	1067	1296	238	2363	1305	1534	2601	1123	1456	22	2579	1145	1478	2601
13	gi046	1068	1254	279	2322	1347	1533	2601	934	1456	211	2390	1145	1667	2601
14	gi048	1073	1413	115	2486	1188	1528	2601	929	1455	217	2384	1146	1672	2601
15	gi050	1079	1401	121	2480	1200	1522	2601	956	1453	192	2409	1148	1645	2601
16	gi052	1081	1367	153	2448	1234	1520	2601	1016	1453	132	2469	1148	1585	2601
17	gi055	1094	1310	197	2404	1291	1507	2601	953	1444	204	2397	1157	1648	2601
18	gi041	1108	1292	201	2400	1309	1493	2601	945	1443	213	2388	1158	1656	2601
19	gi052	1118	1200	283	2318	1401	1483	2601	735	1442	424	2177	1159	1866	2601
20	gi055	1124	1297	180	2421	1304	1477	2601	957	1436	208	2393	1165	1644	2601

Table4: Frequency occurrences of transitions on 'V' and inverted 'V" pattern of TNP for Senior aged images.

sno	Imgid	V pattern Count (VC)							inverted V pattern Count (IVC)						
		0	2	4	0+2	0+4	2+4	0+2+4	0	2	4	0+2	0+4	2+4	0+2+4
1	006A69	1139	1337	125	2476	1264	1462	2601	968	1395	238	2363	1206	1633	2601
2	003A61	1140	1248	213	2388	1353	1461	2601	922	1392	287	2314	1209	1679	2601
3	004A53	1145	1251	205	2396	1350	1456	2601	1043	1390	168	2433	1211	1558	2601
4	004A62	1149	1219	233	2368	1382	1452	2601	967	1378	256	2345	1223	1634	2601
5	004A63	1165	1184	252	2349	1417	1436	2601	1033	1378	190	2411	1223	1568	2601
6	005A61	1177	1149	275	2326	1452	1424	2601	1022	1376	203	2398	1225	1579	2601
7	006A61	1189	1183	229	2372	1418	1412	2601	973	1371	257	2344	1230	1628	2601
8	006A67	1189	1183	229	2372	1418	1412	2601	968	1369	264	2337	1232	1633	2601
9	004A64	1192	1193	216	2385	1408	1409	2601	951	1363	287	2314	1238	1650	2601
10	004A61	1213	1136	252	2349	1465	1388	2601	1027	1362	212	2389	1239	1574	2601
11	gi066	1214	1261	126	2475	1340	1387	2601	1002	1359	240	2361	1242	1599	2601
12	gi068	1220	1252	129	2472	1349	1381	2601	1047	1358	196	2405	1243	1554	2601
13	gi065	1238	1122	241	2360	1479	1363	2601	1067	1358	176	2425	1243	1534	2601
14	gi062	1239	1247	115	2486	1354	1362	2601	878	1357	366	2235	1244	1723	2601
15	gi065	1249	1163	189	2412	1438	1352	2601	1054	1355	192	2409	1246	1547	2601
16	si070	1274	1121	206	2395	1480	1327	2601	954	1354	293	2308	1247	1647	2601
17	si068	1276	1153	172	2429	1448	1325	2601	963	1354	284	2317	1247	1638	2601
18	si071	1305	1146	150	2451	1455	1296	2601	1044	1347	210	2391	1254	1557	2601
19	si269	1319	1111	171	2430	1490	1282	2601	1040	1333	228	2373	1268	1561	2601
20	si066	1324	1089	188	2413	1512	1277	2601	1062	1332	207	2394	1269	1539	2601

Table5: Frequency occurrences of transitions on 'V' and inverted 'V" pattern of TNP for Senior citizen's facial images.

To find the potentiality of the proposed algorithm various experiments are conducted. These experiments uses remaining40% of images from the four databases. The experiments are conducted on the system with CPU of Intel Core i7-2640 M Processor 2.8GHz (Turbo Boost up to 3.5 GHz), Memory of 8 GB, Windows 7 Professional (64 bit) and Mat Lab (64 bit) R2010a.The amount of time consumed for the proposed method is 42.36 seconds when cumulative dataset is used which consists of 7641 images.

The images used in these experiments are images which are not used in the process of generate the FV. Totally 7641 images are used for testing the proposed algorithm. The experiments are conducted individually in each database and finally conduct the cumulative experiment. The experimental results of the each data base are list out in tables from 6 to 9 and cumulative experiment result is shown in Table 10. The overall percentage of correct classification when the user defined algorithm used for age estimation is 96.67%.

V.CONCLUSIONS

The present paper proposed a robust method for estimation of facial images of the human facial image. The present approach identified 'V and inverted 'V' patterns with 5-bits on each 5×5 sub image. On each 'V; and inverted 'V' patterns calculate the transition count i.e. zero, two and for transitions and add these values and treat them as FV. Based on these FV values, this paper defined an algorithm for estimating the predefined age groups. In future we can evaluate the performance by Using techniques or algorithms

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