Teeth Recognition for Person Identification

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***Abstract*— In this research work, a model of teeth recognition has been proposed to identify a person. The persons' teeth image have been matched against the database of teeth images. An algorithm has been developed to recognize the teeth image by using the image processing methods. The author has been set a similarity criterion to match the teeth image against the image database by specifying the threshold value. This similarity criterion is used to identify a person. The labial teeth and gingiva photographic image database (LTG-IDB) have been taken to verify the results. The database consists 90 photographic images from 27 subjects. . The experiment results has carried on 20 teeth images of same person and 50 teeth images of different persons. MATLAB has been used for this purpose.**

Keywords— **Teeth image; Image processing; morphological operations; LTF-IDB database; MATLAB**

I. INTRODUCTION

The author has been introduced a new approach to recognize the teeth of people. A set of teeth images have been used as template and saved in the image database. Most biometric methods use a single image to identify a person. These processes are complex and need sophisticated equipment and a controlled environment to be correctly used. It is almost impossible to fulfill these conditions to recognize the teeth [3] [8] [9]. Author has been taken the RGB image of teeth of persons. The RGB image has been converted into the gray-scale image. The gray-scale image is converted into image of size 20×20 by applying the resize operation. Author has recognized the pattern of teeth and converted the image into binary image by applying the threshold value [1]. The binary image has cropped into smaller size and number of one's has been counted present in the pattern [4] [5]. Then, the teeth image has fetched from the image database and match with the existing teeth image [3]. Author has been derived the similarity criteria. If similarity measure between these two teeth image is above threshold value, then the image belongs to the same person, otherwise, not [2] [6] [7]. MATLAB has been used to implement the algorithm [10].

The paper is organized as: author has proposed the model in section II. The results analysis have been performed in section III. Finally, section IV conclude the paper.

II. PROPOSED MODEL OF TEETH RECOGNITION

The block diagram of proposed model is shown in fig. 1:

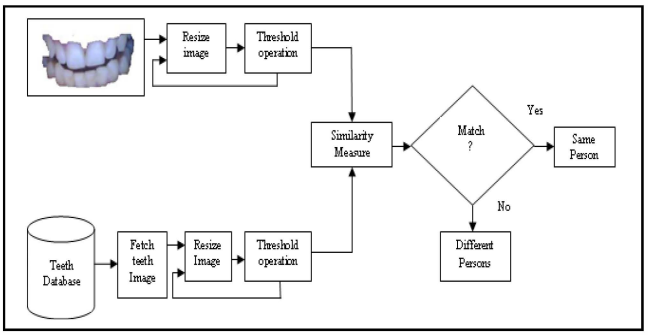


Fig. 1. Block diagram of teeth recognition

A. Methodology

1. Read the original RGB image.
2. Resize the RGB image into size 256×256.
3. Convert the RGB image into gray-scale image.
4. Resize the image into size 20×20.
5. Convert gray-scale image into binary image by choosing threshold value.
6. Crop the binary image.
7. Count the number of one's.
8. Take another RGB image and repeat step from 1 to 7.
9. Calculate the percentage difference between these two images.

$$Difference = \left| \frac{Image\_1 - Image\_2}{(Image\_1 + Image\_2)/2} \right| \times 100 \quad (1)$$

10. Find the similarity between these two images

$$Similarity = 100 - Difference \quad (2)$$

11. Choose a threshold value.
12. If Similarity $\geq$ Threshold, then images belongs to same person otherwise they belong to different persons.
13. End.

B. Working of the proposed model

The following steps are:

1. Take RGB Image of teeth 1 as shown in fig. 2:

Fig. 2. RGB Image of Teeth 1

2. Convert RGB Image of teeth 1 into gray-scale image which is shown in fig. 3:

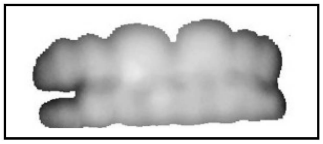


Fig. 3. Gray-scale Image of Teeth 1

3. Convert gray-scale image of teeth 1 into 20 ×20 matrix as shown in fig. 4:

255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255
255	255	255	255	255	255	255	255	255	255	255	241	200	220	255	255	255	255	255	255
255	255	255	255	255	255	249	184	166	209	254	235	153	129	120	223	255	255	255	255
255	255	255	255	233	244	199	135	161	150	209	199	163	177	148	142	128	216	255	255
255	255	194	182	137	150	149	172	194	183	178	192	191	200	178	135	115	91	194	255
255	230	112	114	145	154	152	194	210	204	175	176	205	209	192	164	153	108	121	250
255	152	123	151	166	180	176	204	217	213	189	187	211	213	201	181	169	141	105	222
233	97	143	165	178	193	190	212	222	216	199	198	214	213	203	189	177	155	109	207
208	100	151	171	180	196	196	217	227	215	203	204	213	208	201	188	177	159	110	209
186	99	152	166	170	193	192	218	230	212	202	201	206	199	195	175	165	151	112	226
186	94	139	144	139	171	173	209	220	203	191	188	196	189	189	173	158	127	114	244
213	76	90	91	108	155	163	197	200	196	193	180	194	186	190	183	168	119	95	245
253	206	189	152	119	164	174	195	186	196	204	191	196	189	193	194	181	144	90	209
255	234	137	112	144	186	189	195	183	202	211	197	197	190	195	194	182	169	116	167
255	117	69	103	161	194	190	194	186	198	205	195	196	189	193	189	177	171	127	153
248	104	121	146	168	194	184	189	184	189	194	186	190	178	177	172	157	147	105	171
253	119	119	149	153	171	164	168	162	162	166	158	162	156	156	158	175	162	164	232
255	190	118	117	156	175	215	221	194	208	216	219	213	234	240	242	255	255	255	255

Fig. 4. Gray-scale matrix of Teeth 1

4. Convert gray-scale image of teeth 1 into binary image by applying threshold (threshold = 186) as shown in fig. 5:

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	1	1	0	0	0	1	1	0	0	0	0	0
0	0	0	0	0	0	0	1	1	1	1	0	0	1	1	1	1	1	0	0
0	0	0	1	1	1	1	1	0	1	1	0	0	0	1	1	1	1	0	0
0	0	1	1	1	1	1	1	0	0	0	1	1	0	0	0	1	1	1	1	0
0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	0
0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0
0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0
1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0
1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	1	1	1	1	0
0	1	1	1	1	1	1	1	0	0	0	0	1	0	1	0	1	1	1	1	0
0	0	0	1	1	1	1	1	0	1	0	0	0	0	0	0	0	1	1	1	0
0	0	1	1	1	1	1	0	0	1	0	0	0	0	0	0	0	1	1	1	1
0	1	1	1	1	1	0	0	0	1	0	0	0	0	0	0	0	1	1	1	1
0	1	1	1	1	1	0	1	0	1	0	0	1	0	1	1	1	1	1	1	1
0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Fig. 5. Binary matrix of Teeth 1

5. Crop binary image of teeth 1 into 3×18 matrix and count the number of 1's (Numbers of 1's = 127).

6. Take RGB Image of teeth 2 which is shown in fig. 7:

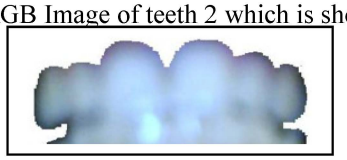


Fig. 6. RGB Image of Teeth 2

7. Convert RGB Image of teeth 2 into gray-scale image as shown in fig. 7:

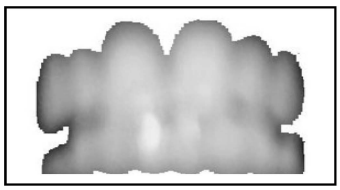


Fig. 7. Gray-scale Image of Teeth 2

8. Convert gray-scale image of teeth 1 into 20×20 matrix which is shown in fig. 8:

255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255
255	255	255	255	255	255	199	185	233	255	255	206	172	193	253	255	255	255	255	255
255	255	255	255	255	218	126	133	154	247	233	158	159	145	213	252	246	255	255	255
255	255	255	255	255	185	153	175	156	212	206	180	193	176	173	150	139	248	255	255
255	248	244	201	192	171	181	197	182	190	193	198	207	196	159	144	122	192	214	252
254	155	133	145	142	159	199	209	200	174	182	209	214	205	177	169	151	121	100	220
235	120	138	159	168	175	205	213	207	185	190	213	217	210	188	184	166	136	112	174
217	124	155	170	179	185	207	213	209	194	198	214	217	211	195	192	175	153	129	148
195	125	162	173	185	190	207	211	211	201	205	215	220	211	194	193	178	162	139	138
197	129	162	171	183	188	204	212	217	204	203	211	217	207	185	184	176	164	140	143
196	127	155	157	166	177	200	209	216	199	195	207	209	202	177	171	166	158	136	159
195	115	130	129	145	168	194	202	221	198	192	209	201	196	179	170	160	139	122	196
213	87	101	114	139	167	190	196	229	211	195	215	198	197	192	180	165	126	182	251
251	183	201	129	156	178	190	194	231	223	203	214	201	200	200	192	179	129	152	217
255	255	178	136	172	181	187	193	229	219	201	205	197	201	200	191	187	149	104	136
255	161	88	151	171	175	182	184	211	205	196	197	190	193	194	185	185	168	139	137
249	115	123	153	156	157	167	163	182	182	175	181	170	172	177	167	170	164	145	139
246	114	112	124	158	180	158	200	194	192	198	173	200	177	151	161	153	133	118	146
255	182	172	192	233	255	247	255	255	255	255	249	255	250	228	244	227	200	183	217
255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255

Fig. 8. Gray-scale matrix of Teeth 2

9. Convert gray-scale image of teeth 1 into binary image by applying threshold (threshold = 186) as shown in fig. 9:

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0
0	0	0	0	0	0	0	1	1	1	0	0	1	1	1	0	0	0	0	0
0	0	0	0	0	0	1	1	1	1	0	0	1	0	1	1	1	1	0	0
0	0	0	0	0	1	1	1	0	1	0	0	0	0	0	1	1	1	0	0
0	1	1	1	1	1	0	0	0	1	1	0	0	0	1	1	1	1	1	0
0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1
0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1
0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1
0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	0
0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	1	1	1	0
0	1	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0
0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1
0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1
0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0	1	1	1	1	1	1	0	0	0	0	1	0	1	1	1	1	1	1	1
0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Fig. 9. Binary matrix of Teeth 2

10. Crop binary image of teeth 1 into 3×18 matrix and count the number of 1's. The total number of one's present in the pattern is 126.

11. Calculate the percentage difference between two images by counting numbers of 1's.

$$Difference = \left|\frac{127 - 126}{(127 + 126)/2}\right| \times 100 = 0.79\ \% \qquad (3)$$

12. Calculate the similarity between teeth images.

$$Similarity = 100 - 0.79 = 99.21\ \% \qquad (4)$$

13. If similarity is above specified threshold value (Threshold value is 74). Teeth images belong to same person; otherwise they belong to different persons.

III. RESULT ANALYSIS

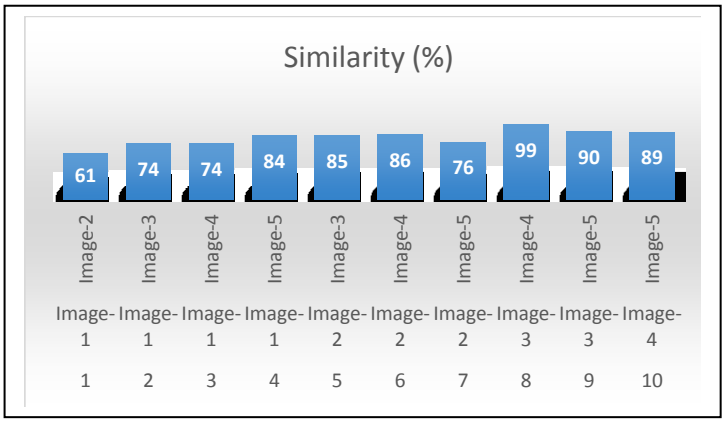
Author has been taken 20 teeth images of same person and 50 teeth images of different persons. An experiment has been conducted to match the teeth images of a person against the database of teeth images. The table I has shown the results on the teeth image belong to the same person. Both the images

match against the similarity criteria. If they are more than specified threshold value, then they belong to the same person. The threshold value is 74. The experiment results prove that the accuracy of the proposed model is found more than 90%.

TABLE I. TEETH IMAGE OF SAME PERSON

S No	Same person		Similarity (%)
1	Image-1	Image-2	61
2	Image-1	Image-3	74
3	Image-1	Image-4	74
4	Image-1	Image-5	84
5	Image-2	Image-3	85
6	Image-2	Image-4	86
7	Image-2	Image-5	76
8	Image-3	Image-4	99
9	Image-3	Image-5	90
10	Image-4	Image-5	89

The similarity between two teeth of same person has been shown in fig. 10:



In table II, authors have taken two set of teeth images belong to different persons. The experiment results show that the teeth images of different persons match only in case of 20%. The accuracy of the system is more than 80% in this case.

TABLE II. TEETH IMAGE OF DIFFERENT PERSON

SN	Different Persons		Similarity (%)
1	Image-11	Image-12	74
2	Image-11	Image-13	27
3	Image-11	Image-14	1
4	Image-11	Image-15	45
5	Image-11	Image-16	20
6	Image-12	Image-13	50
7	Image-12	Image-14	22
8	Image-12	Image-15	69
9	Image-12	Image-16	42
10	Image-13	Image-14	68

SN	Different Persons		Similarity (%)
11	Image-2	Image-15	51
12	Image-2	Image-16	25
13	Image-3	Image-11	79
14	Image-3	Image-14	18
15	Image-3	Image-15	65
16	Image-3	Image-16	38
17	Image-4	Image-11	79
18	Image-4	Image-12	94
19	Image-4	Image-13	45
20	Image-4	Image-14	17

The similarity between two teeth of different person has shown in fig. 11 and 12:

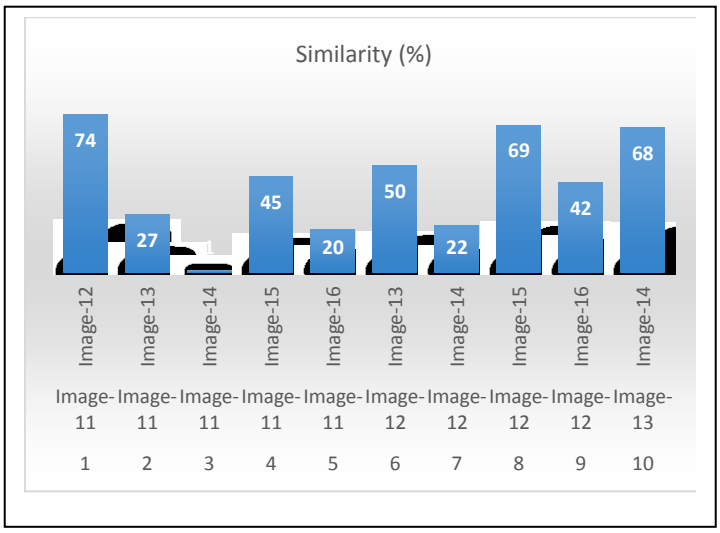


Fig. 11. Similarity among different set of teeth

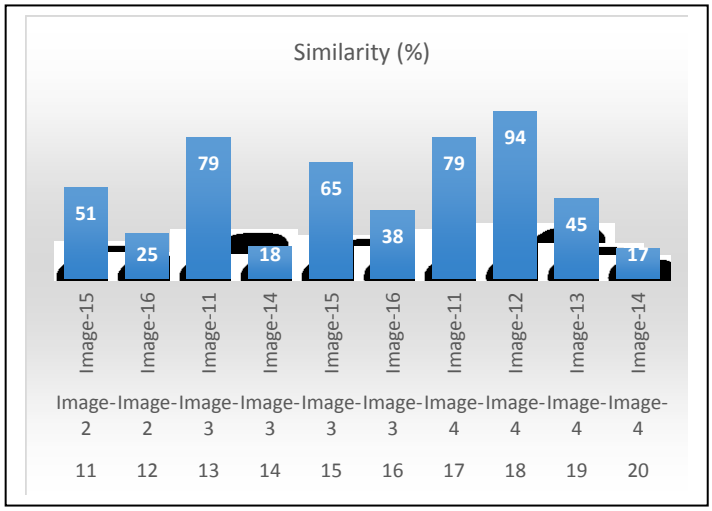


Fig. 12. Similarity among different set of teeth

IV. CONCLUSION

In this paper, the model of teeth recognition for person identification has been proposed. The image processing techniques have been used to match the pattern of teeth image against the teeth image database (LTG-IDB). If the similarity between two teeth images is above the specified threshold value, then they belong to the same person otherwise they belong to different persons. The author concluded that the accuracy of the proposed system is more than 90% when the teeth images belong to same person. The proposed system is

80% accurate when the teeth images belong to different persons. In short, the conclusion is that the accuracy of the proposed system is more than 85% on the given set of teeth images.

ACKNOWLEDGMENT

The author is grateful to the Management, the Dean, the HOD and all staff members of Faculty of Computing department, Botho University, Gaborone, Botswana for their valuable support.

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