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Labial Teeth structure for human identity

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Abstract:

In this paper, we have proposed a model of teeth recognition to identify a person. The teeth image of a person is matched against the teeth image database. We have developed an algorithm to recognize the teeth using image processing techniques. The proposed work is an application of pattern recognition, which analyses the pattern of teeth images. A similarity criterion has been derived to match against the specified threshold value. This similarity measure has been used for person identification. The experiment results has been carried on 20 teeth images of the same person and 100 teeth images of different persons from our database and Labial Teeth Database of Color Imaging Lab - University of Granada – Spain. MATLAB 7.4 has been used for this purpose. The paper is described in different sections: section I introduces the proposed system of teeth recognition. In section II, we have proposed the model for teeth recognition, methodology and working of the proposed algorithm. We have analyzed the results in section III. Finally, section IV provides a conclusion.

Key words: Dental identity, Forensic Dental Biometric, Dental Biometric, Segmentation, Matching, image processing.

I. INTRODUCTION

During the Roman Empire period, killing of LoillaPaulina, was identified by her dental caries. Disaster occurred in Amoedo, Paris during 1897 French dental society used dental identification technique for identifying victims [10]. In forensic department, the police perform manual comparisons of ante-mortem (AM) and post-mortem (PM) dental records, for identifying a person during fire accidents or disasters because teeth and components of dental restorations have a very high melting point and is annealed only at high temperatures. A teeth filling retains its shape upto 600°C and the amalgam withstands up to 1100°C. A person's dental pattern can be used as same degree of reliability as DNA; this report has been released by the University of Grandana because they used this method used by the forensic police to identify dead bodies [13]. All these methods are practically used very rarely because of any insufficient data in the database.

As the digital imaging device and the computer recognition algorithm are improving quickly, more effort will be spent on digital image recognition to facilitate the biometrics and medical decision-making process. There are many theories and methods of pattern recognition that can be used for teeth image recognition [3]. This paper introduces a new approach to recognize the teeth of people. Teeth images have been used as templates and saved in the image database. The research on teeth recognition is based on the image processing techniques. Most biometric methods utilize a single image for person identification. 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]. We have taken the RGB image of teeth of person.

The RGB image is converted into the gray-scale image. The gray-scale image is converted into image of size 20×20 by applying the resize operation. We have 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 is fetched from the image database and matched with the existing teeth image. We have derived the similarity criteria. If similarity measure between these two teeth images is more than the threshold value, the image belongs to the same person [2] [6] [7].

II. PROPOSED MODEL OF TEETH RECOGNITION

In this proposed typical architecture consist of preprocessor, dental recording, processing of image, matrix generation, storing of processed data in to database, search data, retrieval, comparison of processed data, makes decision and trigger authorization. During preprocessing Meta data of all the remaining records about individuals like name, age, employee number, etc. are filled. During dental

recording, a high resolution camera needs to be attached with system to record face of the individual to capture. The distance between camera and human face should be less than 50cm. There should be face chin holder to capture teeth image very clearly. System will give instruction on the posture for taking face image with teeth exposed. This image will be extracted and trimmed for only teeth portion. The segmentation of the teeth is extracted from the whole face image using clustering technique. This algorithm groups the pixels into a number of clusters such that the intensity of pixels of a cluster has almost similar values.

The algorithm also detects the skin part of human body present in the image. We have used a face detection system based on the algorithms by applying a series of operations like edge detector, morphological operator, filled region, and non-face. We have to record each image into matrix form into database for future processing.This image is getting resized for 256X256 for consistency purpose. Later, this will be converted into grayscale image. The image is again resized into 20X20 to enable captured data to record into database. There is an option to fix dynamically, fixed value of threshold or use the formula furnished. So we take 18X18 matrix data for calculation. It will be input for converting image into matrix format. Decision logic will be used by creating multiple threshold values but whole experiment should have similar setup which means same camera and same threshold is used in this experiment. The block diagram of proposed model is shown below in Figure1.

There are different types of dental radiograph, Bitewing X-ray- Bitewing x-ray is taken at routine check-ups. Periapical x-ray- It shows entire tooth, including crown, root and bone, external picture as JPG. Panoramic x-ray- It gives broader overview of entire dentition. It shows not only teeth also sinus, upper and lower jawbone. X-ray based picture required special equipment related to medical purpose. Normal Tooth pictures can be taken using camera installed in experimental area with facility to take picture while user reading letters “EEEEE” which gives wide coverage of user teeth. In our experiment we take this JPG images as input.

2.1 LABIAL TEETH DATABASE

Color Imaging Lab - University of Granada, Spain has images of human teeth, Labial Teeth and Gingiva Image photographic image database (LTG-IDB), developed at the Color ImagingLab at the Optics Department of the University of Granadain Spain.The LTG-IDB currently contains more than 90 photographic digital still of teeth images. Images in this database are available in raw image format (which is the unprocessed sensor data of the camera in a specific vendor dependent data format, in this case the *Canon raw image format cr2*), as well as *JPEG* and *TIFF*. The strengths of this database are the fixed, well-defined and well known parameters of image acquisition.We have downloaded these images to extract teeth image for testing purpose [14].

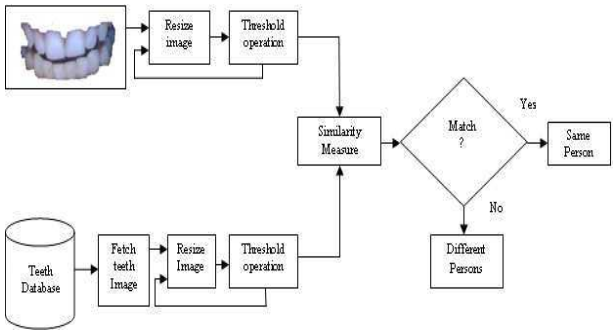


Figure 1: Block Diagram of teeth recognition

2.2 METHODOLOGY

There are two major formulas used for executing proposed algorithm. One is find the difference and similarity of the cropped matrix which is created around middle point of the image. As stated above, one uses percent difference when comparing two calculated or experimental valuesto each other. Typically, one is interested in the percent difference of two values pertaining to the same property or characteristic of an object or system (mass, velocity, charge, etc.) Typically, both values are calculated using different methods, theories, or devices. Just as with percent error, calculating percent difference is as follows.

$$\text{Difference } \%D = \left|\frac{I1-I2}{(I1+I2)/2}\right| \times 100 \quad \text{.....(1)}$$

$$\text{Similarity } \%(S) = 100 - D \quad \text{.....(2)}$$

Where $I1$ and $I2$ correspond to the experiment values of interest [15].

Algorithm:

Step 1. Collect Meta data like employee id about the person's image and store in database assign unique id for image.

Step 2. Read the RGB image.

Step 3. Extract teeth part.

Step 4. Resize the image into size 256 × 256.

Step 5. Convert the RGB image into gray-scale image.

Step 6. Resize the image into size 20 × 20 and store in database.

Step 7. Find $Threshold = \frac{(Gray\ Matrix\ Max\ value + Gray\ Matrix\ Min\ value)}{2}$

Step 8. Convert gray-scale image into binary image by using threshold value.

Step 9. Crop the binary image from row focused as 5X18 in the middle.

Step 10. Count the number of one's store

Step 11. Take another RGB image from learning database and repeat steps 1 to 10.

Step 12. Calculate the percentage difference between these two images.

Step 13. $Difference\% = \left|\frac{Image\ 1 - Image\ 2}{(Image\ 1 + Image\ 2)/2}\right| \times 100$ .....(3)

Step 14. Find the similarity between these two images

Step 15. $Similarity\% = 100 - Difference$ .....(4)

Step 16. Repeat above steps with multiple images of the same person in the learning database. If Similarity is within Acceptance Range consecutively compared with multiple image of same person, images belongs to the same person otherwise they belong to different persons.

Step 17. End.

Acceptance range is derived from difference of percentage between various sample images of the same person taken during the training time. Let us take for example a person is taken 10 images during the training. All these10 images are cross compared with one another and the difference range is determined.

In the database, every image Meta data is stored. Meta data contains like name, age, employee number. We may store up to 50 images or more of the same person. More number of learning data will give higher accuracy. Every trail data will be stored and kept for future use. The similarity has been calculated at random of two images of the same person. Average of the previous images similarity should be matching within threshold range; if not system will identify as different person. Based on this calculation authentication activity will be done. We can compare the pattern between the same person image and different person images. These patterns can be arrived only when you compare images in cross comparison. For the same person min and max range will be within certain limit but for different person's image. Based on this observation the system can very easily make out if the image belongs to a particular individual or not. If the images match, the person is granted access to proceed with further steps else access is denied.

Toleration level acceptance criteria is defined based on learning images. While pattern regeneration compares the key data with multiple test data of same person, if similarity is above specified threshold value, Teeth images belong to same person; otherwise they belong to different persons. Once the person is identified using his Meta data his previous experimental data range is compared to ensure accuracy.

2.3 WORKING OF PROPOSED ALGORITHM

The following steps are carried using algorithm to calculate similarity % of two images.

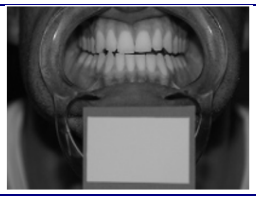
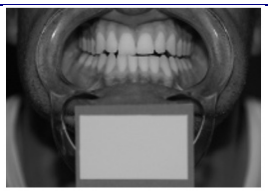
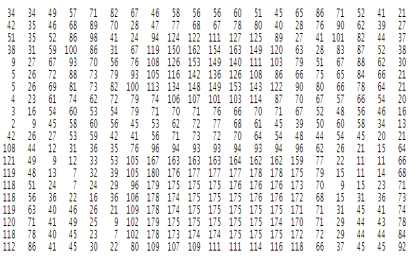
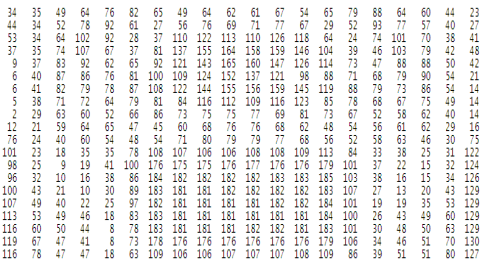
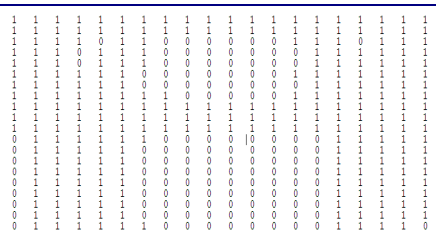
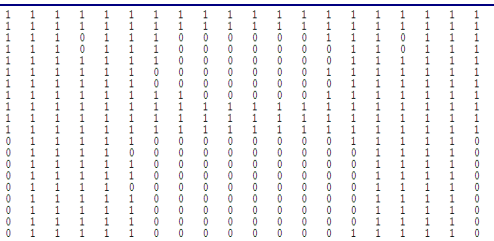
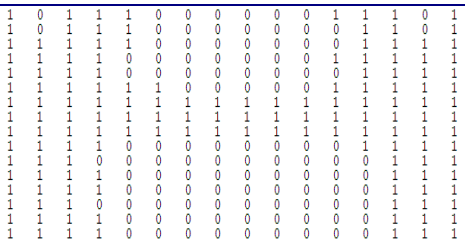
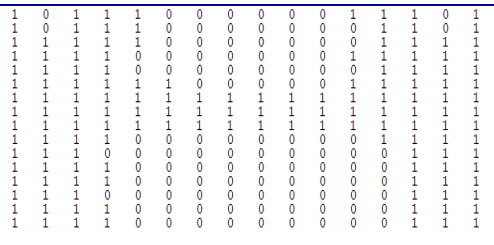
Description of Operation	First Image	Secound Image
RGB Image		
gray image		
The matrix of first gray-scale image		
Calculate the Threshold	The maximum threshold value of image:threshold1 = 180 The minimum threshold value of image:threshold2 = 2 The average threshold value of image:threshold = 91	The maximum threshold value of image:threshold1 = 185 The minimum threshold value of image:threshold2 = 2 The average threshold value of image: threshold = 94
The matrix of binary-scale image is		
The matrix of cropped image 18X18		
ones in image	150	148
Difference %	1.3423%	
Similarity%	98.6577%	

Figure 2: Step by step execution of algorithms

III. EXPERIMENTAL RESULT ANALYSIS

We have been taken 20 teeth images of same person and 100 teeth images of different persons. An experiment has conducted to match the teeth images of a person against the teeth image database. The table 1 has shown the results on the teeth image belongs 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. Matching is critical and tricky stage of dental biometric system which finds out difference between two dental processed data. Here we consider cropped data in matrix format for matching of the dental image. Conclusion can be made by matching one original image in order to increase the accuracy. Algorithm can create pattern of the same person image created using learning data. When comparison is made though all of the training data it is based on more number of sample. It will ensure accuracy of the result is always high.

S No	Same person		Similarity(%)
1	Image 1	Image 2	98.66
2	Image 1	Image 3	100
3	Image 1	Image 4	98.66
4	Image 1	Image 5	91.66
5	Image 1	Image 6	87.26
6	Image 2	Image 3	98.66
7	Image 2	Image 4	100
8	Image 2	Image 5	93.01
9	Image 2	Image 6	88.57
10	Image 3	Image 4	98.66

Table 1: Teeth Image of Same Person

The similarity between two teeth images of same person was taken and calculated similarity using proposed algorithm. Randomly taken images are compared with each other images of the same person. We may observe the pattern in Figure 3 it may vary between 88 to 100%. The table needs to be compared for accuracy of the individual teeth image.

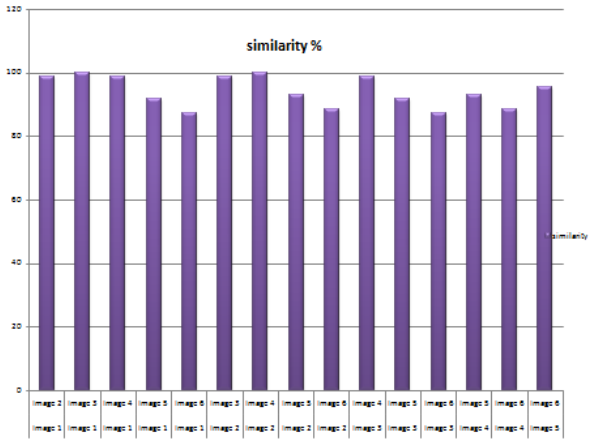


Figure 3: Similarity among same person teeth images variations within limits

In Table 2, We have taken set of teeth images belonging to different persons. The experiment results show that the teeth images of different persons and its similarity percentage. The similarity between two teeth images of different persons as shown in figure 4 and 5: We need to observe the patterns of which range from 1 to 95%. So the range difference can't vary this much for the same person. Based on the range observation system can easily make out this image is belongs to different person.

Below figure demonstrates teeth structure as one of parameters in verification process.

Figure 3a. Teeth structure verification being used in ATM machine.

S No.	Different Persons		Similarity(%)	S No.	Different Persons		Similarity (%)
1	Image 11	Image 12	74	11	Image 2	Image 15	51
2	Image 11	Image 13	27	12	Image 2	Image 16	25
3	Image 11	Image 14	1	13	Image 3	Image 11	79
4	Image 11	Image 15	45	14	Image 3	Image 14	18
5	Image 11	Image 16	20	15	Image 3	Image 15	65
6	Image 12	Image 13	50	16	Image 3	Image 16	38
7	Image 12	Image 14	22	17	Image 4	Image 11	79
8	Image 12	Image 15	69	18	Image 4	Image 12	94
9	Image 12	Image 16	42	19	Image 4	Image 13	45
10	Image 13	Image 14	68	20	Image 4	Image 14	17

Table 2: Teeth Image of Different Persons

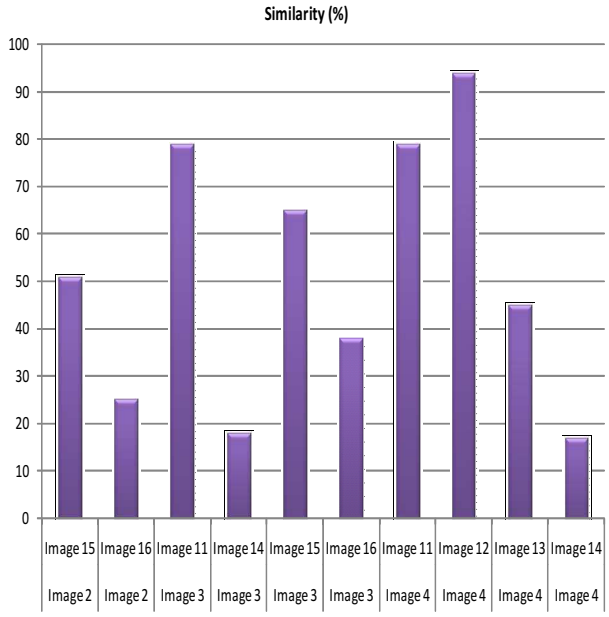


Figure 4: Similarity among different person teeth variation outside limits

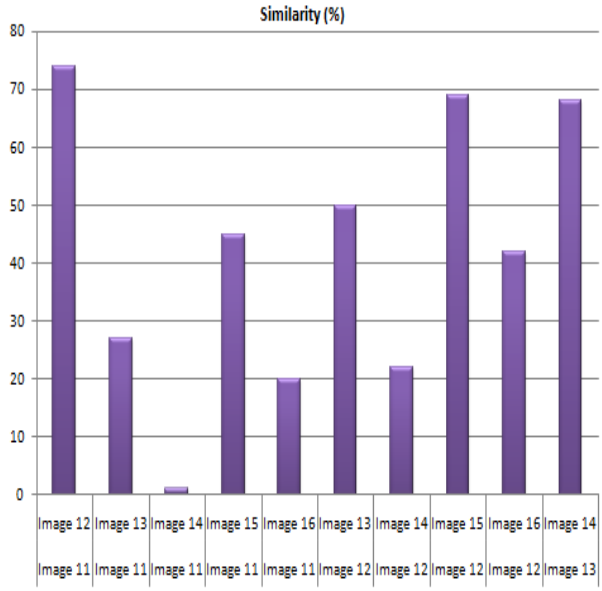


Figure 5: Similarity among different person teeth variation outside limits

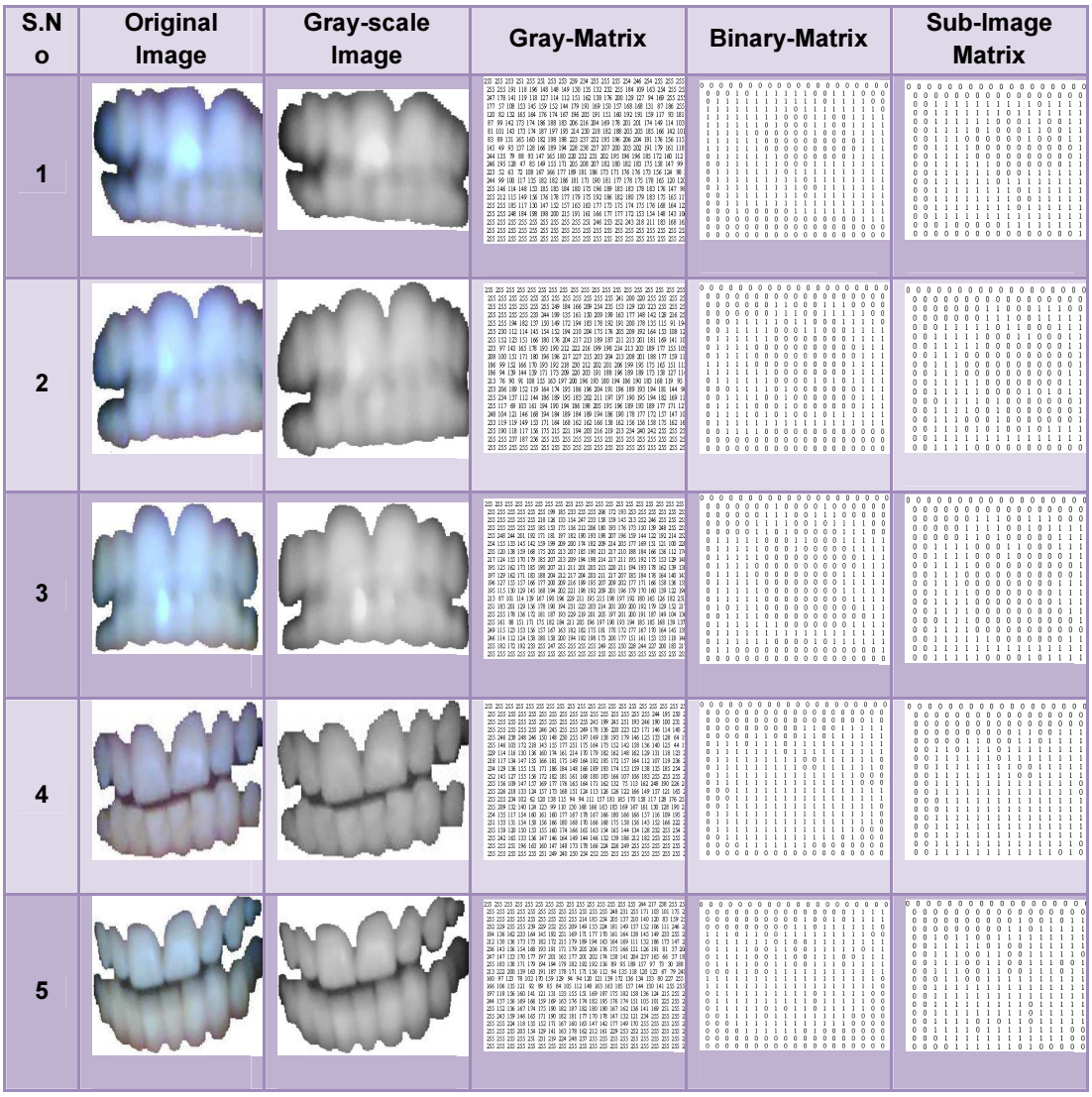
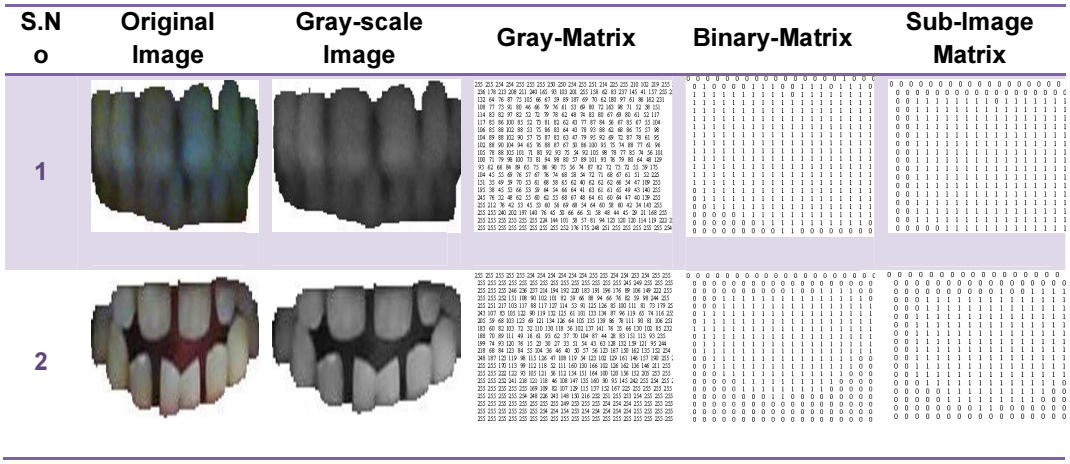


Figure 6 Teeth images belongs to same person

Figure 6 has list of images taken from same person with different variations. Figure 7 has list of images taken from different individuals with different variations. It has gray images and its matrix along with binary matrix to enable calculating similarity.



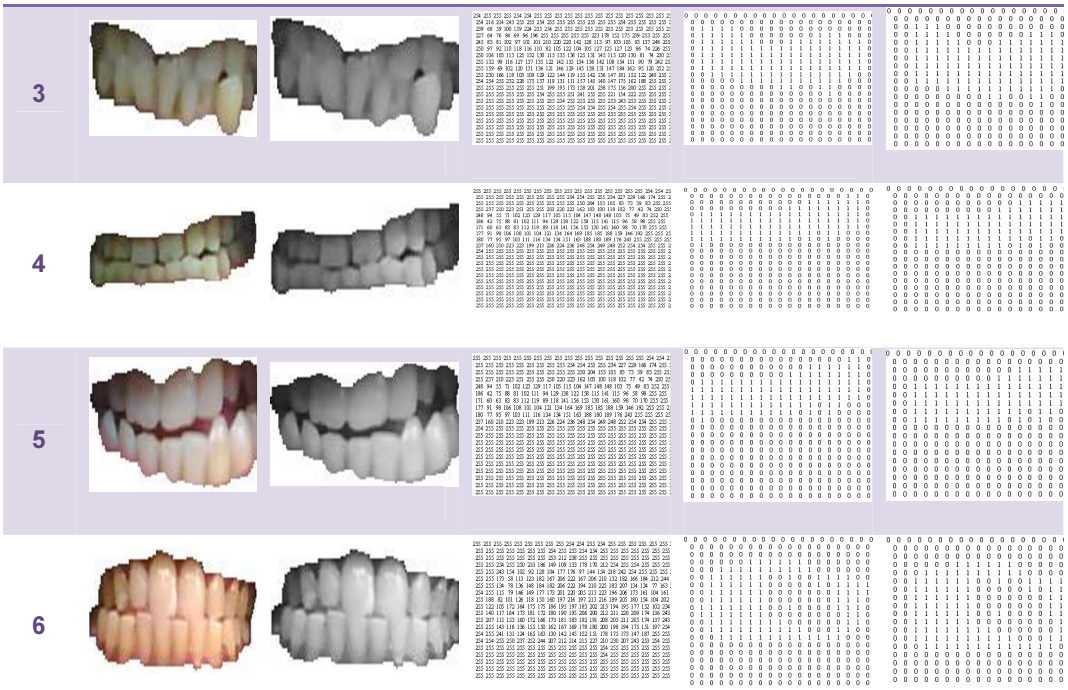


Figure 7.Teeth images belongs to different person

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. 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. We have concluded that the accuracy of the proposed system is more than 90% when the teeth images belong to same person. The proposed system is accurate when the teeth images belong to different persons because consistency is missing. In short, the conclusion is that the accuracy of the proposed system is more than 85% on the given set of teeth images belongs to same person. This paper proposed algorithm for dental image registration using the phase-based image matching. Experimental performance evaluation demonstrates efficient performance of proposed algorithm.

Algorithm is developed as semi automatic on JPG images because during the cropping stage we can define the size of the matrix for maximum accuracy. Threshold point also selected manually, these can be automated based on the usage and alignment to the application and infrastructure. In this method collection of sample image is user friendly. It is very simple image when the individual is reading letters “EEEEEE” face snap is taken. This can be used in most of common corporate and restricted areas where their data is present always. It can be used as additional parameter to identify a person in voter’s database, National security database, employee records. Even this can be used as key to open doors, office, Bank, schools attendance purpose addition to thumb impression reading. We have used this method in ATM simulator design as additional static parameter for identifying banking customer during transactional based security authorization[12]. Front elevation of the radiograph and X-ray images of teeth of cadavers can be compared with this image to get comparison results for the purpose of forensic analysis.

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