Identification system by Tongue based on Bhattacharyya distance

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Abstract— Tongue recognition is a biometric technique that can be applied to different areas of expression of human identity. Recognition of the tongue is a difficult and complex problem that is important for surveillance, security, and intelligent interaction between computers and humans. The main idea of proposed system rely that on that any image of a person's tongue has multiple unique features. Those features vary from one tongue to another. The system proposed in this paper uses group, the Extract the characteristics based on the wavelet Transform where it uses information color (color space RGB) at a certain form of detailed wavelet transforms (discrete wavelet transform), and use of Bhattacharyya distance for comparison between persons.

The tongue datasets that are used for of the suggested system are gathered from 30 volunteers of various samples; 4 have been from every individual, images have been captured in various expressions, illuminations, orientations, skin colors, backgrounds, varied in the age) from male and female, results indicated the discrimination rate for waveleting 72%, persons were recognized using Bhattacharyya distance by 93%.

Keywords: Wavelets transform Tongue images, tongue recognition, Bhattacharyya distance, and recognition.

1. Introduction

A pattern is group of concepts and phenomena or the things where components of a group like one another at certain ways or aspects [1] individual is highly sophisticated data, due to the fact that it is of a better ability of pattern recognition. The model has been characterized as the opposite to the chaos. It's an entity, it can be presented a name as, a pattern can be a sound wave, a fingerprint image, a human face, a bar code, a handwritten word, etc. [2]. Recognition Pattern field had a great deal of interest lately due to their applications rising which aren't merely challenging, they require more computations as well. Those applications comprise the biometrics (i.e. identity recognition which is based on a variety of physical characteristics like (the face and the finger-prints), document classifications (efficient search of the texts), financial forecasting, organizing and retrieving data-bases multi-media, and data mining (pattern, recognizing such as an outlier at massive numbers of multi-dimensional pattern types, or correlations) [3]. Biometrics can be defined as automated approach for the identification or the verification of an individual’s identity based on behavioral and physiological features [4]. Human beings are recognized from physical features and not from some external things they have to provide for the process. Personal features are difficult to replicate therefore almost accurate results are obtained. Various well known methods have already been implemented in human Identify (fingerprint, iris, retina, face etc.) [5].

2. Tongue Recognition (TR):

The tongue is an organ inside the mouth that is well-enclosed inside the oral cavity. The tongue is protected from the environment and each tongue is different from the other. Each tongue has unique characteristics that vary from person to person even among identical twins [6]. It is protected inside the mouth and difficult to form. Tongue also displays physiological tissue information and geometrical shape information that are useful in identity verification applications [7]. Each tongue varies in aspects such as texture and shape, and the tongue is the
only organ located within the body. The tongue is connected to the oral cavity and cannot be examined without the permission of the person concerned. [8] Biometrics of the tongue can work as a very reliable method the personal identification serve as a generic biometric in each applications [9]. The tongue can be considered as an important organ in human body which has an important role in human survival. [10]. After collecting images of an individual tongue using a digital device (such as a digital camera), the body of the tongue should be automatically divided first. Fragmentation of traditional methods imposes the fragmentation of an object from the image that reveals to us a central part of face (the mouth area). Because the mouth contains not only the tongue, but there are lips, teeth and other object in the mouth. Problem in the fragmentation of the image is how to find tongue between other organisms at area mouth [10].

3. Wavelet Transform

Wavelets are a function used to divide a continuous time signal or a particular function to different size components. Therefore it is a mathematical function. Wavelet transform provides powerful tools for signal analysis that are utilized in feature extraction, image compression and noise cancellation extensively. Wavelet decomposition it is a Multiple resolution technology in the most used image processing tasks. As a result of the exceptional feature of the time-frequency localization, the Wavelet transformation provide a powerful mathematical tool, the images usually contain varying local stats resulting from different combinations of characteristics like the edges, relatively low heterogeneous proportions, and woven areas. While like spatial and variability non-static is defying to any statistical characterizations, multiresolution elements are handled easier [11] we get details and approximations in the analysis of the wavelet. Approximations are the signal components of low-frequency and high-scale, and details can be considered as components of high frequency and low scale. Wavelet analysis strength is in its capability of the representation of the signals in compact in several resolution levels. Two wavelet transform types exist, DWT and continuous wavelet transform (CWT). The main distinguishing characteristic among the DWD and the CWT is the fact that the DWT uses an obvious sub-set of scales and translation values and the CWT utilizes the translation and all possible scales [12].

- **Haar Filter**

Haar filter consists of high pass filter (HPF) and Low pass filter (LPF) which is defined at following equations:

\[
\text{HPF: } \frac{1}{\sqrt{2}} [1 - 1], \quad (1)
\]

\[
\text{LPF: } \frac{1}{\sqrt{2}} [1 \ 1], \quad (2)
\]

The band pass filter convolution in a specific orientation yields in what is known as the details images and the convolution with LPF yields what is known as the image of approximation. The bands that have been transformed (LL bands of scaling and 3 wavelet bands LH, HH, an HL,) may be produced through the application of the filters above to each one of the (2x2) adjacent pixels of the entire pixels of the image. This method can be referred to as the Fast Mallet algorithm transformation. The filters of HP and LP can be referred to as filters of decomposition due to the fact that they perform the separation of the image or decomposing it to the approximation coefficients and the detailed coefficients respectively. In Figure (1) shows decomposition wavelet for two levels.

![Figure (1) Two-level Decomposition of the Sub Band of the Wavelet](image)

Figure (1) Two-level Decomposition of the Sub Band of the Wavelet [19].
4. Bhattacharyya Distance

Bhattacharyya distance (Bhattacharyya 1943, 1946) has been used as a disparity or similarity measurement between distributions of probability of the 2 entities which need being compared [13]. N statistics, Bhattacharyya distance performs the measuring of similarities of 2 distributions of probability. It is tightly associated with the coefficient of Bhattacharyya that can be known as the measurement of the overlapping amount between 2 populations or statistical pattern. The two measures have been named for (A. K. Bhattacharya); who had worked in the 1930’s at (“Indian Statistical Institute”) and is a statistician [14]. At the simplest of formulations, Bhattacharyya distance between 2 classes over normal distributions may be computed through the extraction of mean and variances of 2 distinct classes or distributions, as shown in following.

\[
D_B(p,q) = \frac{1}{4} \ln \left( \frac{1}{4} \left( \frac{\sigma_p^2 + \sigma_q^2}{\sigma_p^2 + \sigma_q^2 + 2} \right) + \frac{1}{4} \left( \frac{\mu_p - \mu_q}{\sigma_p^2 + \sigma_q^2} \right)^2 \right)
\]

(3)

As shown the symbols:
\(D_B(p,q)\) stands for the distance between \(q\) and classes or distributions.
\(\mu_p\) stands for \(p\)-th distribution mean,
\(\sigma_p^2\) represents \(p\)-th distribution variance.
\(p, q\) represent 2 distinct distributions.

5. Previous Work

The need Tongue recognition, verification of identity and investigations of database images have drawn the interest of numerous scholars. Some proposed studies which are related to this paper’s objectives will be stated in the paragraphs below.

- In 2013, Manoj Diwakar and et al [9], the paper show as two phases. (1)- detection out spots on tongue with assist of histogram (2) - extract tongue image and recognize from tongue-image database.
- In 2015, Amit Bade and et al[4], The paper presents a sufficient biometrical system of tongue identification for the authentications that are based on Dual Tree Complex Wavelet Transformation. Beneficial and accurate results for the acceptance of this system worldwide.DT-CWT (Dual Tree-Complex Wavelet Transform).
- In 2016, Akhil Paulose and et al [15], the paper has presented a type of extraction approach of color tongue images that has utilized the greedy rules in addition to fusing the information of the color and the space for the sake of extracting tongue body area from the background in a precise manner. This approach’s has been rather high. The suggested methodology has been innovative, however, the precision wasn’t high, about 87.3% only, and the test of the efficiency has not been stated by the researchers.
- In 2017, Vibhooti Markandey and et al [16], The paper considers colored pixel analysis using the technique of Mean Squared analysis (MSE). it assures more accuracy of the results.

6. Methodology

A variety of images were taken from different types of tongue images taken in different conditions, varying in expression, lighting, orientation, and background, and vary in ages, and images were taken under fixed positions, and features of the shape can be extracted through the image based on the characteristics of wavelet transform Used at different levels, this paper is made using the c # program. Figure (2) illustrates the system working algorithm.
6.1 Image Acquisition

The most important part of the project, capture different types of tongue images with the development of digital imaging technology for several years. Tongue images were obtained by different types of Colored cameras, because these types of imaging devices are easy and simple to implement. Figure (3) illustrates the imaging device.

![Figure (3): Tongue image capture device [17]](image)

6.2 Pre-Processing

Processing: Resizing the input image (512 * 512), methods of Image segmentation are used for removing the area of the background because our study focuses on the tongue area only. Tongue images are used for good implementation of the tongue recognition system, some stages used in the processing unit in the system is (1) remove the background because we focus on the tongue only, (2) uses fragmentation of RGB color images.

6.3 Feature Extraction

In this Stage, from Tongue images we extract only basic information. The information extracted represents the features required for distinguishing between individuals. The suggested system utilizes a set of distinctive characteristics, namely: wavelets transformation using the (Haar filter).

6.3.1 Feature Extraction the Wavelet Transform

In this section, tongue image goes through a multiple sub-phase for the purpose of extracted texture features. This sub-section explains in detail the following:

6.3.1.1 Tongue Image Input
Before extraction and wavelet analysis of features, tongue image is fragmented to separate the tongue from the background. After the tongue image is revealed, the tongue clip will be inserted into the proposed system, and then decompose into the RGB sub-image, so the proposed system uses three sets of images (color images in red, green and blue) and will be inserted in the next stage for conversion.

![Color Image](image1.png)  ![Red](image2.png)  ![Green](image3.png)  ![Blue](image4.png)

**Figure (4) Images Preprocess for Three Bands**

### 6.3.1.2 Wavelet Transforms Sub Stage

In stage this (2-D wavelet transformation) which has been carried out through those input images with the use of the (Haar filter wavelet decomposition) which has been applied to data through the calculation of (differences and averages of adjacent elements). Haar wavelet works first, on adjacent horizontal elements and then on adjacent vertical elements. By N elements, be The Haar wavelet transformation.

By N elements, is calculated Haar wavelet transforms shown below:

1. Detection all pair of samples of the average (N/2).
2. Detection the difference among all average and samples. It has been computed from the (N/2 differences).
3. Run the 1st half of the array with averages.
4. Run the 2nd half of the array with the differences.
5. Repeat the procedure on the 1st half of array, (The length of the array must be a power of 2).

Purpose of the application of this phase is the extraction of coefficients from tongue image, post getting the tongue clip. In this work 6 images of details are obtained and 1 image of approximation (i.e. image of low-resolution). Therefore, all tongue images gave been described by the coefficient matrices of the wavelet representing much massive amounts of information (= the image input size). As a result image tongue has been described through (3 * 7) color band = (21).

### 6.3.1.3 Feature Extraction Statistical Measures

Here, the statistical measures will be computed for all bands (LH1, HH1, HL1, HL2, LL2, LH2 and HH2) bands, are typically beneficial for the representation of data features or characteristics.

Statistical measures Used she:

- **Mean**: \( \mu = \frac{1}{MN} \sum_{i=1}^{M} \sum_{j=1}^{N} x(i, j) \), \( .(4) \)
- **Variance**: \( \sigma^2 = \frac{1}{MN} \sum_{i=1}^{M} \sum_{j=1}^{N} (|x(i, j)| - \mu)^2 \), \( .(5) \)

Where \( x(i, j) \) represents a wavelet coefficient of the N and M are the row and column size.
6.3.2 Result Experimental of Feature Extraction

Results experimental of the suggested system utilize different set of discriminatory characteristics which (wavelet transformation), and Use Bhattacharyya distance, in pattern recognition as a way to recognize tongue images.

6.3.2.1 Results of Wavelet Transform

At this point, uploading an image (direction expression or expression), includes the click button the image upload process and other click button takes a colour range (red, green, and blue). And 6 image details and saved, Table (5) shows the results of the band analysis (HL1, LH1, HH1, LH2, LL2, HL2, and HH2 bands) from tongue database samples.

Table (5) show Analysis Results Bands of (Wavelet Transformation) from tongue Image in Data-base from some Sample.

| Class | Image | Color | LH1 | H1 | HH1 | LL2 | LH2 | HL2 | HH2 |
|-------|-------|-------|-----|----|-----|-----|-----|-----|-----|
| C1    | ☺    | ☺     | ☺   | ☺  | ☺   | ☺   | ☺   | ☺   | ☺   |
| C2    | ☺    | ☺     | ☺   | ☺  | ☺   | ☺   | ☺   | ☺   | ☺   |
| C3    | ☺    | ☺     | ☺   | ☺  | ☺   | ☺   | ☺   | ☺   | ☺   |

6.3.2.1.1 Results of Bhattacharyya distance between an unknown person and someone within the database.

At this stage, when the image is uploaded, the click button includes the process of uploading the image within the database and upload an image that is not in the database of an (unknown person) and compare the two images, Table (6) shows the results.

Table (6) Level1, Analysis Results of Bhattacharyya distance from Sample of tongue Image Database.

| Picture Level 1 | Mean | varian ce | Picture 2 | Mean | varian ce | Bhattacharyya distance | Result |
|-----------------|------|-----------|-----------|------|-----------|------------------------|--------|
|                 |      |           |           |      |           |                        |        |
Result is the Bhattacharyya distance collection obtained from comparing a person in the database with another person who is not in the database.

Table (7) Level2, Analysis Results of Bhattacharyya distance from Sample of Tongue Image Database.
Result is the Bhattacharyya distance collection obtained from comparing a person in the database with another person who is not in the database.

The feature extraction process is performed as follows in the following steps.

### Algorithm Feature Extraction Steps

**Inputs:** Color (Tongue Images)

**Outputs:** Extraction of the information of texture (Mean and Variance)

| Step  | Description |
|-------|-------------|
| Step1 | Read tongue image data. |
| Step2 | Input all bands color images (Red, Green and Blue) through the use of color information in (DWT). |
| Step3 | Wavelets transform reach to (2-levels) of decomposition, using Haar discrete wavelet transform. |
| Step4 | Calculation of Variance and Mean characteristics of coefficients of wavelet Reaches (21 sub-images), for all sub images one value from (Variance and Mean) is computed, hence will have 42, 14 * 3 color band = 42 Features. |
| Step5 | Insert the Mean, Variance, in Feature Database for tongue image. |
| Step6 | If more tongue images are found, repeat the steps from (1-5) |
| Step7 | End. |

## 7. Results and Conclusions

In the presented study, a wavelet transformation algorithm was utilized for the extraction of the characteristics as well as Bhattacharyya distance was used to distinguish the image of the person’s tongue from the other, the system was tested on a group of images of tongue gathered from 30 individuals, where 8 images were collected for every individual collected under different conditions. The results indicated the discrimination rate for waveleting 72%, as for the results Bhattacharyya distance, The images of people were recognized by 93% and not recognized by 7% and the reason 1) Difficulty Take pictures of the tongue 2) Environmental conditions during the capture 3) The tongue was affected by food before taking pictures. Conclusions drawn from test results, which may be summarized in the following manner:

1. The use of color information to extract texture features in the discrete wavelet transform performs good results, from color bands (Red, Green and Blue) texture features are extracted, where features differ in the color band.
2. Use Bhattacharyya distance for recognizing the tongue image leading to get strong results.
3. On recognition the tongue image using Bhattacharyya distance based on wavelet conversion led get good results.

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