

Review Article

Tongue Printing: A Unique Identification System

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ABSTRACT:

Biometric authentication helps in the identification and verification of individuals. Currently there are many biometric systems that are used for identification. Tongue print is a new biometric authentication system because the tongue is a unique structure, no two tongue prints are similar and therefore cannot be easily forged. The present review article describe about the tongue printing.

Keywords: Biometric, authentication, Tongue print.

Received: 8 February, 2019

Revised: 27 February, 2019

Accepted: 28 February, 2019

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This article may be cited as: Arora S, Kaur G, Neha. Tongue Printing: A Unique Identification System. J Adv Med Dent Sci Res 2019;7(4): 115-117.

INTRODUCTION:

Tongue is a dynamic organ which helps in various functions such as articulation of speech, perception of taste, and formation of food bolus. It is well protected from the external environment and enclosed in the oral cavity with palate on the superior aspect, floor of the mouth on the inferior aspect, mandibular teeth on the lateral aspects, pharyngeal region posteriorly, and the lips anteriorly.¹ Every individual has unique tongue in terms of shape and surface textures. It is the only internal organ that can be stuck out of mouth for inspection, and yet it is otherwise well protected in the mouth and is difficult to forge.² It presents both geometric shape information and physiological texture information which are potentially useful in identity verification applications.³ Human identification is one of the challenging areas that man has been met with. The forensic odontologist mainly deals with the identification based on recognition of unique features present in an individual's oral structures. The tongue is very unique vital organ and its vitality is well inscribed in Traditional Chinese Medicine as "Tongue of life". It is known to be a mirror of the oral and general health. The

human tongue is encased within the oral cavity and can be easily drawn out and displayed for inspection and palpation purposes.⁴ Biometrics refers to a real-time identification system that is used in the identification of a person using a specific physical or behavioral characteristic which is compared with a library of characteristics of many other people.⁵ This is done using a biometric scanning device (tongue-print scan) which captures the user's biometric data such as the tongue-print scan and converts it into a digital information that the computer interprets and verifies. There is a higher level of assurance in this type of identification process.⁶ Tongue print is the information carried on the exposed portion of the tongue that is the shape and texture put together. The geometric shape of the tongue is usually constant, and the physiological surface texture does not vary a lot.⁷ The tongue provides both static and dynamic features for authentication.⁸ Therefore, the use of tongue prints as a biometric authentication system has gained lot of popularity. The first tongue recognition system was proposed by Liu *et al.* in 2007.⁵ Recently, tongue recognition systems based on 2D dual-tree complex wavelet transform have been proposed by Bade *et al.*⁹

Classification

The characteristic features seen on the dorsal surface of the tongue have been classified by various authors indifferent studies [Table 1].⁴ Another classification was put forth by Stefanescu *et al.* in 2014 [Table 2].⁴

Table 1: Classification of features on dorsal surface of tongue

| Geometrical features of the tongue | Shape of tongue | Textural variations in tongue |
|------------------------------------|---|---|
| Length Width Thickness | Elliptical Hammer Rectangular Acute triangular Obtuse triangular Square Round | Tongue fissure or tongue crack Smooth tongue |

Table 2: Classification of tongue features by Stefanescu *et al.*

| Tongue texture | Shapes of the tongue | Longitudinal grooves | Lingual apex |
|--|--|---|------------------|
| Physiological Scrotal Geographic | Ovoid Ellipsoid Rectangular Pentagonal Trapezoidal to asymmetrical | Perceptible/imperceptible Rectilinear/twisty Superficial/deep | Sharp Septate |

Sexual Dimorphism In Based On Tongue Characteristics

The scrotal tongue and geographic tongue were characteristic feature of female patients. Patients with sharp tip at the lingual apex were females and males had septate tips. The males have an increased length and width compared to females. In histological examination, it has been detected that there is a significant difference in the orientation of the muscle fibers of the tongue among men and women. This difference is characteristic in the middle region of the tongue.⁴

Tongue Print Collection and Identification

Tongue prints can be obtained in many ways. A simple visual inspection of the tongue reveals many features such as the color of the tongue, mobility, surface textural variations, and any other special characteristics if present. Digital photographs of the tongue can be captured and matched with a database for verification. They can also be used to identify the shape of the tongue. The shape of the tongue is obtained by joining three reference points. A study carried out in Hong Kong Polytechnic University in 2007, was designed to develop tongue image database, which included both tongue geometric shape and surface textures of individuals, and this database was assumed to be a valuable resource for assessment, comparison, and evaluation.⁵ Three-dimensional analysis of the tongue can be performed by taking an alginate impression followed by cast preparation.⁴ This helps in capturing the unique features and reproducing the monto a cast which can be used for study purposes. Digital software has been formulated which autocorrects for the color and hue along

with the positional alterations and camera conditions and then analyses the tongue for its color and texture to match with its database to bring about positive identification. Many studies have been researched into preparing a proper algorithm for tongue image analysis.¹⁰ Other methods tried are capturing the video of a tongue and extracting images from the same as the tongue is a nonrigid organ. Alternate method includes sublingual vein analysis, which is one of the common methods employed in tongue diagnosis.¹¹ An ultrasound technique has been employed using an ultrasound transducer placed in the sublingual area to analyze the tongue function.¹²

Difference between Tongue Print and Other Biometric Systems

The various other biometric systems that are used for security purposes are fingerprint, retinal scan, skin color, voice check, palm print, face scan, signature check, etc. These systems has some disadvantages like fingerprints can be eroded, changed due to work, altered by surgery, and subjected to injuries and burns, so they are not stable. Voice can be affected by sicknesses such as cold and cough and in case of extreme emotional states, there are chances of misspoken words. Retinal scan is highly sensitive and dependent on the user and can be affected by bright light and diseases such as cataract and astigmatism. Skin color can change with age, burns, diseases, and use of skin creams or medications.¹³ The tongue is unique to every person with respect to its shape and surface textures. Since it is an internal organ, it can be easily exposed for inspection and the exposed surface carries the required information. Tongue print is a distinctive biometric tool

which cannot be forged easily. Advantages of tongue prints over other biometric systems are genetic independence (no two tongues are similar), physical protection (well encased in the oral cavity) and its stability over time.^{14, 15}

Conclusion: The human tongue is unique in shape, texture and is suitable for the use in identity recognition. It can be easily examined thus, making it real proof of life. The morphological aspect of the tongue is unique for each and every individual and cannot be forged. Thus, it is a better biometric authentication tool than others.

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