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**Traditional Chinese medicine —  
Computerized tongue image analysis  
system —**

**Part 5:  
Method of acquisition and  
expression of tongue colour and  
tongue coating colour**

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*Médecine traditionnelle chinoise — Système d'analyse d'images  
numérisées de la langue —*

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*Partie 5: Méthode d'acquisition et expression de la couleur de la  
langue et du revêtement de la langue*



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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

This document was prepared by Technical Committee ISO/TC 249, *Traditional Chinese medicine*.

This corrected version of ISO/TR 20498-5:2019 incorporates the following corrections:

- The upper and lower limits of some domains in A.2 have been reversed to correct editorial errors.

A list of all the parts in the ISO 20498 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at [www.iso.org/members.html](http://www.iso.org/members.html).

## Introduction

As one of the most distinctive traditional Chinese medicine diagnosis methods, tongue diagnosis is a method of inspecting the patient's tongue and its coating to determine his or her disease or syndrome. With growing global demand for traditional Chinese medicine, there is an increasing demand for international medicine and academic exchanges on tongue diagnosis as well as tongue-related devices. Traditional tongue diagnosis, mainly dependent on the practitioner's visual observation and text description, often varies with the practitioner's experience, environmental changes and other factors, which makes it difficult to make an accurate diagnosis and archive the tongue image. Therefore, it is necessary to quantify and digitize the tongue manifestation.

With modern scientific knowledge and technology, the practitioner's subjective judgement about tongue manifestation has gradually developed into an objective determination by computerized tongue image analysis system (CTIS) with a standard calculation method. According to statistics, more and more traditional Chinese medicine practitioners have come into contact with and used a device for tongue diagnosis, which undoubtedly plays a leading role in the promotion of tongue-related products worldwide. Thus, it is of the utmost urgency to standardize the CTIS, which will bring benefits to companies involved in the trade of tongue-related devices and to people assisting with CTIS.

Therefore, as one of the five parts of the ISO 20498 series, this document intends to quantify and digitize the tongue manifestation used in the CTIS, which is of great importance to the international trade and service of CTIS, thus increasing business profit.

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# Traditional Chinese medicine — Computerized tongue image analysis system —

## Part 5: Method of acquisition and expression of tongue colour and tongue coating colour

### 1 Scope

This document describes a method of acquisition of tongue image and expression of tongue colour and coating colour by computerized tongue image analysis system (CTIS).

This document does not cover the clinical tongue diagnosis result.

### 2 Normative references

There are no normative references in this document.

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### 3 Terms and definitions (standards.iteh.ai)

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:  
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afbf39de129b/iso-tr-20498-5-2019

— ISO Online browsing platform: available at <https://www.iso.org/obp>

— IEC Electropedia: available at <http://www.electropedia.org/>

#### 3.1

##### **tongue body**

muscles and vessels of the tongue

#### 3.2

##### **tongue coating**

layer of fur-like substance stuck on the tongue

#### 3.3

##### **tongue colour**

colour of the tongue body

#### 3.4

##### **coating colour**

colour of the tongue coating

#### 3.5

##### **tongue image**

digital image acquired by the device

### 3.6

#### **L\*a\*b\* colour space**

three-dimensional, approximately uniform colour space, produced by plotting, in rectangular coordinates  $L^*$ ,  $a^*$ ,  $b^*$

Note 1 to entry: The quantity  $L^*$  is a measure of the lightness, where  $L^* = 0$  corresponds to black and  $L^* = 100$  corresponds to the perfect reflecting diffuser. Visually, the quantities  $a^*$  and  $b^*$  represent respectively the red-green and yellow-blue axes in colour space, such that:

- $+a^*$  is a measure of the degree of redness;
- $-a^*$  is a measure of the degree of greenness;
- $+b^*$  is a measure of the degree of yellowness;
- $-b^*$  is a measure of the degree of blueness.

If both  $a^*$  and  $b^*$  are equal to zero, the test piece is grey.

[SOURCE: CIE 17.4, 845-03-56, ISO 5631-2:2015, 3.6, modified — "of the test piece" has been removed and "achromatic" has been replaced with "grey".]

### 3.7

#### **standard colour chart**

apparatus consisting of 24 single colour patches used for the evaluation of colour calibration of CTIS

Note 1 to entry: The colour chart in this document is supplied by Pantone. It can be replaced when a new special colour chart made for tongue colour is available.

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## 4 Colour calibration of the acquisition device

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### 4.1 Choice of colour space

With the help of L\*a\*b\* colour space's special features, white balance calibration can be done by setting the white balance parameter on the camera before taking the photo or adjusting during post-processing. This is because  $L^*$  represents lightness, which is completely independent of  $a^*$  and  $b^*$  (represented colour), and thus the adjustment of the  $L^*$  does not affect image colour data.

In view of image compatibility, the parameter ranges of various tongue colour and tongue coating colour calculated in L\*a\*b\* colour space can be converted to any other colour space by conversion formulas.

### 4.2 Calibration of the acquisition device

#### 4.2.1 General

In order to reflect realistic tongue colour information in the tongue image, chromatic aberration resulting from the acquisition device itself should be adjusted. Therefore, the prerequisite procedure for tongue image analysis is to calibrate the device hardware characteristics. The calibration is made in two steps. The first is whiteboard calibration, and then colour calibration.

#### 4.2.2 Whiteboard calibration

As one of the factors affecting colour calibration, the determination of the camera's shooting mode is an important part of tongue image acquisition, which has a close association with whether the collected data are real or not. Once fixed in a certain mode (except AUTO mode), the system error of colour is relatively constant. Therefore, once colour distortion is determined under the current mode, the adjustment value is also determined.

Tongue colour analysis needs high-quality images, so it is necessary to check if the auto white balance by the camera is valid enough for our research. Most commercial cameras can adjust the white balance



automatically by the software installed in them. A method named whiteboard calibration is offered in this document to meet users' needs for colour high-fidelity images. This method is also useful for those cameras that cannot adjust the white balance automatically.

Whiteboard calibration is carried out using the following steps:

- 1) Take pictures of a standard whiteboard with the device.
- 2) Select 24 points that are distributed evenly and calculate colour deviation  $\Delta e_i$  for each using [Formula \(1\)](#) and average deviation  $\Delta E$  using [Formula \(2\)](#).
- 3) Adjust the white balance value according to the average deviation value.
- 4) Repeat steps 1), 2) and 3) until the colour deviation value is less than 5.

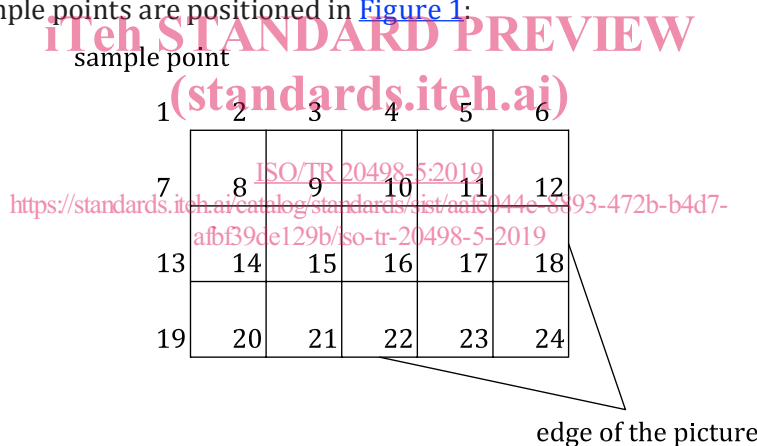
Single deviation:

$$L^*a^*b^* \text{ colour space: } \Delta e_i = \sqrt{\Delta L^{*2} + \Delta a^{*2} + \Delta b^{*2}} \quad (1)$$

Average deviation:

$$\Delta E = \frac{1}{24} \sum \Delta e_i \quad (2)$$

The suggested sample points are positioned in [Figure 1](#):



**Figure 1 — Position of sample points for whiteboard calibration**

### 4.2.3 Colour calibration

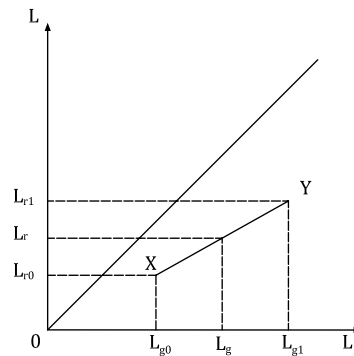
Colour calibration in  $L^*a^*b^*$  colour space is carried out using the following steps:

- 1) Take pictures of 24 kinds of colour on a standard colour chart with the device.
- 2) Calculate the real  $L^*a^*b^*$  value for the tongue image by linear interpolation. Take  $L^*$  component as an example. For each pixel in a tongue image, its real  $L$  value ( $L_r$ ) will be calculated using [Formula \(3\)](#).

$$\frac{L_g - L_{g0}}{L_r - L_{r0}} = \frac{L_{g1} - L_{g0}}{L_{r1} - L_{r0}} \quad (3)$$

In [Formula \(3\)](#),  $L_g$  represents the raw  $L^*$  value from the image.  $L_g$  comes from a certain pixel of tongue image.  $L_{g0}$  and  $L_{g1}$  are calibration points coming from the image of the colour chart.  $L_{r0}$  and  $L_{r1}$  represent the value of the colour chart. For any  $L^*$  value from any pixel in the tongue image, the two closest calibration points are found and the  $L_r$  will be calculated.

A sketch is shown in [Figure 2](#). Point X and Y are the reference points on the colour chart.  $L_{r0}$  and  $L_{r1}$  are respectively the  $L^*$  value of Point X and Y according to colour chart (here subscript r refers to real value).  $L_{g0}$  and  $L_{g1}$  are raw  $L^*$  value coming from the photo of reference point on the colour chart (here subscript g refers to acquired value).



**Figure 2 — A sketch of linear interpolation**

Here linear interpolation is used for the calibration of the acquisition device since the referenced colour chart can only supply 24 kinds of colour. For pixels which drop between two calibration points, there should be a method to calculate deviation for correcting image. In this case, linear interpolation is a simple and accurate method to do the work. [Annex A](#) provides an example of linear interpolation for certain CTIS.

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Because of the short distance between the device and the tongue, the collected image geometric distortion is very small, so geometric correction is excluded.

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## 5 Methods of digital representation of tongue colour and coating colour

### 5.1 Clustering method

The clustering method can be used for tongue colour representation. k-means clustering is a method of vector quantization, originally from signal processing, which is popular for cluster analysis in data mining. k-means clustering aims to partition  $n$  observations into  $k$  clusters in which each observation belongs to a cluster with the nearest mean, serving as a prototype of the cluster.

Digital data of tongue colour or coating colour is clustered into certain numbers of classes by k-means and then the colour value of central point of the cluster with most sample points is represented as the colour value of tongue colour or coating colour.

The cluster centres resulting from k-means reflect the space distribution of the pixels in  $L^*a^*b^*$  colour space. The result may differ from the mean value result, but it can reflect more information of the space distribution in colour space while mean value can only reflect the distribution on one axis.

### 5.2 Histogram method

A histogram bar plot is used to show the distribution of tongue image in  $L^*a^*b^*$  colour space. A histogram is an accurate graphical representation of the distribution of numerical data. To construct a histogram, the first step is to "bin" the range of values – that is, divide the entire range of values into a series of intervals using [Formula \(4\)](#) – and then count how many values fall into each interval using [Formula \(5\)](#). In this document, data of the images in the same catalogue is sorted into 20 equally spaced bins between min and max value, and the  $L^*a^*b^*$  values of every pixel on the sample are counted.

$$w_b = (w_{\max} - w_{\min}) / 20 \tag{4}$$

$h_b$  = total pixel number which  $L^*$  (or  $a^*$ ,  $b^*$ ) value fall in the range of certain bin (5)

### 5.3 Mean value method

This document also uses the mean value method to represent colour, that is, to get the average pixel value on the examples using [Formula \(6\)](#). And an expression formula of "mean  $\pm$  standard deviation" is used to indicate the colour range of tongue colour and coating colour under every colour category.

$$L_{\text{ave}} = \frac{1}{n} \sum L_{i,j} \quad (6)$$

where

$L_{\text{ave}}$  is the mean value of all the  $L$  value of the sample picture;

$n$  is the total number of pixels of the sample picture;

$i$  is the row number of a certain pixel;

$j$  is the column number of a certain pixel.

[Annex B](#) presents an example for different methods of digital representation of tongue colour and coating colour by tongue images within a certain database.

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