A Study on the Geometry and Color Calibration Method of Tongue Imaging Device for Health Care

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***Abstract*—A tongue diagnosis system is a diagnostic device that can determine the health condition through an image of the tongue. One can check one's health status every day through one's tongue. In addition, the checked health status can be transmitted or stored using a smartphone. The color and geometric information of the developed tongue diagnosis was color corrected using a color chart, and a chess board was placed at the upper tongue image acquisition position to perform geometric correction using corner points. Through this correction method, the basis for obtaining accurate information of the tongue was prepared.**

Keywords—tongue diagnosis, imaging device, color, geometry, calibration

I. Introduction

Oriental medicine diagnoses by identifying the phenomena occurring in the body. Tongue color, movement, size, shape, tongue color and ratio are used to diagnose diseases and pattern identification [1]. To observe the tongue, the results of observation and diagnosis of the tongue vary according to the surrounding light environment and the experience of an observer. Therefore, tongue diagnosis systems have been developed that acquires an image by limiting the shooting conditions to analyze the color and shape of the tongue by taking an image of the tongue [2,3]. In particular, for daily health management, a web camera is used to reduce the volume of space, and a smartphone is used to acquire image data to reduce the size of the data storage and processing system. Through this, its volume and weight were reduced to reduce the space of homes and facilities [4]. Geometry and color characteristics should not change depending on the surrounding conditions, so the consistency of the geometry and color information obtained by the image measuring device is tested and the correction methods are studied.

II. Methods and Materials

A. The structure of the tongue diagnosis device

In order to use it in a small space like a home, the volume should be small and the weight should be light, so we tried to reduce the size of the main body first. First, the front camera was adopted as a Web Cam with performance similar to that of a CCD camera. A camera with a focal length of 10 cm and a resolution of 2560 x 2048 with a sensor resolution of 1920 x 1080 released by Microsoft was selected. In particular, the focal length contributes to reducing the depth size of the main body. The side camera is a Full HD resolution Web Cam released by Yoichi. Its feature is that the focal length is about 6 cm, so the width of the side can be reduced.

The light is a mini pocket light from SUTEFOTO, and the color temperature and brightness can be freely adjusted, and the adjusted settings can be fixed. The Munsell color checker [5] for color correction is the same as used in hospital devices and is placed under the tongue. In addition, to reduce the volume and weight, a smartphone was used as a system for capturing, storing, and processing tongue images. This smartphone is placed 20 cm in front of your eyes so that you can monitor the position of your tongue.

The front and side cameras are connected to a USB hub through a USB port, and the output of the hub is connected to the input of the smart phone in C type, and the charging power of the lighting is connected to the power supply port of the USB hub so that it can be charged. The inside of the main body is painted in off-white color so that light reflection from the lighting device can be softened, and the corners are softened to prevent angles. A tongue diagnosis system implemented in this way is shown in Figure 1.

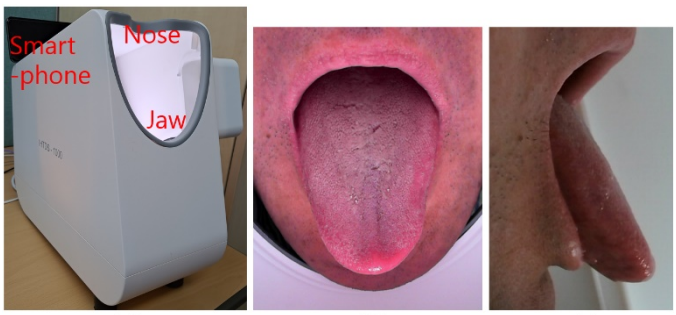

Figure 1. (a) Tongue diagnosis system and (b) frontal and (c) lateral image of a tongue

B. Properties of acquired images

A frontal image and a lateral image are obtained from the developed tongue diagnosis system. Since diagnosis is made by finding the color, shape, movement, and distribution of the tongue in the frontal image, it is important to find the geometric characteristics and color characteristics of the frontal image of the tongue. From the side, geometric information is more

Korea Institute of Oriental Medicine

important than color, but this study focuses on frontal images that represent color and geometric information.

The acquired frontal image consists of an upper part including the tongue and a lower part including the color chart since the device photographs the tongue in the upper part and the color chart in the lower part. First, they find one color patch in the color checker at the bottom, find the CIE La*b* average value in the color patch, and calculate the L, a*, and b* color calibration ratios compared with the reference color value, respectively. Color correction is performed by multiplying the pixels of the entire image by these ratios.

In the color-corrected image, the corner points of the squares in the upper chess board [6] are detected and a straight line is drawn through vertical corner points to correct the geometric distortion.

C. *The uniformity test of tongue imaging part*

In the previous chapter, color correction was performed using the lower color checker, and geometric distortion was corrected by finding corner points of the chess board in the area for tongue image acquisition. However, it seems that the uniformity of lighting on the upper chess board is poor. To correct this, the overall average of the average values of the white blocks on the chess board is obtained and the ratio is obtained by comparing with the average values of the white blocks at the edges of the entire image. The color values of all pixels are uniformly corrected according to the distance according to the color calibration ratios at edges like Equation (1).

$$g_i(x,y) = \frac{f_i(x,y)}{WH}\left(\frac{Av_{WB}(UL)}{Av_{Total\,WB}}(W-1-x)(H-1-y) + \frac{Av_{WB}(UR)}{Av_{Total\,WB}}x(H-1-y) + \frac{Av_{WB}(LL)}{Av_{Total\,WB}}(W-1-x)y + \frac{Av_{WB}(LR)}{Av_{Total\,WB}}xy\right) \quad (1)$$

i is CIE L, a*, b*, that is, each color element, and $f_i(x,y)$ and $g_i(x,y)$ are the color element value and calibrated value of a pixel on the original chess board, respectively. $Av_{Total\,WB}$ is the average value of all white blocks $Av_{WB}(UL)$, $Av_{WB}(UR)$, $Av_{WB}(LL)$, and $Av_{WB}(LR)$ means the average value of the first white block on the upper left, the average value of the upper right white block, the average value of the lower left white block, and the average value of the lower right white block, respectively. W and H mean the width and height of the entire image. Color calibration ratios at each edge are $\frac{Av_{WB}(UL)}{Av_{Total\,WB}}$, $\frac{Av_{WB}(UR)}{Av_{Total\,WB}}$, $\frac{Av_{WB}(LL)}{Av_{Total\,WB}}$, and $\frac{Av_{WB}(LR)}{Av_{Total\,WB}}$, respectively.

III. Results

Figure 2 shows the image in which the entire color is corrected with the color values of the color chart selected from the lower image including the color chart. A corner point was found by placing a chess board on the upper part where the tongue is photographed.

Figure 3 shows the geometrically corrected image based on the corner point by placing the chess board on the upper part where the tongue must be captured originally.

Figure 2. Images after color correction

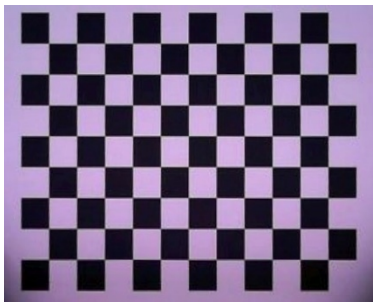

Figure 3. Images after geometry correction

IV. Conclusions

A tongue diagnosis system is an examination device that can determine the health condition through an image of the tongue and therefore you can check your health status every day through your tongue. In addition, the checked health status can be transmitted or stored using a smartphone. Light weight and small volume make it possible to install a tongue diagnosis system in a home or healthcare facility, and the accuracy of tongue imaging is more important. In this paper, color correction was performed using a color chart, and geometric correction was performed using corner points by placing a chess board at the upper position to acquire a tongue image. What remains is to correct the distortion of a lateral image caused by the side camera. Such a tongue diagnosis system to have been calibrated can be used for accurate diagnosis.

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Korea Institute of Oriental Medicine

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