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Technical Report

Effect of Fixing a Tiny Wearable Display on a Tongue Imaging Analyzing System (TIAS) to Improve Stability of Tongue Presentation

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Abstract: The tongue is said to express the condition of the entire body. Therefore, tongue diagnosis is an important diagnosis method in Kampo Medicine. Changes in the color of different parts of the tongue reflect different health conditions. Digital tongue image capturing systems such as the tongue image analyzing system (TIAS), are aimed at performing diagnosis at a low cost, before the occurrence of illness. We successfully acquired a digital tongue image using the TIAS. However, it is difficult to designate the same analysis region among datasets owing to instability of tongue indication by participants (human subjects) without shape normalization.

In this study, we examined the effect of attaching a small viewer to a TIAS to improve the stability of tongue presentation and the accuracy of color evaluation.

Key words: tongue diagnosis, tongue imaging, oriental medicine, pre–illness, diagnosis by color

1. Introduction

Tongue diagnosis is one of the diagnostic methods used in Japanese traditional Kampo medicine. In Kampo medicine, it is considered that the condition of the tongue reflects that of the whole body. It is possible to diagnose the physical condition of patients from various tongue characteristics, including color, shape, wetness, tongue coating, and texture. In addition, when making a tongue diagnosis, there are cases in which diagnosis is performed by looking at the color of the tongue after dividing it into specific areas rather than looking at the entire tongue.

Multiple studies have reported a correlation between the shape and color of the tongue and an individual's health[1, 2]. However, most people are unaware of how to present their tongues and therefore require practice and guidance for proper tongue indication. We attempted to improve tongue imaging diagnosis for the general population by attaching a tiny monitor to a tongue imaging analyzing system (TIAS).

2. Method

Tongue images were obtained by using TIAS[3] and digitized into 8×3 bits and 1024×1280 pixels, as shown in Figure 1(a). The diffuse illumination required to obtain tongue images is provided in TIAS using an integrating sphere. This enables tongue imaging without glare. In this case, the doctor can see the image of the tongue of the subject on the computer monitor, but the subject cannot see the image of their tongue. The measurement time is only approximately 20–100 s; however, the subject may feel uneasy owing to his/her mouth being opened wide and unfamiliarity with the required behavior (showing the tongue). This can cause tongue presentation to be unstable.

To improve conditions, some studies were performed with tongue shape normalization[4]. In this study, we tried to fix a tiny display to a TIAS to improve the stability of tongue indication itself. The first challenge of this method, as shown in Figure 1(a), was that there was no space for fixing the monitor to the TIAS. To this end, we researched recently developed wearable displays. Figure 1(b) shows a commercially available wearable display. In the first scenario, we wore the wearable display (Glasses). This was useful for getting an image of our own tongue. However, it was difficult to wear it if already wearing other glasses. Additionally, lack of contact is a desirable medical treatment quality to eliminate the threat of possible infection.

In the second scenario, we tried fixing the wearable display to the side of the device and used one eye to view the display, as shown in Figure 2. Since the position of the eyes of the examinee differs from one individual to another, the position could be adjusted by using the universal arm, as shown in Figure 3. The subject could see their own tongue image real-time, as shown in Figure 4(c). Figure 4(a)

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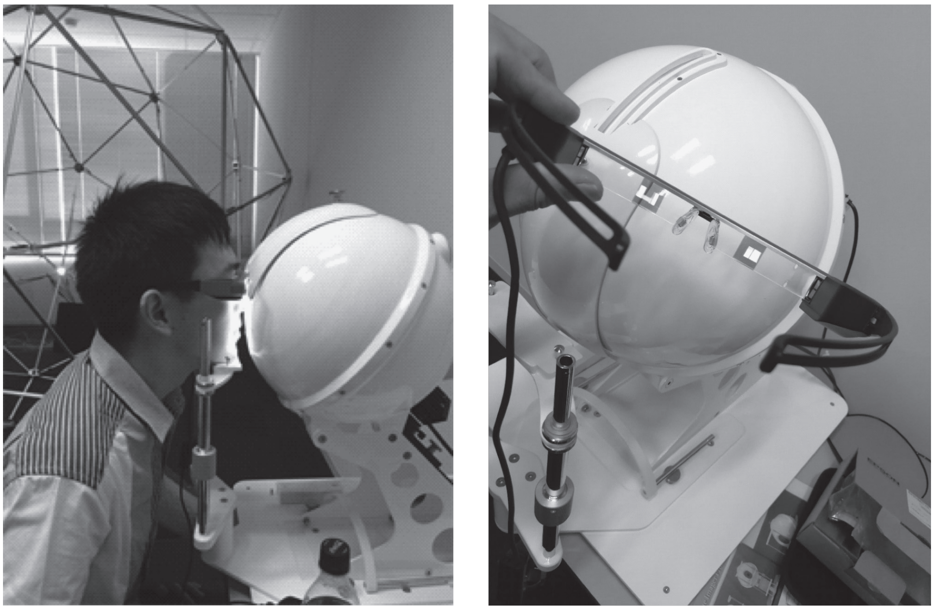


(a) (b)

Figure 1 (a) Image of TIAS for a human participant. (b) TIAS with wearable display.

(a) (b)

Figure 2 Concept picture of TIAS using one eye of the wearable display.

shows a photograph of the TIAS using one eye of the wearable display, Figure 4(b) shows the tongue image that the doctor sees on a computer, and Figure 4(c) shows the image of the tongue on the wearable display that the examinee sees.

By using one eye of the wearable display as shown Figure 4, we tried to confirm the effect of affixing a tiny wearable display to a TIAS. Figure 5(a) shows tongue shapes with the wearable display and Figure 5(b) shows tongue shapes without the wearable display. In this case, vertical rate of change of tongue outline at 5 and 20 s was 5.9% without the display and 1.3% with the display.

2a. Usability of wearable display

In this study, we used smart glass (OLED display) with a resolu-

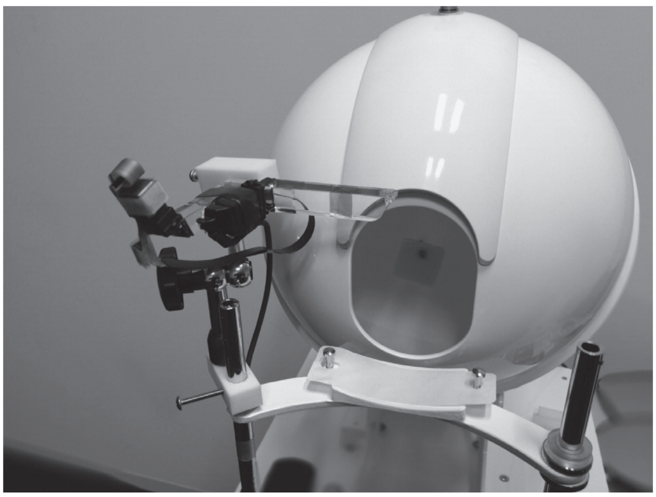


Figure 3 Photograph of TIAS using one eye of the wearable display.

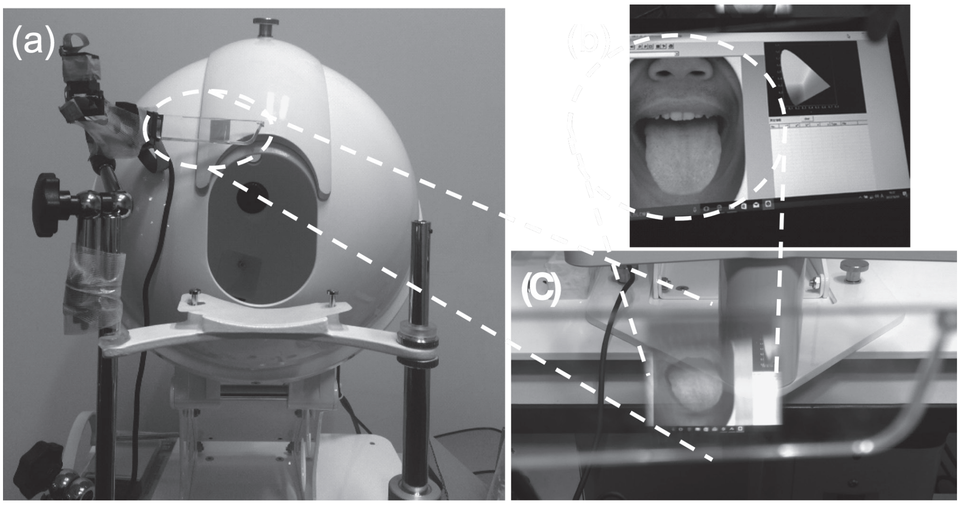
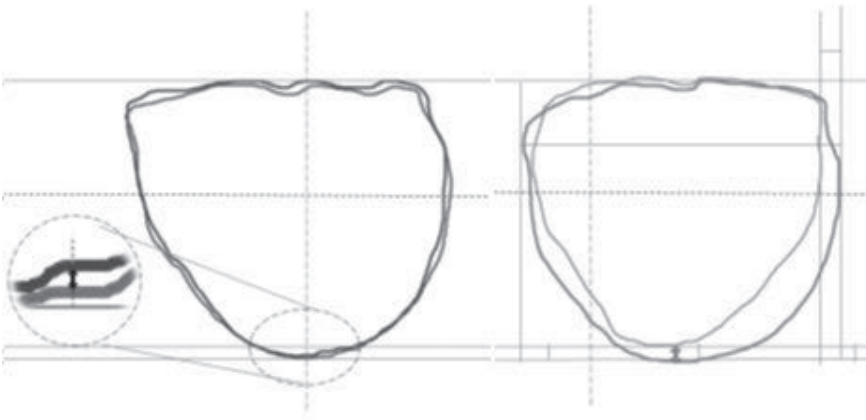


Figure 4 (a) Photograph of TIAS using one eye of the wearable display, (b) tongue image indicated on the medical practitioner's computer, and (c) tongue image on the wearable display (subject person side).



(a) (b)

Figure 5 Example of tongue shape at 5 and 20 s, (a) with the wearable display, (b) without the wearable display.

tion and color of 1280 × 720 dot and 8×3 bit, respectively. However, this device is a multifunctional pair of smart glasses not suitable for a use as an external monitor. Because image data is wirelessly transmitted to the main body, instances such as display delay or disconnection of images are likely to occur. We thus changed the resolution to 960 × 540 dot (LCOS display). This tiny wearable display has a HDMI input, and therefore, is easy to use for TIAS, as shown in Figure 6.

3. Results and Discussion

Effect of fixing a tiny wearable display to a TIAS

By using the tiny wearable display shown in Figure 6, we confirmed the effectiveness of the display. Images of the tongue of eight subjects were obtained with and without the display. The tongue indication could be influenced by familiarity and experience with the process. Therefore, first, images were obtained with glasses for four subjects (subjects A–D) and then images were obtained without glasses for the four remaining subjects (subjects E–H).

Figure 7(a) shows one of the tongue images, and Figure 7(b) shows the changes in tongue shape every 5 s over a total of 100 s. By using this data, we measured each tongue width (mm), tongue height (mm), and integrated tongue area (mm^2). For example, the change in tongue size versus time is shown in Figure 8. The data with the tiny display was smaller than the data without it, as shown in Figure 8. The average reduction ratio of the width, height, and area was 91.7%, 86.9%, and 77.5% respectively. Because it is not appropriate to compare the standard deviations as it is, we calibrated each value with the display at each reduction ratio.

To calculate the temporal fluctuation of the size of the tongue, standard deviations were obtained with respect to changes in size. Table 1 includes the standard deviations of each. To compare the results with and without tiny displays, we highlighted those with less fluctuation in Table 1.

We confirmed that the tiny wearable display is a useful device for TIAS. By using the device, the stability of the subject's tongue movement improved. The greatest advantage is that the subject gains a sense of security during imaging of the tongue. These evaluations include many subjective factors, but further studies are planned using objective indicators of the human body.

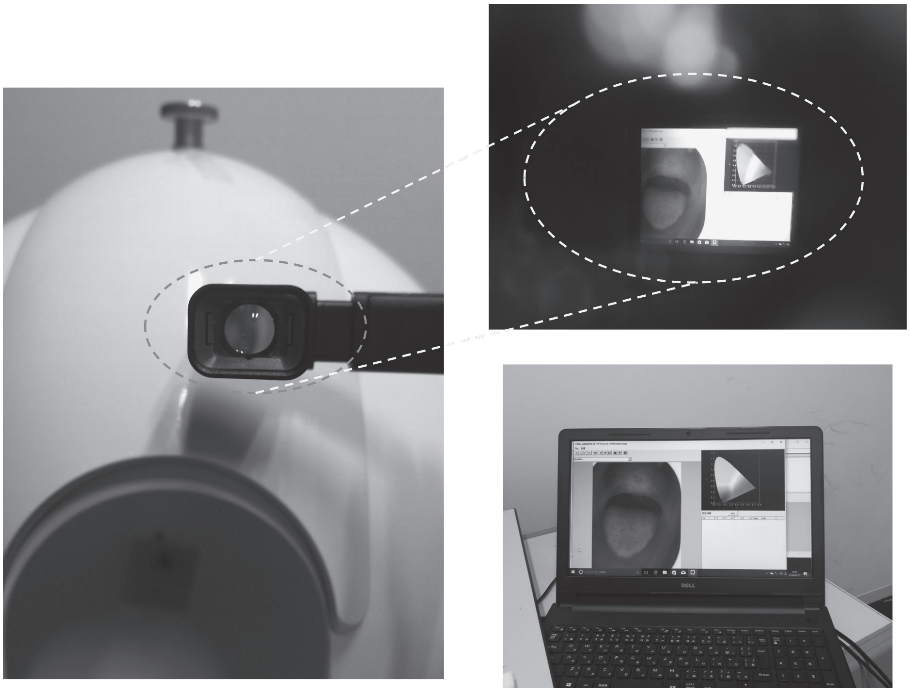
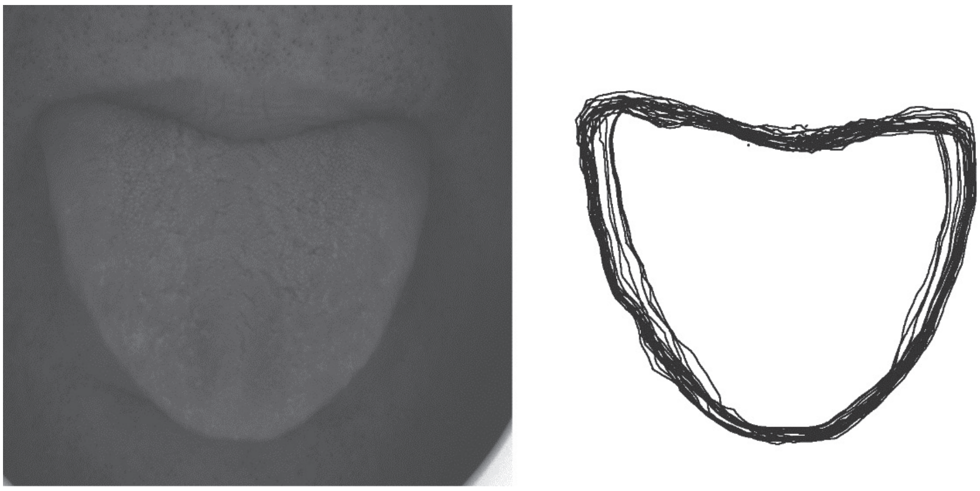


Figure 6 Photograph of TIAS using one eye of the wearable display with HDMI signal input.



(a) (b)

Figure 7 (a) One of the tongue images and (b) changes in tongue shape over 100 s.

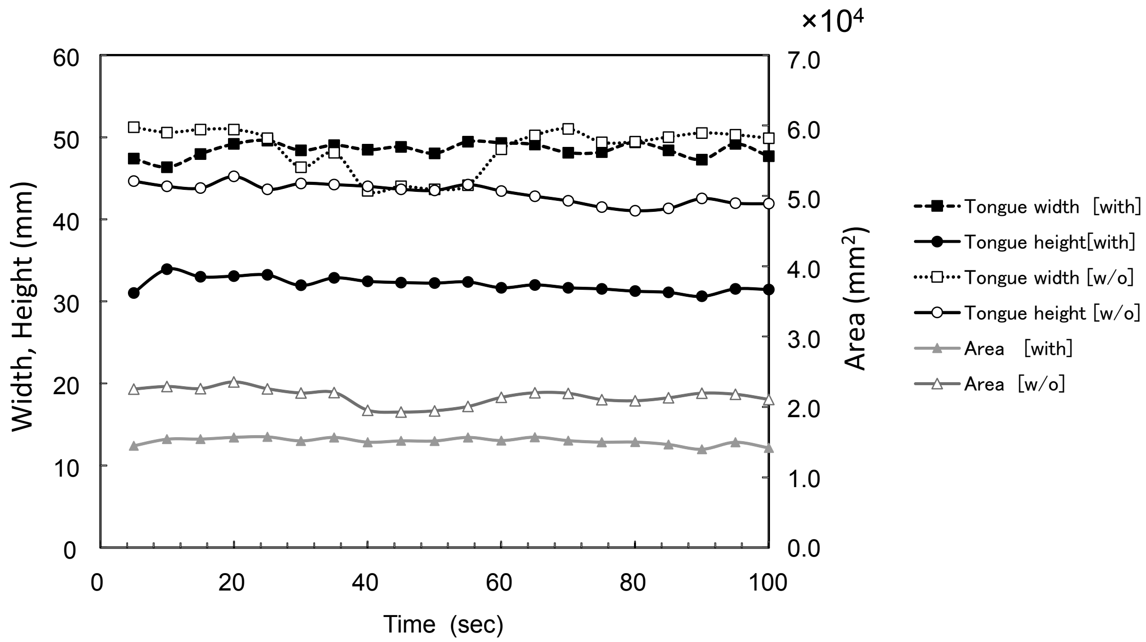


Figure 8 Changes in tongue size (width, height, and area) versus time.

Table 1 Calibrated standard deviation taking account of width, height, area reduction rate) over 100 s. These data were highlighted against less fluctuation. The measurements were first performed with glasses for four subjects (subjects A–D) and without glasses for four subjects (subjects E–H).

Calibrated standard deviation taking account of width, height, area reduction rate						
	With tiny display[Calibrated]			Without tiny display		
	Tongue width (mm)	Tongue height (mm)	Area (mm²)	Tongue width (mm)	Tongue height (mm)	Area (mm²)
A	0.6	1.6	898.7	1.7	1.2	572.3
B	2.0	1.6	717.6	1.5	1.3	1.288.4
C	0.9	1.1	700.6	3.8	1.7	1.682.0
D	1.2	3.2	1.877.3	1.9	1.4	1.167.8
E	0.6	1.3	1.039.2	0.5	4.0	2.787.0
F	2.6	0.6	950.3	0.9	2.9	1.512.1
G	1.6	2.8	2.014.7	1.3	3.7	2.265.9
H	1.0	1.2	659.5	2.3	3.7	1.869.9
Averege	1.3	1.7	1.107.2	1.7	2.5	1.643.2

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