

혀 영상 분석을 이용한 건강 모니터링에 대한 연구

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A Study on Health Monitoring Using Tongue Image Analysis

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요 약

본 논문은 개인의 혀영상을 이용한 건강 모니터링 방법을 제안한다. 이 방법은 혀의 절대적 특징들을 이용하지 않고, 병원에서 검진된 기준 건강 상태(reference health condition)와의 차이인 상대적 특징들을 사용한다. 사용자는 건강 모니터링 시스템으로 매일 혀영상을 촬영하여 전통 중의학에 기반한 관심 영역을 추출하고 분석하도록 한다. 실험에서 1개월간 제안한 방법으로 혀영상들을 분석한 결과 본 논문의 방법이 건강 모니터링에 사용될 수 있음을 보였다.

1. Introduction

The principles of traditional Chinese medical diagnosis are based on the information obtained from four diagnostic processes, which are inspection, listening and smelling, inquiry and palpation. The examination of tongue is one of the most important approaches for getting significant evidences in diagnosing the patient's health conditions[1].

There are some recent reports[2-4] on a digital tongue diagnosis system using tongue images. All these studies tried to use absolute measurements such as tongue substance and coating.

This paper presents health monitoring method using tongue images of a person based on traditional Chinese medicine. The method uses not absolute tongue features but relative ones which are differences from *reference health condition*, diagnosed in hospital, for a person.

2. Health Monitoring By Analysis of Tongue Images

Tongue images for a person can be acquired by a digital camera module connected to a computer system as shown in Fig. 1. To reduce color distortion, light color and illumination emitted from light source is retained to consistent situation at every tongue image

acquisition.

A block diagram of our method for health monitoring of a person using tongue images is shown in Fig. 2. Template tongue images and their features for a person on the tongue database can be used for tongue image registration and comparing tongue features. When tongue images are acquired for health monitoring, the images are registered to corresponding template tongue images to extract ROI's of the tongue. Tongue features such as tongue color and coating are calculated for the extracted ROI's of the tongue. Health condition can be determined by comparing features of between input tongue images and the tongue database. If the comparison results are significantly different from usual features on the database, the monitoring system can give warning on his or her health condition, or recommend careful activity or to see a doctor.

Regions of interest (ROI's) in a tongue image are top, middle, side, and bottom portion of the tongue. Tongue ROI's corresponding to organs based on traditional Chinese medicine theory[1]. Extraction of ROI's is performed using template tongue images of each person as shown in Fig. 3. A tongue image is registered to one of the template tongue images with predefined ROI's. Tongue template images and their features are stored to a tongue database.

When a person starts to do health monitoring, he or she should be diagnosed in hospital whether

there are some problems in his or her health or not, which is called *reference health condition*, and make template tongue images. As the user acquires his or her tongue images, health condition is determined by inspecting difference in tongue features of between an input tongue image and the database which is assumed to be normal health condition. Large difference means that current health condition is worse than before and its body part corresponding to its tongue region can be known according to traditional Chinese medicine where tongue condition corresponds to health condition in a human body. Tongue color can be main criterion to decide whether internal organs are weak or strong while tongue coating can be is provided to determine whether energy of a stomach is clean or cloudy. In a normal tongue, the tongue surface is regular red and luster, and has thin white substance and slight moisture.

3. Experimental Results and Discussions

Experimental equipment was set as shown in Fig. 1, where light source was set to 1000 lux in luminance by controlling electric power and measuring luminance by a luminance meter. Tongue images were acquired by a digital camera with resolution of 2272 x 704 pixels in a 1/2.5" CCD and focus length of $f = 6.2$ mm.

We performed experiments to do health monitoring for a person for a month. Template tongue images were acquired and stored to a tongue database for each person after health condition was checked in hospital. Tongue images for each person were acquired in the morning and at special time every day.

To examine variation in health condition, we chose five different situations, including "drunken", "after sleeping drunken", "after exercise", "after a meal", and "usual time", at the time of tongue image acquisition.

The values of hue, saturation, intensity color were quite different from each ROI of the tongue images. Among situations, there was small difference in hue and saturation color component for the middle part of the tongue while there was variation in intensity color component as shown in Fig. 4. This result suggested that our method can be contributed for health monitoring using tongue images based on traditional Chinese medicine while there might be errors in measurements. Other factors which can cause differences among situations for health monitoring are required to be researched to improve measurement accuracy in the future.

4. Conclusion

This paper presented health monitoring method using tongue images of a person based on traditional Chinese medicine. The method uses not absolute tongue features but relative ones which are differences from *reference health condition*, diagnosed in hospital, for a person. In the experiments, it was shown that there were differences in HSI and larger in saturation and intensity color differences among five situations. This suggested that our method can be

contributed for health monitoring using tongue images based on traditional Chinese medicine. We will study on other factors which can cause differences among situations for health monitoring and continue to examine tongue images by our method under various situations in the future.

References

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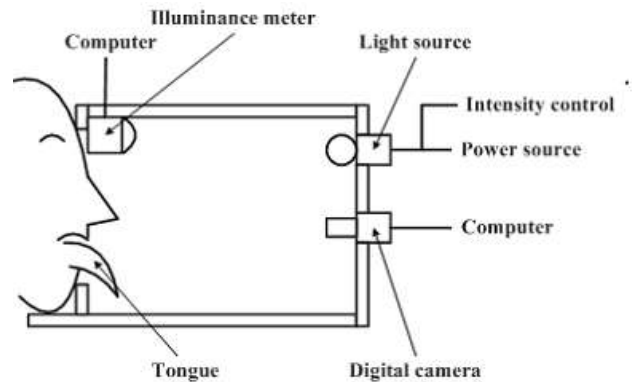


Fig. 1. Experimental configuration to acquire tongue images for health monitoring of a person.

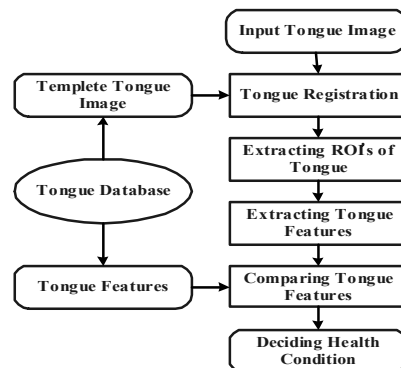
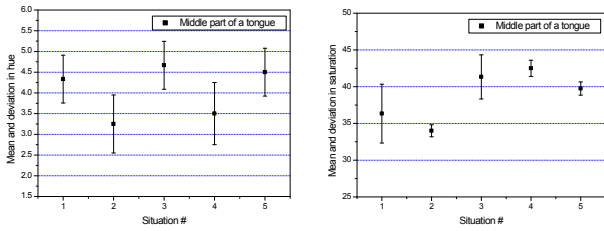


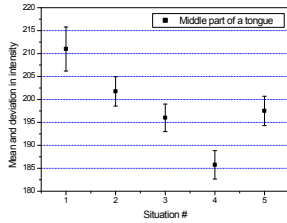
Fig. 2. A block diagram of our health monitoring method of a person using tongue images.



Fig. 3. Typical template tongue images for a person on a tongue database.



(a) (b)



(c)

Fig. 4. (a) Hue, (b) saturation, and (c) intensity values at peak frequency in HSI histogram for the middle part of the tongue in tongue images which were acquired under situations of "1: drunken", "2: after sleeping drunken", "3: after exercise", "4: after a meal", and "5: usual time".