CHAPTER 1

INTRODUCTION

1.1 Background and Motivation

TCM has a long history that was around 3000 years ago. Many researchers had done researches to see how effective TCM in the medical field. As a result, it had been proved that TCM is adequate for handling many diseases and improving quality of life [1, 2]. In the process of development, TCM found four specific methods in diagnosing its patients. Those are inspection which is using visual inspection for observing abnormalities in the tongue and another vital body, listening and smelling which is detecting abnormalities inpatient voice and odor, inquiring which is inquiring about observable symptoms and relevant medical history, and palpation which is palpating corresponding body parts to predict pathological changed.

In the inspection method, the tongue becomes one of the things that is being observed because the tongue becomes a link between the internal organs and the outside world. Therefore, the tongue becomes an indicator to judge whether it's abnormal or not. If there is an abnormality, it means there is something wrong with the internal organs. There are several aspects to consider whether tongue can be said as abnormal or not, such as a body of tongue and coating of the tongue. In Joyce et al. [3], I found that when judging body and coating, also there are some aspects, such as the shape of the body, the color of coating and body, the thickness of the coating, moisture, movement, etc. However, color is easy to get influence by the light environment, age of the doctor, experience, etc. Thus, researchers researched to make a system to get a consistent result, that is ATD. ATD system is needed to make a consistent result in TCM treatment which can handle the subjectivity of doctors in judging color [4].

In nowadays, the self-diagnosis and health monitoring demands have been increased. It encourages the implementation of ATD in the smartphone for a public online used case. So that, it provides a media to doctor and patient for diagnosing tongue. But in the public online case, the diversity of sources will make a higher chance to get a bias in the result such as different sensor sensitivity and lighting conditions. In Hu et al. [5], their framework implements SVM to estimate lighting conditions and polynomial color correction (PCC) to do color correction. The result shows it can be implemented well in one smartphone under a controlled condition in the black box. However, the actual implementation will require more various conditions. So that, the framework that can be adapted in the various condition is needed to support ATD in the smartphone used, especially in public used condition.

1.2 Problem Addressed

In a public online used case, a smartphone will be used as the device for capturing the image. But smartphones available in public are various, which means the used sensors are different from each other. Every sensor has different sensitivity through the light and color, which is easy to be influenced by lighting conditions in the captured image. So that it will cause a bias in the result and needs dataset of each sensors in big amount. However, big amount dataset for all sensors is not available now.

Although some researchers have tried to propose color correction algorithms like K-PLSR for solving small amount of dataset problem, I found that every sensor can be optimized more by choosing the best parameter and kernel. So, it still can be improved for getting a better result to handle the various environmental problem and different sensor sensitivity. The improvement of it still not implemented yet in current ATD system.

In the current ATD system, the steps before disease prediction are usually image acquisition, color correction, image segmentation, and feature extraction. The feature extraction step has many variations which is one of them is color classification. Since this thesis content is about proposed framework for TCCS, the feature extraction step is color classification. TCCS is part of ATD system. However, as has been said before, current ATD system has not implemented yet improved color correction algorithms in TCCS.

Because of that, current TCCS system needs an alternative framework to get more consistent color of tongue image which is not affected by lighting condition and sensor condition. For getting the consistent color of tongue image, this thesis proposes a framework as a part of ATD system before predicting the disease. So that the proposed framework for TCCS will correct the color of tongue, segmenting the corrected tongue image, and classify the color of tongue to certain reference for becoming the input data for ATD system to predict a disease. However, the predicting disease is outside of this thesis scope.

1.3 Content and Innovation

This thesis proposes an alternative framework that has four general steps, those are image acquisition, color correction, image segmentation, and color classification. This thesis will prove that the proposed framework can get consistent color in tongue images under various conditions. The primary role in handling various condition problems is located in the color correction step. So, this framework content is mainly focused on the proving implementation of recently improved algorithms which has not been implemented yet in one unity ATD system for smartphone used.

The color correction algorithm that is used in this framework is K-PLSR optimization. K-PLSR optimization is more reliable in choosing the best parameters of K-PLSR and handling linearity problems, which often happens in the PLSR and polynomial regression. So, this algorithm is more robust to handle various conditions. Besides that, the algorithm that will be used in the image segmentation is U-Net and the algorithm that will be used in the classification is euclidean distance.

1.4 Thesis Content Structure

The thesis content structure is divided into six chapters. For more detail about the explanation of each chapter can be shown as follows:

1. **Introduction**

   This chapter discusses the background of this thesis, the problem that wants to be solved, and the innovation that is offered by this thesis.

2. **Related Works**

   This chapter discusses the current research status of ATD system and the problem that can be improved in this thesis.

3. **Methodology**

   This chapter discusses the methodology that will be used in the proposed framework including the definition of the methodologies, related works, and the reason for choosing the algorithms.

4. **Design of Framework**

   This chapter discusses the detail of framework design including the flows and the implementation steps.

5. **Experimental Result and Analysis**

   This chapter discusses the result of the experiment by using the proposed framework including the setting of the experiment, result, and the discussion.

6. **Closing**

   This chapter discusses the final conclusion, the limitation that is existed in the current proposed framework, and suggestion for future works.