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Design and Realization of the Detection and Analysis System of Human Facial Skin

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Abstract: *Designed and developed a detection and analysis system of human facial skin to realize the comprehensive evaluation of facial skin quality, including the six indicators of roughness, texture, glossiness, moisture, elasticity and color, on the basis of utilizing the high-definition skin camera to get the image of facial skin and combining the technologies of image processing and intelligent information processing, this system, with interactive interfaces, applied the mixed programming technology of C# and MATLAB. It can help consumers to understand their facial skin condition in real time conveniently and objectively and provide professional skin care suggestions, having wide application prospects.*
Keywords: *evaluation and judgment, image processing, mixed programming, skin condition.*

I. INTRODUCTION

With the continuous improvement of people's living standards, more and more people especially women are concerned about skin maintenance gradually. However, it requires technical methods to detect and analyze the quality of skins. Besides, it needs professional knowledge to take good care of skins. As for foreign countries, Japan and German have reached an international leading level in skin detection and analysis system. For instance, the facial image analyzer created by CK (German) can take pictures of faces relying on colored lights and UV light sources. It can make comparatively scientific evaluations on wrinkles, oil and fat secretion, speckles, the size and number of pores on the skin's surface [1]. The APHRODITE skin detection and analysis system developed in Korea has achieved the diversified measurement of 3D images of skins, horns, pores, wrinkles, etc., and can predict the trend of skin improvement. Other similar products include the Visia skin evaluation system in America and so on [2]. In China, there are not many available products for skin detection and analysis. The HSK-SKIN multi-functional skin image analysis system jointly produced by the All-army Skin Disease Center, Air Force General Hospital and other institutes is the most representative high-tech skin micro image product at present and can have direct digital image observation, diagnosis and quantitative analysis of living skins. Nevertheless, in general, there are certain disadvantages like too large volume, inconvenience for carrying, high cost and so on in the existing skin detection and analysis systems abroad. When it comes to domestic products, there are also deficiencies such as the single indicator, low measurement accuracy, complicated steps, etc..

Skin quality evaluation plays a significant role in the process of skin maintenance. In recent years, some researchers conducted exploratory studies on this issue. For example, Chen Jin, et al. focused on the quantitative evaluation of facial skin roughness and its application in medical cosmetology. And they also analyzed the significance of objective and quantitative evaluation of facial skin textures in cosmetic dermatology and care medicine [3]; Wen Xiang, et al. tried to figure out the relationships between female age and skin factors including textures, roughness as well as elasticity by three noninvasive methods, which provided a valuable reference for the confirmation of skin evaluation indexes [4]; Our team proposed to decide the weight of each skin index by an improved no-linear CRITIC method and to obtain the level of skin evaluation through a fuzzy matrix composition [5]. In addition, we established a fuzzy optimization classification model for TCM constitutional types on the basis of multi-attribute skin indexes [6], which provided a theoretical support for further human kin improvement.

Aiming at the problems existing in domestic and international skin detection and analysis products currently, we researched and developed a kind of human facial skin detection and analysis system which collected skin images via a high-definition skin camera and realized the comprehensive evaluation of skins in terms of six indexes (roughness, textures, moisture, elasticity, color, and glossiness) as well as skin quality. Moreover, this system could be integrated in a portable suitcase and possessed many advantages including small volume, convenient carrying, simple operation, high cost performance and so on.

II. HARDWARE COMPONENTS

The hardware part of this system consists of a high-definition skin camera, a tablet PC and a portable suitcase. Its structural design is shown as the Fig.1 below.

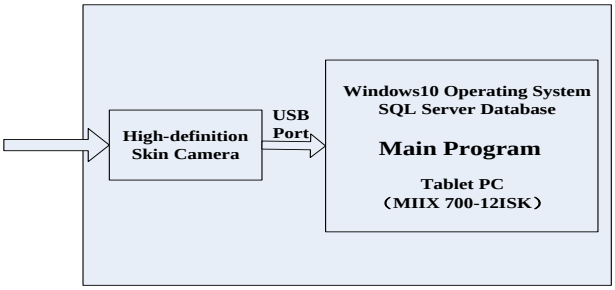

Fig.1 Frame diagram of the system hardware

The high-definition skin camera connects with the tablet PC via a USB port and supports a maximum resolution of 1280x1024. On the outside of its hand shank, there is a button that is used for adjusting brightness so as to enable the system to gather objective and effective pictures of human skins, which can decrease the errors caused by manual operations. We chose Lenovo (MIIX 700-12ISK) as the tablet PC for it has many advantages such as small volume, strong functions, exquisite appearance and convenience for use. This PC is equipped with internal memory of 4.00G, a processor with 1.51GHz as well as a 64-bit operating system - windows10, which ensures fast analyses and comprehensive display of high-definition skin images as well as favorable user experience. First, the high-definition skin camera captures images of skins. Next, the images shall be uploaded to the PC terminal through the USB port. Then, we can achieve the connection with the server's database via Wifi.

III. SOFTWARE DESIGN

1. Overall Structure of Software

The software part of this system contributes to the functions like facial image collection, analysis and evaluation, query and uploading of data, software instruction, etc.. Its functions depend on several modules and we can invoke and observe the functioning of each module via the main interface [7-8]. Its structural design is shown as the Fig.2 below.

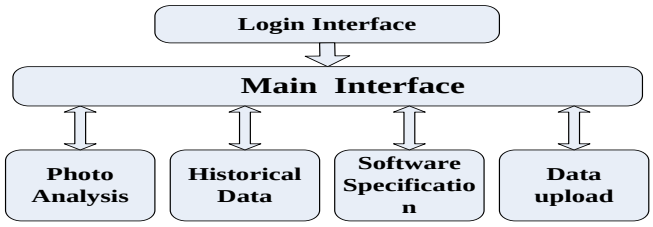

Fig.2 System function structure diagram of software module

This system is based on Visual Studio2015, .NET Framework4.0, SQL Server 2012 database and a development mode of Windows Form [9-11]. It is a programming frame intended for client application and can offer strengthened accessibility, tooling support as well as lower cost of development. VisualC# is a specially designed object-oriented programming language for .NET and has advantages like friendly interface, quick implementation and easy maintenance. VisualC# is weak in mathematical calculation and development efficiency while MATLAB can undertake complicated calculation. Therefore, this system has adopted a mixed-Language programming based on a combination between MATLAB and C# [12-14], not only giving full play to the powerful role of MATLAB in calculation but also makes good use of the strength of C# in terms of user application interface programming [15-17].

2. Software Design and Operation

The operational process is as shown as the Fig.3 below.

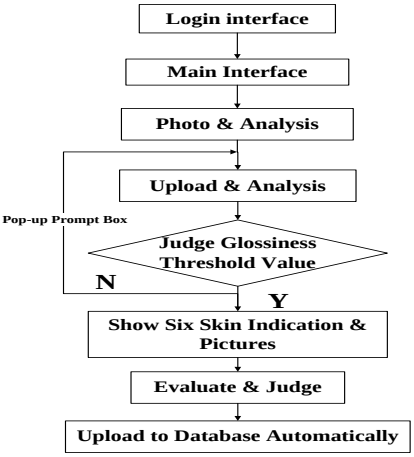

Fig.3 The software flow chart of skin detection and analysis system

The beginning log-in interface is intended to prevent the log-in of illegal users and to protect information security. The administrator's password is encrypted and users cannot log into the main interface unless their accounts and passwords correspond to the database, which further strengthen the security of the system. The main interface is composed of 4 sub-interfaces including image analysis, historical data, data uploading as well as software instruction and it loads through building windows controls by itself. In the sub-interface of image analysis, it's required to collect the specific images of forehead, corners of eyes, cheeks and chin. Then, it completes a skin quality evaluation and information management according to the procedures including image collection, feature analysis, skin evaluation and experts' advice. In the sub-interface of historical data, it provides queries of users' historical data. Besides, it can extract the target data and transfer it into trend charts so users can have a direct understanding of the changes in skin conditions. In the sub-interface of data uploading, it can upload the data of local databases to the server database when Wifi[18] is available so as to provide the foundation for the analysis of users' data. As for the sub-interface of software instruction, it offers a detailed introduction of the system's primary functions and algorithm principles, which enhances the friendliness during users' experience.

3. Practical Application Examples

This system provides convenient skin detection and analysis. The Fig.4 shows the main interface.

Fig.4 Software main interface

Fig.5 The historical data interface

For example, we conducted a detection and analysis of the images of 4 facial parts of a 24-year-old man and then made professional comments and suggestions.

The detection result is as follows: roughness (0.0725), textures (0.4675), color (33.2275), glossiness (7.63), elasticity (0.6625), moisture (62.905). Thus, the system gave a comprehensive score of 83, which indicated that his skin was in good condition. The Fig.5 is a trend chart about this user's historical skin roughness data from September 1st to September 27th and suggests that his skin is basically stable with slight fluctuations.

IV. CONCLUSION

Our team designed a human facial skin detection and analysis system that achieved effective analysis of six indicators, including roughness, texture, glossiness, moisture, elasticity and color, as well as a comprehensive evaluation. Furthermore, this system implements a unified management of texts, image features and historical data via a mixed-Language programming of MATLAB and C#, which not only gives full play to the strong calculation of MATLAB but also avoids the re-translation of algorithms. In addition, this product can be placed in a portable suitcase with distinctive advantages such as the small volume, convenience for carrying, simple operation, strong practicability and so on.

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