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A Mobile Device-Based Hairy Scalp Diagnosis System Using Deep Learning Techniques

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***Abstract*—This paper proposes a mobile device-based hairy scalp diagnosis system, which adopts deep learning techniques. The proposed system is composed of a mobile device, a cloud-based AI training server, and a cloud-based database. Moreover, the proposed system can detect and diagnose four common hairy scalp symptoms: dandruff, folliculitis, hair loss, and oily hair. As a result, the experimental results showed that the recognition accuracy of the proposed system could achieve up to 95.59%.**

***Keywords*—Artificial intelligence over the Internet of Things (AIoT); deep learning; hairy scalp diagnosis; haircare; healthcare**

I. INTRODUCTION

Nowadays, almost everyone has hairy scalp problems due to poor daily habits, high living pressure, imbalanced nutritional intake, and toxic substance in the living environment. Today, even more than 30% of people are hairy severe scalp problems and might also cause hair fall.

To face such increasingly hairy severe scalp problems, the dedicated services of scalp physiotherapy have appeared in recent years. The current process stage of physical therapy detects and diagnoses the state of the patient's hairy scalp by manual recognition, which leads to the different results of hairy scalp examination by different scalp physiotherapists. In other words, we lack a unified and standardized diagnostic process that the scalp symptoms of each patient cannot be accurately recognized.

Recently, due to the popularization of artificial intelligence (AI) and deep learning (DL) techniques, some previous works of using DL technology to detect and diagnose the scalp symptoms have also been appeared [1]-[3]. These DL-based methods [1]-[3] were tried to replace the traditional manually hairy scalp status detecting and diagnosing method for solving the problem of the non-unified and standardized diagnostic process. However, these previous works [1]-[3] are to put the pre-trained module into the scalp detection instrument and directly recognize the symptoms after the scalp detection instrument takes a scalp photo.

Such above mentioned DL-based methods are limited by the computing ability of the microprocessor in the instrument, and it not possible to adopt a more powerful module with higher accuracy and computation.

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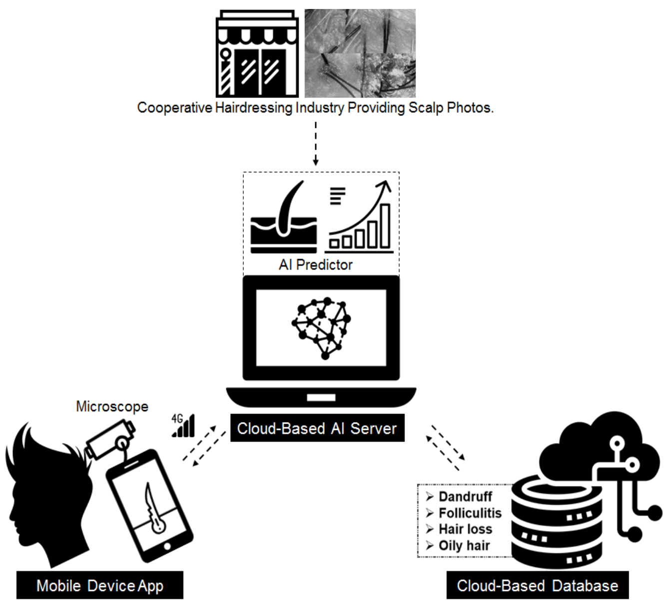


Fig. 1. System Architecture of the proposed system.

To further improve the accuracy of hairy scalp recognition and allow people to complete preliminary scalp health detection and diagnosis at home for improving the current health problem caused by scalp problems. In this paper, a mobile device-based hairy scalp diagnosis system is proposed, which adopts the modern DL techniques. The health condition of hairy scalp can be diagnosed at home, and the scalp care treatment can further be processed according to the diagnosing results.

II. THE PROPOSED SYSTEM

Fig. 1 shows the system architecture of the proposed system, which is composed of a mobile device, a cloud-based AI training server, and a cloud-based database. The mobile device is equipped with a microscope to take a 200x magnified photo of the hairy scalp. The could-based AI training server uses the picture of hairy scalp symptoms provided by the cooperative hairdressing industry as our training dataset to obtain a prediction module for diagnosing the symptoms of hairy scalp. Currently, the proposed system can detect and diagnose four common hairy scalp symptoms: dandruff, folliculitis, hair loss, and oily hair. Fig. 2 shows the operation screens of the proposed mobile device app. Fig. 2 (a) is the start screen. Fig. 2 (b) shows the screen that takes a photo of the hairy scalp and uploads this photo to the cloud-based AI training server for diagnosing the symptoms of hairy scalp. Fig. 2 (c) shows the diagnosed results, which include symptom distribution and severity of the hairy scalp.

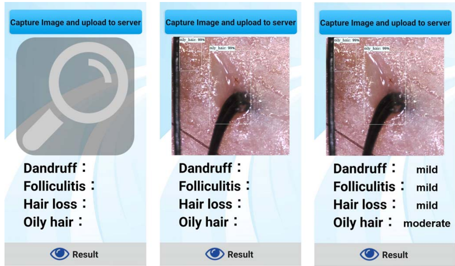
This paper chooses several suitable DL modules as our experimental training modules. Two detection modules (SSD [4] and Faster R-CNN [5]) with Inception v2 [6] and Inception ResNet v2 Atrous [7], [8] are selected. We used more than 2,000 hairy scalp symptoms pictures and labeled these pictures by the hairy scalp care experts. For the training process, 90% of these pictures to be training samples, and 10% of these pictures to be validation samples. All training modules can achieve convergence with 100,000 steps.

The experimental results of two detection modules (SSD and Faster R-CNN) with inception v2 and inception ResNet v2 Atrous are shown in Table 1. The hairy scalp symptoms diagnosed results are also demonstrated in Fig. 3. The SSD module has faster recognition speed than the Faster R-CNN module, but there is a problem that small objects would miss detection. Most hair loss features could not be detected so that the overall recognition accuracy of hairy scalp symptoms detection is relatively low. Although the recognition speed of faster R-CNN is not as good as that of the SSD, however, the recognition speed is not affected by the operation flow of the proposed system. The Faster R-CNN module with Inception ResNet v2 Atrous architecture has better stability and higher accuracy. As a result, we decide to adopt the Faster R-CNN module with Inception ResNet v2 Atrous architecture as our prediction module.

The cloud-based database is used as the interface between the mobile device app and the cloud-based AI training server. The cloud-based database stores the time, symptom distribution, and severity of hairy scalp photos, and transmits back the hairy scalp symptoms diagnosed result by the cloud-based AI training server to the mobile device app, as can be seen in Fig. 2 (c).

III. Conclusion

In this paper, a mobile device-based hairy scalp diagnosis system, which adopts deep learning techniques, has been proposed. We compared serval common DL modules to choose the DL module that is the most suitable for diagnosing four common hairy scalp symptoms. The experimental results showed that the accuracy of the proposed system can achieve up to 95.59% for recognizing four common hairy scalp symptoms.



(a) (b) (c)

Fig. 2. Operation screens of the mobile device app. (a) App start screen; (b) Take a photo of the scalp and upload to the cloud-based AI training server; (c) Symptom distribution and severity of the hairy scalp.

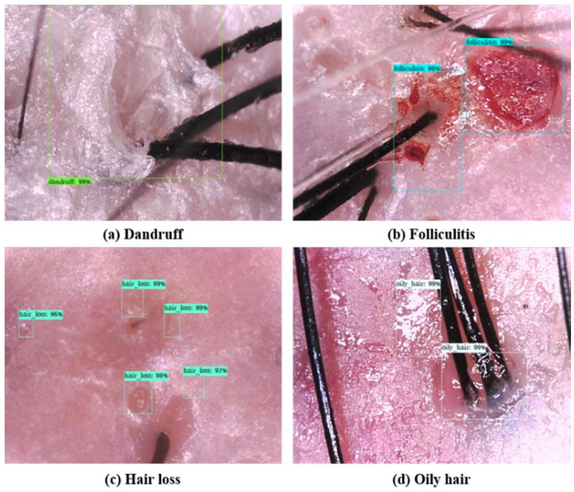


Fig. 3. Hairy scalp symptoms diagnosed results.

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TABLE I. Experimental Results of Two detection modules (SSD and Faster R-CNN) with Inception v2 and Inception ResNet v2 Atrous

Method	Backbone	Steps	AP [Dandruff]	AP [Folliculitis]	AP [Hair Loss]	AP [Oily Hair]
SSD [4]	Inception_v2 [6]	100,000	86.80%	79.69%	69.89%	75.63%
Faster R-CNN [5]	Inception_v2 [6]	100,000	98.07%	96.92%	92.21%	94.85%
Faster R-CNN [5]	Inception_ResNet_v2_Atrous [7], [8]	100,000	99.86%	98.15%	95.59%	98.91%

*Please note that the AP means average precision.