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Smart Home Platform for Hair Loss Treatment Medical Devices Based on LG Pra.L Medi Hair

An Hyosung
Dept. of Information System
Hanyang Univ.
Seoul, Republic of Korea
anhyosung@hanyang.ac.kr

Zhang Yan
Dept. of Information System
Hanyang Univ.
Seoul, Republic of Korea
wkddus@hanyang.ac.kr

Jeon Hyuna
Dept. of Information System
Hanyang Univ.
Seoul, Republic of Korea
younghyuna12@hanyang.ac.kr

Park Jinwoo
Dept. of Information System
Hanyang Univ.
Seoul, Republic of Korea
jinwoo220@hanyang.ac.kr

***Abstract*—Hair has held a significant position in human society throughout history. However, with time, issues like environmental pollution, social concerns, and improper use of various chemicals have exacerbated the problem of hair loss among people. This issue is now affecting individuals at a younger age, demonstrating a trend towards earlier onset.**

As the demand for hair loss treatment has grown, various products such as hair loss shampoos and medications have emerged. Additionally, advancements in technology have made it possible for at-home medical devices to become readily available. In 2020, South Korean company LG Electronics introduced its hair care product, LG Pra.L Medihair, which garnered considerable attention.

However, it's important to note that treating hair loss is not an overnight process and requires consistent, long-term usage. To prevent individuals from giving up due to a lack of immediate results, we have incorporated features like reminders and visual comparison charts of treatment progress in our device. These enhancements provide users with a more intuitive way to monitor their hair loss treatment.

Furthermore, we offer personalized preventive and treatment solutions based on users' age and scalp condition. We also recommend medications and shampoos that can be used in conjunction with the Pra.L Medihair device. In essence, this application aims to assist users in a more effective utilization of the Pra.L Medihair machine for hair loss treatment.

Keywords—visualization, personalized, effective

TABLE I
ROLE ASSIGNMENTS

Roles	Name	Task descriptions and etc.
User/ Customer	An Hyosung	The main users and customers of this application are people who have hair loss or are worried about that. This app can increase customer satisfaction because it works without charging. UI/UX will also be user-friendly and reduce complexity by adding only the necessary features. If the user reports an unexpected error, we will receive feedback and correct it through inquiries and suggestions.
Backend developer	Park Jinwoo	As a backend developer, responsibilities include building a login and registration system for user authentication. Additionally, implementation of an e mail-based authentication code sending feature and a password recovery function is undertaken. Furthermore, design and establishment of a database to store and manage user hair loss data, information collected from Medi Hair, and recommended treatment methods and product details are carried out. Development of an API that provides personalized information and recommendations based on analysis results from the AI model is also a key task. Lastly, construction of a system that integrates remote control functionality via Bluetooth is executed.
Frontend developer	Zhang Yan	Front-end developers are responsible for developing and maintaining the user interface of an application. Implement user interface interactions through HTML, CSS and JavaScript as well as various derived technologies, frameworks, and solutions. Test user interfaces to ensure functionality is working properly, debugging and fixing potential issues. Also works with back-end developers to ensure that the front and back ends of the application work together effectively.
Development manager	Jeon Hyuna	The software development manager is responsible for managing and leading the entire software development team to ensure the successful delivery of the project. Promote cooperation between front-end and back-end developers and improve development efficiency. Maintain and upgrade the software by feeding back the needs of users and customers.

I. INTRODUCTION

A. Motivation

Hair is becoming a symbol of youth as the desire to maintain healthy youth naturally emerges as life spans increase and social activities increase in line with the rapid changes in modern society. Hair originally has the purpose of maintaining body temperature and protecting the head, but over time, it has changed into one of the means of expressing one's personality. Throughout history, and in most (although not all) civilizations, scalp hair has been associated with positive signals such as beauty and power but Baldness or hair loss on the other hand has a negative attribute [1].

Today, the demand for various hairstyles increases the frequency of physical and chemical beauty, resulting in damage not only to the hair but also to the scalp, causing hair loss. As a result, interest in scalp care for healthy scalp and beautiful hair is increasing, and various hair care products are being created for people who are severely stressed by hair loss. In terms of hair loss, not only genetic factors, which are fundamental reasons, but also acquired factors such as environmental pollution, stress due to social life, and hormonal secretion abnormalities caused by changes in negative eating habits are increasing. Hair loss, which used to be a symbol of aging, has become lower in age, with the average incidence of hair loss for men from 34.1 in 2005 to 31.6 in 2010, and young college students in their 20s are also seriously considering hair loss [2].

In addition to the increase in hair loss among young men in their 20s and 30s, women's hair loss is also increasing due to malnutrition, perm, dyeing, and drying caused by excessive diet, and the hair loss market is expanding rapidly due to this increase in the hair loss population, and the hair loss-related industry has entered a growing period [3]. The domestic hair loss market consists of hair care products, hair care services, hair loss treatments, wigs and hair transplants, and related new products are being developed one after another in the pharmaceutical and household goods industries. South Korean firm LG Electronics has also launched its hair care product, LG Pra.L Medihair.

In this article, we define the direction of in-depth development of Pra.L Medihair and present methodologies and prototypes for developing related applications. The current Pra.L Medihair has raised complaints and problems from several users. We also present a solution to this in this article. Therefore, we want to provide a new product utilization method and vision.

B. Problem Statement (client's needs)

Due to the nature of Medihair's treatment method, it takes a long-term commitment of at least four months to see noticeable results, which can be challenging for first-time users. If significant results are not seen within a short period, it is easy to become discouraged and fail to achieve the expected treatment outcomes. Furthermore, since this product does not require daily use, it is easy to forget to use it.

Among the various causes of hair loss, severe mental stress can also significantly impact hair growth. Faced with a relatively long waiting period, psychological stress may also increase.

Similar to hair loss shampoos, Medihair only has a therapeutic effect on specific causes of hair loss. Given the diversity of factors causing hair loss, individual analysis based on scalp type and the location of hair loss is necessary before treatment.

C. Research on Any Relative Software

- ATOMOM

This is artificial intelligence (AI) skin health measurement and customized management software for atopic dermatitis patients. It provides a 1:1 customized care program by analyzing the skin condition and lifestyle habits of skin photos taken of the user's face, body, etc., using non-face-to-face atopic dermatitis diagnostic technology obtained by using AI to learn from tens of thousands of dermatological clinical data. It also has an ai health report that analyzes more than 40 types of diagnosis and degree of improvement of atopic dermatitis and other skin diseases, health record management that helps prevent worsening of symptoms, and a peace-of-mind store that provides products that contain only those that have been selected through strict benchmarks.

- LG ThinQ

This is a smart home platform and software from LG Electronics. It is designed to enable LG's appliances and smart devices to connect to the Internet with smart control, automation and connectivity features to provide a more convenient home experience. With LG ThinQ, users can remotely control and monitor LG appliances that support the platform, such as a washing machine that allows you to remotely view its laundry status and formation completion via your phone.

- INOUT

This is a simple and neat recipe, exercise, and weight loss logging software. Users can identify their weight changes at a glance through charts and graphs, as well as get detailed information on calories and nutrients consumed on a daily, weekly, and monthly basis. And you can customize the notifications to receive them at the desired time for healthy habits.

- Google Calendar

This is an online calendar application developed and provided by Google Inc. designed to help users easily manage and organize their time, schedule and appointments. Users can easily create, edit and delete events, appointments and reminders. Google Calendar supports day view, week view, month view and task list view for users to better understand their schedule. And reminders and notifications can be sent to ensure users don't miss important appointments and events. These reminders can be sent via email, mobile notifications, pop-ups, and more.

- Google Analytics

This is a free web analytics tool provided by Google that focuses on measuring and improving online business results by collecting and analyzing data about website visitors. It provides more than 100 standard reports covering a wide range of data about visitors, and by selecting the data to be analyzed, reports can be customized to view data on specific metrics and dimensions. System segments and customized segment functionality for more in-depth data analysis are also available.

II. Requirement

A. Sign up

When the app starts, it displays the login and sign-up screen. During the sign-up process, the User enters their ID, password, and email. An authentication code is sent to the User's email address, and when the User enters the correct authentication code, the sign-up button becomes active. When storing the password in the database, use Flutter's crypto encryption library to perform SHA-256 hashing on the password and store the hashed password.

B. Log in

When the app starts, it displays the login and sign-up screen. The User enters their ID and password. The entered password is hashed using SHA-256. If this hashed password matches the ID stored in the database, the app displays a 'Login Successful' message and proceeds to the next screen. If the password is incorrect, messages like 'Incorrect password' or 'The entered ID does not exist' are displayed. Additionally, provide an option for password reset through email verification for users who have forgotten their passwords.

C. Developing a Hair Loss Analysis AI Model

Using 100,000 scalp image data categorized by types available on AI-HUB, machine learning is conducted to build an AI model. The AI model analyzes the User's hair loss progression based on scalp types (dry, oily, hair loss-prone) and different hair loss patterns. The AI model provides information to the User regarding potential improvements and treatment duration based on the User's hair loss progression.

D. Collecting Hair Loss Information from the User

After the login, users enter the information about their hair loss progression. For example:

- Duration of experiencing hair loss
- Medications currently being taken
- Areas affected by hair loss
- Family history of hair loss

By using the information provided by the User, the AI model assesses their hair loss progression, and provides solutions.

E. Receive and Analyze Hair and Scalp Information from Medihair

Medihair products are equipped with five microscopes designed specifically for hair (front, center, rear, and two sides) to capture images of the user's hair thickness, hair density, and scalp condition from various areas. Using an AI model, this information is analyzed to determine the progression of the user's hair loss. Each time data is retrieved from Medihair, it is saved along with the date. Additionally, a feature will be developed to compare the user's hair and scalp information at 1-month, 3-month, 6-month, and 1-year intervals.

F. Recommend Customized Treatment Methods, Medicines, and Shampoos

Based on the user's hair loss status, we recommend suitable treatment methods. (e.g., Monday: TopCare mode, Wednesday: FrontCare mode, Friday: TotalCare mode, recommended three times a week). We assess the type of hair loss and recommend appropriate medications (e.g., for thinning hair or hair density issues, medications with relevant nutrients or medicines will be suggested). Lastly, we recommend a shampoo suitable for the user's scalp condition (e.g., protein shampoo or hair loss prevention shampoo depending on the scalp's condition). When recommending shampoos, we'll also provide a link where the shampoo can be purchased (For medications, only the information will be displayed as they are not available for online purchase).

G. Provide Scalp Solutions and Information on Scalp Age

We assess the user's progression of hair loss and offer solutions for preventing and treating hair loss. The expected improvements from the solution will also be communicated (e.g., By implementing the solution, the progression rate of hair loss could increase from 5 years to 7 years). Using the AI model, we determine the 'age' of the user's scalp and provide this information. We'll also inform the user about the potential improvement in their scalp's age if they follow the provided solution.

H. Personalized Notification

The AI model allows the User to choose whether to receive notifications based on the recommended treatment plan. If the User opts to use the notification, personalized notifications are provided tailored to the User's ongoing routine. (e.g.: Today is Wednesday, and it's the day for FrontMode. Please operate Medihair in FrontMode before 9 PM.)

I. Remote Control Functionality

Currently, a remote control is required to operate Medihair. The application connects to Medihair via Bluetooth and sends instructions present on the remote to Medihair. Functions such as checking the battery level of Medihair, viewing real-time scalp images, and selecting modes are available.

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