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

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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

<i>Roles</i>	<i>Name</i>	<i>Task descriptions and etc.</i>
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.
Back-end Developer	Park Jinwoo	As backend developer responsibilities include building a login and registration system for user authentication. Additionally,

<i>Roles</i>	<i>Name</i>	<i>Task descriptions and etc.</i>
Backend Developer	Park Jinwoo	implementation of an email-based authentication code sending feature and a password recovery function is undertaken. Further-more, 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.
Front-end 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.

The list of experiences related to hair loss, the associated costs, and the impacts:

1. Hospital visits and treatment expenses:

- Hair loss symptoms may require visits to the hospital and consultations with medical professionals.
- This leads to medical expenses, and often requires regular treatment sessions and monitoring.
- These costs can be a financial burden and may escalate if long-term treatment is necessary.

2. Purchase of hair loss treatment medications and associated costs:

- Depending on a doctor's prescription, you may need to purchase hair loss treatment medications.
- These medications vary in price depending on the type and brand and typically require long-term use.
- The cost of purchasing and using hair loss treatment medications adds to the overall expenses of managing hair loss.

3. High costs associated with hair transplantation:

- In cases of severe hair loss, individuals may consider hair transplantation as an option.
- Hair transplantation is a surgical procedure that can be quite expensive, and it also involves a recovery period.
- This can result in significant financial expenses and impact daily life during the recovery period.

4. Purchase of wigs:

- When hair loss leads to significant hair thinning or baldness, individuals may need to purchase wigs.
- The price of wigs can vary depending on the materials and styles chosen, and there are ongoing maintenance costs to consider as well.

5. Additional stress:

- Hair loss-related changes in appearance and societal pressures can lead to additional stress.
- Stress can have negative effects on mental health and quality of life, potentially requiring additional expenses for stress management and psychological support.

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. Like 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

Objective: ATOMOM aims to provide personalized and effective care for individuals dealing with atopic dermatitis, a chronic skin condition characterized by inflammation, itching, and discomfort.

Key Features :

1. Personalized Care Program: ATOMOM utilizes AI to analyze skin conditions and lifestyle habits based on user-submitted photos of their face and body. This analysis allows for the creation of a tailored care program, taking into account the individual's unique needs and characteristics.
2. Diagnostic Accuracy: By leveraging AI and learning from a vast database of dermatological clinical data, ATOMOM can provide accurate diagnoses and assess the severity of atopic dermatitis and other skin diseases.
3. Health Record Management: The software helps users manage their health records, which is crucial in tracking the progress of their condition and preventing symptom exacerbation.
4. Product Recommendations: ATOMOM offers a peace-of-mind store that recommends products specifically selected through rigorous benchmarks to ensure they are suitable for atopic dermatitis patients.

Primary Users:

1. ATOMOM is primarily designed for individuals who have been diagnosed with atopic dermatitis, a skin condition that often requires ongoing management and care. These users can benefit from the personalized care plans, accurate diagnostics, and product recommendations provided by the software.
2. Healthcare professionals and dermatologists may also find ATOMOM valuable as a tool for assisting in the diagnosis and management of atopic dermatitis in their patients.

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

Objective: LG ThinQ is designed with the aim of creating a connected and intelligent home environment. It serves as a centralized platform that allows LG's appliances and smart devices to seamlessly connect to the Internet and communicate with each other. The primary goal is to enhance the convenience and efficiency of daily life by offering smart control, automation, and connectivity features.

Key Features:

1. Convenient Home Experience: LG ThinQ empowers users to remotely control and monitor LG appliances and smart devices that are compatible with the platform. This includes appliances like washing machines, refrigerators, and air conditioners. Users can adjust settings, receive status updates, and even troubleshoot issues from their smartphones or other connected devices.
2. Energy Efficiency: The platform may help users optimize energy consumption by allowing them to schedule and automate appliance operation based on their preferences and usage patterns.
3. Interoperability: LG ThinQ fosters interoperability between LG devices, creating a seamless ecosystem where appliances work together to provide a more integrated and responsive home environment.

Primary Users:

1. Homeowners and residents who have LG appliances and smart devices that are compatible with LG ThinQ are the primary users of this platform.
2. Individuals who seek greater convenience, energy efficiency, and control in managing their household appliances and systems are the target audience.
3. LG ThinQ can also be valuable for those who appreciate the convenience of remote monitoring and control, allowing them to stay connected to their home even when they are away.

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

Objective: The primary objective of INOUT is to assist users in tracking and managing their weight loss journey, dietary habits, exercise routines, and overall health. It aims to simplify the process of

ogging and monitoring essential health-related data, such as weight changes, calorie intake, and nutrient consumption.

Key Features:

1. **Weight Tracking:** INOUT provides users with an easy way to monitor their weight changes over time through intuitive charts and graphs. This visual representation allows users to assess their progress at a glance.
2. **Nutritional Insights:** Users can access detailed information about their daily, weekly, and monthly calorie and nutrient intake. This feature enables individuals to make informed choices about their diet and nutrition.
3. **Customizable Notifications:** INOUT allows users to customize notifications to receive reminders and alerts at their preferred times. These notifications can serve as prompts for maintaining healthy habits, such as exercise and meal planning.
4. **Streamlined Logging:** The software simplifies the process of recording exercise routines, meals, and recipes, making it easier for users to maintain a consistent and accurate log of their health-related activities.

Primary Users: INOUT is primarily intended for individuals who are actively engaged in weight loss efforts, fitness enthusiasts, and those who are conscious of their dietary habits and nutritional intake. People looking for a user-friendly tool to help them stay organized and motivated on their journey towards a healthier lifestyle can benefit from INOUT.

Health-conscious individuals seeking a simple yet effective way to track their progress and maintain consistent records are the main target audience.

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**

Objective: The primary objective of Google Calendar is to provide users with a user-friendly and accessible tool for managing their time effectively. It aims to streamline the process of scheduling and tracking events, appointments, and reminders.

Key Features:

1. **Time Management:** Google Calendar empowers users to create, edit, and delete events, appointments, and reminders with ease. It offers a variety of views, including day view, week view, month view, and task list view, to help users gain a comprehensive understanding of their schedule.

2. **Notifications and Reminders:** Google Calendar includes a robust notification system to ensure users do not miss important appointments and events. Reminders can be sent through various channels such as email, mobile notifications, and pop-ups, enhancing the likelihood of punctuality and organization.
3. **Collaboration and Sharing:** Users can also share their calendars with others, making it ideal for both individual and collaborative scheduling. This feature is particularly useful for work-related meetings and group events.

Primary Users:

1. Google Calendar is suitable for a wide range of users, including professionals, students, and individuals seeking effective time management solutions.
2. Business professionals often use Google Calendar to schedule meetings, conference calls, and work-related events, facilitating efficient organization and coordination.
3. Students utilize it to manage their class schedules, assignments, and extracurricular activities.
4. Individuals with busy personal lives can rely on Google Calendar to stay on top of family events, social gatherings, and personal commitments.

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**

Objective: The primary objective of Google Analytics is to provide website owners and businesses with valuable insights into the performance and user interaction on their websites. It aims to empower users to make data-driven decisions by offering detailed data and reports about website visitors, their behavior, and interactions on the site.

Key Features:

1. **Performance Measurement:** Google Analytics offers more than 100 standard reports, providing a comprehensive overview of website performance. Users can assess key metrics such as traffic, user demographics, and user engagement to evaluate the effectiveness of their online presence.
2. **Customized Insights:** Users have the flexibility to select specific data metrics and dimensions for analysis, allowing for tailored and

d customized reports that cater to their unique business goals and questions.

3. **Segmentation and In-Depth Analysis:** Google Analytics provides system segments and customized segment functionality, enabling more in-depth data analysis. This allows users to gain a deeper understanding of specific audience segments and user behavior.
4. **Goal Tracking:** Users can set and track specific goals, such as conversion rates, e-commerce transactions, and lead generation, to measure the success of their online initiatives.

Primary Users:

1. Google Analytics is primarily intended for website owners, marketers, and businesses of all sizes that have an online presence and seek to understand and improve their digital performance.
2. Digital marketing professionals use Google Analytics to evaluate the effectiveness of their marketing campaigns, identify opportunities for optimization, and make informed decisions.
3. Website administrators and developers rely on the tool to troubleshoot technical issues, enhance user experience, and refine website design.

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

1. **Login and Sign-up Screen:** Upon launching the app, the user is presented with a login and sign-up screen, providing options for both new users and existing users.
2. **User Registration:** During the sign-up process, the user is required to provide the following information:
 - 2-1. **ID:** A unique identifier chosen by the user.
 - 2-2. **Password:** A secure password of their choice.
 - 2-3. **Email:** A valid email address for communication and verification purposes.
3. **Email Verification:** After the user completes the registration form, the app sends an authentication code to the provided email address. This code serves as a verification step to ensure the user's email is valid and accessible.

4. **Authentication Code Entry:** The user is prompted to enter the authentication code sent to their email. The app validates the code, and the sign-up button becomes active only if the correct authentication code is entered.
5. **Password Hashing:** When storing the user's password in the database, the app employs Flutter's crypto encryption library to perform SHA-256 hashing on the password before storage. Password hashing enhances security by ensuring that plain-text passwords are not stored directly in the database.

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 '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.

B. Log in

1. **Initial Screen:** When the app is launched, the login screen is displayed to users as the initial interface, providing access to existing users.
2. **User Input:** The user is required to enter their credentials, including:
 - 2-1. **ID:** A unique identifier associated with the user.
 - 2-2. **Password:** The secret passphrase known only to the user.
3. **Password Hashing:** The entered password is securely hashed using the SHA-256 hashing algorithm before it is compared to the stored hash in the database. Hashing the password enhances security by ensuring that plain-text passwords are not transmitted or stored.
4. **Validation and Authentication:** The app checks if the entered ID exists in the database.
 - If the ID does not exist, the app displays a message such as 'The entered ID does not exist.'
 - If the ID exists, the app compares the hashed password entered by the user with the stored hash associated with the ID.
 - If the hashes match, the app displays a 'Login Successful' message, indicating a successful login.
 - If the hashes do not match, the app displays an 'Incorrect password' message.
5. **Password Reset Option:**
 - For users who have forgotten their passwords, the app provides a password reset option.
 - Users can initiate a password reset process by requesting an email verification.
 - An email containing a verification link or code is sent to the user's registered email address.

- Upon successful verification, the user is guided through the process of resetting their password.

By implementing these requirements, the login screen of the app ensures a secure and user-friendly experience, providing appropriate feedback for login attempts and offering a password reset option for users who encounter password-related issues.

C. Developing a Hair Loss Analysis AI Model

1. Data Collection: Gather a substantial dataset consisting of 100,000 scalp images categorized by different types (e.g., dry, oily, hair loss-prone) available on AI-HUB. Ensure that the dataset is diverse and representative of various scalp conditions and hair loss patterns.
2. Machine Learning Model Development: Utilize machine learning techniques to build a robust AI model for analyzing users' hair loss progression. The AI model should be designed to accept input in the form of scalp images and relevant data.
3. User Input and Analysis:
 - Users provide input in the form of scalp images, and the AI model processes this data.
 - The AI model analyzes the images to categorize the user's scalp type (e.g., dry, oily) and identify specific hair loss patterns.
 - The model conducts a comprehensive assessment of the user's hair loss condition.
4. Progression Analysis: Based on the user's scalp type, hair loss patterns, and other relevant factors, the AI model assesses the progression of hair loss. It quantifies the severity and stage of hair loss to provide a clear understanding of the user's current condition.
5. Treatment Recommendations: The AI model generates personalized recommendations for the user, including potential improvements and treatment options. Recommendations may include lifestyle changes, product usage, and treatment duration tailored to the user's specific needs.
6. User Communication: The AI model communicates its findings and recommendations to the user through a user-friendly interface. Users can access information about their hair loss progression, potential improvements, and suggested treatment plans.
7. Data Privacy and Security: Ensure that user data, including scalp images, is handled with the utmost privacy and security. Implement encryption and data protection measures.
8. Model Optimization: Continuously improve and update the AI model using new data and research findings to enhance its accuracy and effectiveness in analyzing hair loss.

By fulfilling these requirements, the AI model for analyzing hair loss progression will provide users with valuable insights and personalized recommendations, enabling them to better understand their hair loss

condition and take appropriate steps for improvement and treatment.

D. Collecting Hair Loss Information from the User

1. User Input: After successful login, users are prompted to provide information about their hair loss progression. This information is crucial for the AI model to assess the user's condition accurately.
2. Data Collection:

The following data is collected from the user:

 - Duration of Experiencing Hair Loss: Users provide details on how long they have been experiencing hair loss. This duration helps determine the chronicity of the condition.
 - Medications Currently Being Taken: Users list any medications or treatments they are currently using for hair loss management. This information assists in understanding ongoing treatments.
 - Areas Affected by Hair Loss: Users specify the regions or areas on their scalp or body affected by hair loss. This data aids in identifying the extent of hair loss.
 - Family History of Hair Loss: Users share information about any family history of hair loss, as genetic factors can play a role in hair loss patterns.
3. Database Storage: The collected user data, including hair loss information, is securely stored in a database. Each user's information is associated with their unique user ID for retrieval and analysis.
4. Data Retrieval: When users engage with the AI model for hair loss analysis, their previously provided information is retrieved from the database for reference.
5. AI Model Assessment: The AI model analyzes the user's hair loss progression based on the provided information, combining it with the data collected from scalp images. The model evaluates the severity, stage, and potential causes of hair loss, considering both the user's input and visual data.
6. Personalized Solutions: Based on the assessment, the AI model generates personalized solutions and recommendations for the user. Solutions may include treatment options, lifestyle changes, or product recommendations tailored to the user's specific needs and condition.
7. User Communication: The AI model communicates its findings and solutions to the user through the app's interface. Users can access information about their hair loss progression and the recommended steps for improvement.
8. Data Privacy and Security: Ensure that user data, including hair loss information, is handled with strict privacy and security measures, following data protection regulations.

By implementing these requirements, the app collects and utilizes valuable user data to assess hair loss progression accurately and provide personalized solutions. Data storage and retrieval from the database ensure that the user's

historical information is readily available for analysis and ongoing support.

E. Receive and Analyze Hair and Scalp Information from Medihair

1. **Microscope-Equipped Medihair Products:** Medihair products are equipped with five specialized microscopes, strategically positioned to capture high-quality images of the user's hair and scalp condition from various angles:
 - Front of the scalp
 - Center of the scalp
 - Rear of the scalp
 - Left side of the scalp
 - Right side of the scalp
 - These microscopes are designed to capture detailed data on hair thickness, hair density, and scalp condition.
2. **Data Capture and Analysis:**
 - Each time the user engages with Medihair and the microscopes are used, data is captured and transmitted to the app.
 - The captured data includes images and metrics related to hair and scalp health, such as hair follicle density, hair strand thickness, and any visible scalp issues.
 - An AI model within the app is responsible for analyzing this data to determine the user's hair loss progression.
3. **Timestamping:** Each set of data received from Medihair is saved in the app's database along with a timestamp indicating the date and time of the data capture. Timestamping allows for tracking and monitoring changes in the user's hair and scalp condition over time.
4. **Progression Tracking:**
 - A feature is to be developed within the app that enables users to compare their hair and scalp information at different intervals.
 - Users can choose to compare data at 1-month, 3-month, 6-month, and 1-year intervals to observe changes and improvements in their hair and scalp condition over time.
 - This comparison feature provides valuable insights into the effectiveness of any treatments or interventions undertaken.
5. **User Access:** Users can access their historical hair and scalp information, including images and analysis results, through the app's interface. This information empowers users to make informed decisions about their hair care and treatment options.
6. **Data Privacy and Security:** Ensure that all data captured and stored from Medihair devices is handled securely and in compliance with data privacy regulations.

By implementing these requirements, the app is equipped to receive, analyze, and store hair and scalp information captured by Medihair products. Users can track the progression of their hair loss, make data-driven decisions, and observe changes in their hair and scalp condition over specific time intervals, fostering an informed and proactive approach to hair care.

F. Recommend Customized Treatment Methods, Medicines, and Shampoos

1. **Treatment Method Recommendation:** Based on the user's hair loss status and assessment, the app recommends suitable treatment methods. These recommendations are tailored to address the user's specific needs. For example, a treatment plan may involve different modes for specific days of the week, such as TopCare mode on Monday, FrontCare mode on Wednesday, and TotalCare mode on Friday. The recommended frequency, such as three times a week, is also specified.
2. **Medication Recommendations:**
 - The app assesses the type and severity of hair loss the user is experiencing.
 - Depending on the assessment, the app recommends appropriate medications or treatments. These may include:
 - Medications containing relevant nutrients or active ingredients to address thinning hair or hair density issues.
 - Specific medicines that are suitable for the user's hair loss condition.
 - The app provides detailed information about the recommended medications, including their benefits and how they should be used.
3. **Shampoo Recommendations:**
 - The user's scalp condition is taken into consideration for shampoo recommendations.
 - Depending on the assessment, the app suggests suitable shampoos that cater to the user's specific scalp condition. Examples include:
 - Protein-enriched shampoos for strengthening hair.
 - Hair loss prevention shampoos for addressing hair loss issues.
 - Alongside shampoo recommendations, the app provides a link or information on where the recommended shampoo can be purchased.
4. **User Access and Information Display:** Users can access their customized treatment plan, medication recommendations, and shampoo suggestions through the app's interface. The information is displayed clearly, allowing users to understand and follow their recommended hair care routine.
5. **Data Tracking:**
 - The app tracks the user's progress and adherence to the recommended treatment methods, medications, and shampoos.

- Users can review their treatment history and adjust their routine as needed.

6. **Medication Availability:** For medications, the app displays information about them but does not provide an online purchase option, as medications may require prescriptions or specific regulations.

By implementing these requirements, the app empowers users to receive personalized recommendations for treating their hair loss based on their unique condition. It offers a comprehensive approach by suggesting treatment methods, medications, and shampoos tailored to the user's specific needs, promoting a proactive and informed approach to hair care.

G. Provide Scalp Solutions and Information on Scalp Age

1. **Assessment of Hair Loss Progression:** The app conducts a thorough assessment of the user's hair loss progression based on data collected from scalp images, user-provided information, and AI analysis. The assessment considers factors such as hair density, thickness, and scalp condition to determine the extent and severity of hair loss.
2. **Solution Recommendations:** Based on the assessment, the app offers tailored solutions for preventing and treating hair loss. These solutions are designed to address the user's specific condition and needs. The app provides clear and actionable recommendations, such as changes in lifestyle, treatment methods, medications, and shampoos.
3. **Expected Improvement Communication:** The app communicates the expected improvements that the user can anticipate by implementing the recommended solutions. For example, it may convey that by following the provided solution, the progression rate of hair loss could be slowed down, extending the estimated time it takes for noticeable hair loss from 5 years to 7 years. This information helps users set realistic expectations for their hair loss management.
4. **Scalp 'Age' Determination:** Using the AI model, the app determines the 'age' of the user's scalp. This metric represents the condition and health of the scalp. Scalp 'age' is calculated based on factors such as scalp condition, hair health, and the severity of hair loss.
5. **Potential Scalp Age Improvement:** The app informs the user about the potential improvement in their scalp's 'age' if they follow the provided solution. It may communicate that by adhering to the recommendations, the user's scalp condition can be expected to improve, resulting in a 'younger' scalp compared to its initial state.
6. **User Access and Tracking:** Users can access their personalized solutions, information on expected improvements, and scalp 'age' through the app's interface. The app also tracks the user's progress over time, allowing them to monitor their scalp's response to the recommended treatments.

By fulfilling these requirements, the app provides users with not only tailored solutions for hair loss but also valuable insights into the potential improvement of their

scalp condition. This approach promotes informed decision-making and encourages users to follow a comprehensive hair care routine for better results.

H. Personalized Notification

1. **User Preference:** The AI model offers users the option to choose whether they want to receive notifications based on the recommended treatment plan. Users can set their notification preferences within the app, indicating whether they wish to receive reminders and updates related to their hair care routine.
2. **Tailored Notification Content:** For users who opt to receive notifications, the app generates personalized messages tailored to the user's ongoing hair care routine. These notifications are designed to remind and guide users on their specific treatment plan.
3. **Notification Timing:** Notifications are scheduled to align with the user's recommended treatment plan. The timing of notifications is determined by factors such as the day of the week, the specific treatment mode, and the user's preferred time for hair care activities.
4. **Example Notification:**
 - For instance, if the user's recommended treatment plan includes FrontMode on Wednesdays, the app generates a notification on Wednesday morning.
 - The notification may read: "Today is Wednesday, and it's the day for FrontMode. Please operate Medihair in FrontMode before 9 PM."
5. **User Interaction:** Users can interact with notifications, acknowledging that they have completed the recommended hair care activities for the day. Acknowledgments or responses from users may be tracked to monitor adherence to the treatment plan.
6. **Notification History:** The app maintains a notification history, allowing users to review past notifications and their responses. This history serves as a record of the user's engagement with the recommended routine.
7. **User-Defined Preferences:** Users have the flexibility to customize their notification preferences, including setting specific time windows for receiving reminders or adjusting the frequency of notifications.
8. **User Privacy and Consent:** Ensure that the app respects user privacy and complies with notification preferences set by the user. Obtain user consent for sending personalized notifications.

By implementing these requirements, the app provides a personalized and user-centric approach to notifications, helping users stay on track with their hair care routine. Users receive timely reminders and guidance tailored to their specific treatment plan, promoting adherence and effectiveness in managing hair loss.

I. Remote Control Functionality

1. **Remote Control Integration:** The Medihair application is designed to connect to Medihair devices via Bluetooth. The primary purpose of this integration is to provide users with remote control capabilities for operating their Medihair devices directly from the app.
2. **Instruction Transmission:** When connected to Medihair, the app allows users to send specific instructions to the device. These instructions replicate the functions available on the physical remote control that comes with Medihair.
3. **Real-Time Scalp Images:** The app enables users to view real-time scalp images captured by Medihair's integrated microscopes. Users can observe their scalp condition and hair health directly through the app, fostering a better understanding of their hair loss progression.
4. **Mode Selection:** Users can select different modes for their Medihair device using the app. These modes may correspond to specific treatments or functionalities, such as TopCare mode, FrontCare mode, TotalCare mode, etc.
5. **User-Friendly Interface:** The app provides a user-friendly interface for controlling Medihair, ensuring that users can easily navigate and operate the device remotely.
6. **Connection Stability and Security:** Ensure a stable and secure Bluetooth connection between the app and Medihair to prevent unauthorized access and data breaches.
7. **User Guide and Assistance:** Include a user guide or tooltips within the app to assist users in understanding how to operate Medihair remotely. Provide troubleshooting information and support for connectivity issues, if necessary.

By implementing these requirements, the Medihair application enhances user convenience by allowing them to control their Medihair devices remotely. Users can access key functions, check device status, view real-time scalp images, and select treatment modes through the app, providing a seamless and integrated experience for managing their hair loss.

III. DEVELOPMENT ENVIRONMENT

A. Choice of Software Development Platform

Our team is planning to develop a cross-platform application that will work on both Android and iOS. To achieve this, we will utilize the Flutter framework, allowing us to build a compatible application for both platforms using a single codebase. The backend of the application will be developed using Node.js, known for its exceptional scalability and data processing capabilities, along with support for various modules/libraries that empower developers to implement a wide range of functionalities. Our AI model, built using Scikit-learn, will leverage machine learning to accurately analyze users' scalp and hair conditions, providing tailored recommendations. Hosting the server will be carried out through AWS's EC2, ensuring stability and security, essential for seamless application operation. Finally, MySQL will serve as the database for efficient management of relational data, guaranteeing secure data storage and retrieval. With this technology stack and configuration, our application is poised to deliver an exceptional user experience and reliability.

TABLE II: Tools and Language Choice

<i>Tools and Language</i>	<i>Reason</i>
Flutter	Flutter is good at utilizing as mobile app development framework for several compelling reasons. Flutter, developed by Google, stands out as an exceptional choice for creating and maintaining applications across both iOS and Android platforms, all from a single codebase. This cross-platform capability not only saves development time but also boosts overall productivity. One of Flutter's key strengths lies in its widget-based approach to building user interfaces. This approach allows developers to rapidly design and modify screens, streamlining the development process. Moreover, Flutter boasts near-native performance, ensuring that our application runs smoothly and efficiently on both platforms. It also provides excellent tools for optimizing screen performance, contributing to an enhanced user experience. Another significant advantage of choosing Flutter is its thriving and robust community. This community support means that developers can easily access a wide range of features

<i>Tools and Language</i>	<i>Reason</i>
	and packages, making it simpler to implement new functionalities into our application. This collaborative environment within the Flutter community further accelerates our development efforts, ultimately leading to a more feature-rich and user-friendly app.
MySQL	<p>MySQL is good at utilizing as our preferred database management system for several compelling reasons. MySQL is renowned as a top-tier open-source relational database management system (RDBMS) known for its remarkable stability and exceptional performance. One of its standout features is its ability to efficiently process large volumes of data, making it particularly well-suited for large-scale applications and web services.</p> <p>MySQL offers excellent compatibility by providing support for various operating systems, enabling developers to deploy it in diverse environments seamlessly. Its powerful query capabilities empower developers to execute complex database operations with ease, facilitating the efficient retrieval and manipulation of data. Furthermore, MySQL places a strong emphasis on data integrity and transaction handling, ensuring the safety and consistency of the database. The scalability and high reliability of MySQL make it the ideal choice for robust data storage and processing in large-scale applications. By harnessing the capabilities of MySQL, we can confidently ensure the reliability and performance of our application's data management, enhancing the overall user experience and efficiency.</p>
	Node.js is a server-side JavaScript runtime built upon Chrome's V8 JavaScript engine, offering a powerful combination of asynchronous

<i>Tools and Language</i>	<i>Reason</i>
Node.js	<p>I/O processing and exceptional scalability. Its event-driven, single-threaded model efficiently handles a multitude of connections simultaneously, ensuring high performance even under heavy workloads.</p> <p>One of Node.js's key advantages is its ability to process data swiftly, resulting in significantly reduced response times for web applications. Moreover, by using JavaScript for both the frontend and backend, developers can maintain a consistent codebase, which enhances overall development efficiency and code readability.</p> <p>Node.js also benefits from a vibrant and active community, providing a wealth of modules and packages that can be readily incorporated into our application. This community-driven ecosystem not only accelerates development but also ensures that our application stays up to date with the latest advancements in the Node.js ecosystem.</p> <p>Node.js is particularly well-suited for developing large-scale web applications and real-time applications, making it an ideal choice for building responsive and high-performance network applications. With Node.js at the core of our application, we are confident in our ability to deliver a reliable, efficient, and responsive user experience while leveraging the benefits of Flutter for cross-platform development.</p>

B. Cost Estimation

To ensure the successful development and functionality of our application, it is crucial to establish a seamless flow of data between the server and the database while maintaining real-time communication. To achieve this, we have chosen to leverage Amazon's EC2 (Elastic Compute Cloud) as our server hosting solution. While it's true that hosting on EC2 incurs costs, the advantages it offers are instrumental to our application's performance and reliability.

One of the key benefits of utilizing Amazon EC2 is its scalability. EC2 allows us to easily scale our application's resources up or down to accommodate varying workloads and user demands. This scalability ensures that our application remains responsive and efficient, even during peak usage periods. Additionally, EC2 provides a high level of reliability and availability, which are critical for our application's uptime and data accessibility.

In addition to hosting, we are integrating multiple APIs into our system to access database information and live server updates. This approach not only enhances data retrieval but also keeps our application's information up-to-date, contributing to an improved overall user experience. The combination of Amazon EC2's scalability, reliability, and the integration of these APIs allows us to offer a robust and responsive application that meets the expectations of our users.

TABLE III: Cost Estimation

Tools and Language	Reason
AWS EC2	We have chosen to utilize AWS EC2 as our Virtual Private Server (VPS) provider for a multitude of compelling reasons, each of which significantly contributes to the success of our application. AWS EC2 stands out as a robust and flexible platform that empowers developers with the essential resources for computing, storage, and networking in the cloud environment.
	One of the standout advantages of AWS EC2 is its extensive and versatile toolset. Developers gain access to a comprehensive suite of tools, including virtual machines, containers, databases, content delivery networks (CDNs), load balancers, and DNS management services. These tools collectively streamline the deployment and management of projects, enabling our development team to work efficiently and effectively.
	Moreover, AWS EC2 ensures reliability through its low and predictable monthly rates, providing an affordable yet resilient solution for hosting and managing a diverse range of online projects. This cost-effective approach allows us to allocate our resources judiciously and ensure that our

application remains accessible and responsive to our users.

Furthermore, AWS EC2's scalability is of paramount importance to us. As we continue to grow and develop our application, the ability to easily scale resources up or down to accommodate varying workloads and user demands is crucial. The flexibility and robustness of AWS EC2 make it the ideal choice for not only hosting but also for building and deploying APIs that are integral to the functionality of our application.

C. Software in Use

1. Git & Github

Git, a distributed version control system, records tasks within project folders, enabling systematic development through version management. Multiple developers can collaboratively work on the same project files without exchanging source code separately. Github, a web hosting platform supporting Git projects, provides a user-friendly graphical interface, enhancing collaborative coding and project management.

- Reason of Using Git & Github : Git and GitHub are essential components of our project's development process. Git serves as our version control system, enabling us to track changes in our codebase systematically. This is particularly crucial in a project like ours, where code development evolves over time. With Git, we can create branches, make modifications, and merge changes seamlessly, ensuring that our codebase remains well-organized and that we can easily roll back to previous versions if issues arise. GitHub, as a web-based platform, enhances collaboration among team members. It provides a centralized location for our code repository, allowing multiple developers to work concurrently, review each other's code, and manage project issues efficiently. This streamlines our development workflow, ensuring that our project progresses smoothly and that we can effectively address any challenges that may arise during development.

2. Notion

Notion, an all-in-one productivity and collaboration tool, efficiently manages notes, schedules, tasks, and projects. Serving as a versatile enterprise collaboration tool, it replaces team wikis, project management, and document sharing tools. Notion finds diverse applications,

including personal wikis, websites, blogs, databases, and company websites. It's widely used in businesses in Korea, including platforms like Carrot Markets and Zigzag, offering extensive flexibility in document creation and collaboration.

- Reason of using Notion: Notion is a versatile tool that plays a pivotal role in our project management and documentation efforts. It enables us to create a cohesive and organized workspace where we can manage project timelines, tasks, and documentation effectively. In the context of our hair loss treatment application, we use Notion to maintain a detailed project plan, track progress, and collaborate on tasks and user stories. Notion's flexibility allows us to adapt our workspace to suit the evolving needs of our project, ensuring that we can easily accommodate changes and updates. By serving as a one-stop platform for project-related information, Notion streamlines communication and collaboration within our team, enhancing our productivity and ensuring that everyone has access to the latest project details and resources.

3. AWS EC2 (Elastic Compute Cloud)

AWS EC2, a cloud computing service, allows remote usage of server resources across data center locations. It offers flexible capacity scaling, enabling users to pay for the resources used, ensuring cost-effectiveness. Users have complete control over instances, enhancing security, network configuration, and storage management. EC2 is a powerful and economical choice for hosting various applications and services in the cloud environment.

- Reason of using AWS EC2: AWS EC2 is a crucial component of our project infrastructure. It provides us with scalable and reliable computing resources in the cloud, which are essential for running our hair loss treatment application efficiently. EC2's flexibility allows us to adjust our server capacity based on demand, ensuring that we can handle varying workloads without over-provisioning or incurring unnecessary costs. Additionally, EC2 gives us full control over our server instances, allowing us to configure security measures, network settings, and storage management according to our project's specific requirements. This level of control and scalability is essential for ensuring the availability and performance of our application, especially as it may experience fluctuations in user traffic and data processing needs.

4. Visual Studio Code

Visual Studio Code, an open-source code editor developed by Microsoft, supports Windows, macOS, and Linux platforms. Beyond syntax enhancement and Git control, it features debugging support and SSH access. Users can

customize themes, shortcuts, and settings, enhancing their coding experience. It's a highly adaptable editor that fosters collaboration and allows developers to tailor their workspace to specific needs, promoting efficient coding practices.

- Reason of using Visual Studio Code: Visual Studio Code serves as our primary integrated development environment (IDE) for writing, testing, and debugging code. Its versatility and robust feature set make it an ideal choice for our project. With Visual Studio Code, our development team can enhance code quality through syntax highlighting, Git integration, and debugging support. Furthermore, we can customize the IDE to match our preferred coding styles, increasing our overall coding efficiency. By fostering collaboration and allowing developers to tailor their workspaces to their specific needs, Visual Studio Code plays a vital role in ensuring that our codebase remains well-maintained, efficient, and easily manageable.

5. AWS RDS (Relational Database Service)

AWS RDS simplifies relational database management in the cloud, automating tasks such as setup, scaling, and backups. It offers cost-effective capacity provisioning, eliminating the complexity of hardware management. RDS supports various database engines, providing users with a reliable and scalable solution for handling large datasets. With automated maintenance and backups, RDS ensures data integrity and availability, making it an ideal choice for database management in cloud-based applications.

- Reason of using AWS RDS: AWS RDS plays a critical role in our project by simplifying the management of relational databases in the cloud. As our hair loss treatment application relies on data storage and retrieval, AWS RDS offers a reliable and scalable solution for handling large datasets efficiently. It automates essential database tasks, such as setup, scaling, and backups, reducing the administrative burden on our team. The cost-effective capacity provisioning ensures that we can manage database resources without incurring unnecessary expenses. Additionally, the automated maintenance and backup features of AWS RDS contribute to data integrity and availability, which are crucial for the success of our application. By leveraging AWS RDS, we can focus on developing our application's core features and functionality while relying on a robust and managed database solution.

6. Google Colab

Google Colab, short for Colaboratory, is a cloud-based platform provided by Google that enables users to write and execute Python code in a web-

based interactive environment. It integrates with Google Drive and allows users to create, share, and comment on Colab notebooks, similar to Jupyter notebooks. Colab provides free access to GPU resources, allowing users to accelerate machine learning tasks and data analysis. It also supports collaborative work, enabling multiple users to collaborate in real-time on the same document, enhancing teamwork and productivity. With pre-installed libraries and seamless integration with Google services, Colab simplifies the process of coding, experimenting, and sharing data science projects.

- Reason of using Google Colab: Google Colab serves as a valuable tool for our data science and machine learning tasks within the project. Its cloud-based, interactive Python environment allows us to perform data analysis, model training, and experimentation efficiently. The integration with Google Drive facilitates data storage and sharing, ensuring that our data science team can collaborate seamlessly. Furthermore, Google Colab provides free access to GPU resources, which is essential for accelerating machine learning tasks, especially those related to image processing and analysis within our hair loss treatment application. With real-time collaboration features and pre-installed libraries, Google Colab simplifies our data science workflow, enabling our team to explore and implement advanced machine learning techniques effectively.

7. Figma

Figma is a cloud-based design and prototyping tool that facilitates collaborative interface design and user experience (UI/UX) planning. It offers a web-based platform, allowing multiple designers to work on the same project simultaneously in real-time. Figma supports vector graphics editing, interactive prototyping, and design version control. Its collaborative features make it an ideal choice for remote teams and designers working on projects together. Figma enables seamless communication, feedback, and iteration during the design process. It also provides a platform for developers and stakeholders to visualize the design, fostering better understanding and efficient collaboration between design and development teams.

- Reason of using Figma: Figma plays a central role in the design and prototyping phases of our project. As a cloud-based design and collaboration tool, it enables our design team to work collaboratively on interface design and user experience (UI/UX) planning. Figma's real-time collaboration features are particularly valuable, as they allow multiple designers to work simultaneously on the same project, fostering creativity and efficiency. Its support for vector

graphics editing and interactive prototyping empowers our design team to create visually appealing and user-friendly interfaces. Additionally, Figma's design version control ensures that our design iterations are well-documented and accessible, promoting effective communication between designers and developers. Overall, Figma streamlines our design process, ensuring that our hair loss treatment application's user interface is intuitive and visually appealing.

8. Scikit-learn

Scikit-learn is a popular open-source machine learning library in Python. It provides simple and efficient tools for data mining and data analysis, built on NumPy, SciPy, and matplotlib. Scikit-learn offers a wide range of machine learning algorithms for classification, regression, clustering, dimensionality reduction, and more. It also includes various tools for model selection, evaluation, and data preprocessing. Scikit-learn is designed for ease of use and efficiency, making it accessible for both beginners and experienced machine learning practitioners. Its extensive documentation and community support make it a go-to choice for building machine learning models and conducting data analysis tasks in Python.

- Reason of using Scikit-learn: Scikit-learn is a fundamental component of our data science and machine learning toolkit. This open-source machine learning library in Python offers a wide range of machine learning algorithms, making it indispensable for our project's data analysis and modeling tasks. With Scikit-learn, our data science team can implement classification, regression, clustering, and dimensionality reduction techniques, among others. Its user-friendly interface and extensive documentation make it accessible to both novice and experienced machine learning practitioners, ensuring that our team can leverage its capabilities effectively. Scikit-learn's tools for model selection, evaluation, and data preprocessing further enhance our data analysis capabilities, enabling us to build robust machine learning models and conduct comprehensive data analysis for our hair loss treatment application.

9. NumPy

NumPy is a powerful numerical computing library in Python. It provides support for large, multi-dimensional arrays and matrices, along with a collection of high-level mathematical functions to operate on these arrays. NumPy is the foundation for many other scientific computing libraries in Python. It offers efficient array operations, enabling tasks such as linear algebra, statistical analysis, Fourier analysis, and more. NumPy arrays are faster and more memory-efficient than Python lists, making them ideal for handling large

datasets and numerical computations. NumPy's multidimensional arrays and versatile functions simplify complex mathematical computations and data manipulations, making it an essential library for scientific computing and data analysis tasks in Python.

- Reason of using NumPy: NumPy is a foundational library in our data science and numerical computing toolkit. As a powerful numerical computing library in Python, NumPy provides essential support for handling large, multi-dimensional arrays and matrices, along with a comprehensive collection of mathematical functions. These capabilities are crucial for our data preprocessing, mathematical computations, and data analysis tasks within the project. NumPy's efficiency and performance advantages over native Python lists make it the ideal choice for working with large datasets, ensuring that our data science team can process and analyze data efficiently. Additionally, NumPy integrates seamlessly with other scientific computing libraries, such as SciPy and matplotlib, further expanding our capabilities for advanced data analysis and visualization. In summary, NumPy forms the backbone of our data science and numerical computing workflows, enabling us to perform complex calculations and manipulations effectively.

IV. SPECIFICATION

A. Login Page

The login page consists of the following components: an 'email input field,' a 'password input field,' a 'login button,' a 'forgot password button,' and a 'sign-up button.' The email input field has a maximum length limitation of 20 characters. The password input field must be between 10 and 20 characters in length, and it must contain both English letters and numbers, with the option to include special characters.

When a user enters their email and password and clicks the login button, the system first checks if the email and password meet the specified rules. Subsequently, the login API is invoked, sending the email and the SHA-256 hashed password to the server.

Within the login API, if the email and the SHA-256 hashed password match records in the database, a successful login message is sent along with a token containing the user's information to the page. Upon receiving the successful login message, the user is redirected to the next page using the provided token.

In cases where the email and hashed password do not match any records in the database, the login API sends a login failure message to the page. Upon receiving the login failure message, the system displays the message to the user, indicating that the login attempt was unsuccessful.

Additionally, the login page offers buttons for users who have forgotten their passwords and those who need to sign

up for a new account, allowing them to navigate to the 'forgot password' and 'sign-up' pages, respectively.

B. Register Page

Email-Based Registration: Users opting for traditional email-based registration are required to enter their email address. Upon submission, a verification code is sent to the provided email address. The 'verify code' button remains active for a duration of three minutes after sending the email.

- Email addresses must be under 20 characters in length to meet system requirements.
- Once the correct verification code is entered, the 'sign-up' button becomes active, allowing users to proceed.
- Users are prompted to enter their chosen password twice for verification. Passwords must adhere to the same criteria mentioned earlier, which include a combination of English letters and numbers, a length between 10 and 15 characters, and the option to include special characters. The double entry of the password helps ensure its accuracy.
- If the verification code is correct and the password meets the specified criteria, the user's email and password details are securely stored in the database, with the password being hashed using the SHA-256 encryption method.

This comprehensive registration process provides users with flexibility and security, accommodating various preferences while maintaining the necessary security measures.

C. User Information Entry Page

This page collects the user's name, age, gender, and nickname. Names must be under 5 characters in Korean. Age is a two-digit integer. Gender selection is configured as either male or female. Nicknames are set to under 10 characters and can consist of Korean, English, or numbers. The information collected is stored in the database. The entered age and gender are used to compare with the average hair thickness and density for that gender and age to assess the user's hair loss condition.

D. Main Page

The main page consists of the following elements: 'Welcome to L-Garana' text, 'Hair Analysis button,' 'Analysis Records button,' 'Chatbot button,' 'Community button,' and 'MediHair product photos and buttons.' Additionally, at the bottom of the screen, there are 'Settings button,' 'Home button,' 'Notifications button,' and 'My Page button.'

The functionality associated with each button when clicked:

- Hair Analysis: Clicking this button redirects to a page where users can take pictures of their hair for analysis.
- Analysis Records: Clicking this button takes users to a page where they can review their hair analysis records for the past six months.

- Chatbot: This button leads to a page where users can interact with a generative AI model that provides treatment solutions based on user records and engages in a chat-based conversation.
- Community: Clicking this button directs users to a popular hair loss community where they can engage in discussions and seek advice.
- MediHair Product Photos and Buttons: This section links to a page for connecting with MediHair products, featuring product photos and related buttons.

At the bottom of the screen:

- Settings: Clicking this button navigates to a page where users can manage their records, make changes to settings such as record deletion, and customize their preferences.
- Home: This button returns users to the main page of the app.
- Notifications: Clicking this button takes users to a page where they can set up notifications for their MediHair product usage schedule.
- My Page: This button leads to a page where users can view and manage their personal information. On this page, users can perform actions such as changing their email address or updating their password.

E. Hair Analysis Page

On the 'Hair Analysis' page, users have the capability to take photos of their hair and perform an analysis. These photos can be captured using a mobile phone camera, but for enhanced accuracy, users are encouraged to utilize a digital electronic microscope.

While the analysis is in progress, a demonstration video showcasing the operation of the MediHair product is displayed to the user.

Once the user submits the captured photos, these images are transmitted to the hair analysis AI model via an API. The AI model then processes the user-provided images and derives the following information:

- Type of Hair Loss: The specific type of hair loss the user is experiencing (e.g., frontal hair loss).
- Hair Density: The user's hair density (e.g., 13 per 1cm²).
- Hair Thickness: The diameter of the user's hair strands (e.g., 45µm).

The server retrieves this data and securely stores it in the database, simultaneously sending the information to be displayed on the page. The types and data formats stored in the database include:

- Analysis Date (in yyyy-mm-dd format)
- Hair Loss Status (varchar(5))
- Type of Hair Loss (varchar(5))
- Hair Thickness (float type)
- Hair Density (int type)

- Severity of Hair Loss (varchar(5))

The AI model presents the analyzed results to the user and recommends an appropriate treatment mode based on the findings (e.g., front mode). Additionally, any further details or recommendations from the analysis can be included as needed.

This comprehensive process empowers users to gain insights into their hair health and receive personalized treatment recommendations for their specific hair loss condition.

F. Hair Record Page

The 'Hair Record Page' offers users the capability to access and review their hair analysis records conducted on the 'Hair Analysis Page' within the past six months. This page features two buttons: 'Today's Record' and 'Previous Records.'

Today's Record: Clicking the 'Today's Record' button queries the database for the user's analysis record corresponding to the current date (yyyy-mm-dd). If a matching record exists, it presents the following information:

- Hair Loss Status
- Type of Hair Loss
- Hair Thickness
- Hair Density
- Severity of Hair Loss

If there are no records for the day, a message is displayed, indicating 'No analysis was conducted today.'

Previous Records: The 'Previous Records' button retrieves analysis dates from the past six months stored in the database and displays them for the user to select. Upon selecting a specific date, the system fetches the corresponding analysis details, including:

- Hair Loss Status
- Type of Hair Loss
- Severity of Hair Loss
- Hair Density
- Hair Thickness
- Severity of Hair Loss

These details are then presented on the page for the user's review.

This functionality empowers users to conveniently access and monitor their hair analysis history, facilitating a deeper understanding of their hair health over time.

G. Remote Control Page

The 'Remote Control Page' offers users the convenience of remotely operating their MediHair device directly from within the L-Garana app. MediHair currently relies on a physical remote control, and the L-Garana app seamlessly integrates this remote control functionality.

This feature enhances the accessibility of the app, allowing users to effortlessly control their MediHair without

the need for a physical remote. The available remote control functions encompass:

- Power On/Off: Users can easily turn the Medihair device on or off with the app's remote control feature.
- Start: Initiating the Medihair treatment can be done conveniently through the app.
- Pause: Users have the ability to pause the ongoing treatment using the remote control.
- MODE Setting: The app's remote control allows users to adjust and set different modes for their Medihair treatment.
- MY CARE: This function enables users to access personalized care settings, enhancing the overall Medihair experience.

This integrated remote control feature simplifies the user experience and ensures that users have full control over their Medihair device through the L-Garana app, promoting ease of use and accessibility.

H. Product Recommendation page

L-Garana goes beyond hair and scalp analysis by delivering personalized recommendations for hair care products and dietary choices tailored to the unique needs of each user. The platform categorizes hair loss information and its severity across different regions of the head, including the front, center, and back. Utilizing a sophisticated algorithm, it classifies essential nutrients and ingredients based on the type and severity of hair loss, subsequently suggesting corresponding foods and hair care products.

1. The algorithm retrieves users' hair loss data, including the type of hair loss and its severity (degree of severity), from the database.
2. Leveraging the food and hair care product recommendation algorithm, the platform recommends specific dietary choices and hair care products to address the user's individual needs.

Additionally, this page presents a curated selection of various hair care products such as shampoos, conditioners, and scalp massagers. These products are designed to complement the user's hair care routine, aiming to combat hair loss issues and promote healthier, more resilient hair.

The holistic approach of L-Garana ensures that users receive tailored guidance for both dietary and product choices, empowering them to take proactive steps towards better hair health.

I. Settings

1. Connection:

This section checks the connection status of Medihair. The device connects to Medihair via Bluetooth on the phone. When navigating to 'Connection Status' within the app, if the connection is complete, it will display 'Connected'.

2. Medihair & App Manual:

The app provides access to Medihair's product information and the application manual within the

app itself. This is available without requiring a separate server connection by incorporating the text of the guide and user manual into the app for the user to view.

3. Dark Mode:

The app offers a dark mode option, ensuring a more comfortable and visually appealing experience, especially in low-light environments."

J. Alarm

The 'Alarm Page' provides users with a convenient platform for managing their alarms efficiently. Users have the flexibility to set alarms based on specific days of the week and minute intervals. Leveraging the capabilities of the flutter_local_notifications Plugin library, the app sends timely reminders for Medihair usage at the scheduled times on the designated days.

Key features of the 'Alarm Page' include:

- Toggle Alarms On/Off: Users can easily enable or disable alarms with a simple toggle switch, giving them full control over their alarm settings.
- Delete Alarms: Unwanted alarms can be effortlessly removed from the list, ensuring a clutter-free alarm setup.
- Set Specific Dates and Times: Users have the freedom to customize each alarm by specifying particular dates and times for their Medihair usage reminders.

This user-friendly interface streamlines the process of setting and managing alarms, ensuring that users receive timely reminders for their Medi-hair usage. These alarms play a crucial role in helping users monitor and maintain their hair health effectively over time.

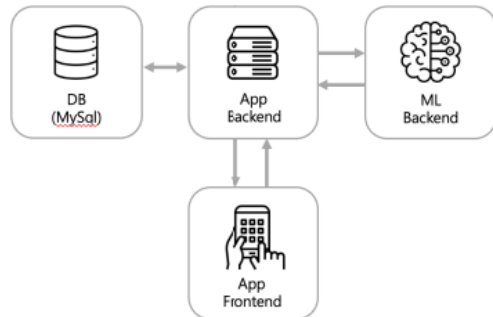
K. Profile

On the profile management page, users can log in and log out. Pressing the logout button takes the user back to the initial login screen. Additionally, the option to add a new profile is provided, allowing each profile to have a unique nickname. Clicking the button to add a new user prompts the user to enter their name, age, gender, and nickname. Names must be five characters or less and composed of Korean characters. Age is a two-digit integer. Gender options are set to be selectable between male and female. Nicknames are set to be 10 characters or less and can be composed of Korean, English, and numerals. The information of the new user, such as name, age, gender, and nickname, is added to the User_Info table corresponding to the user's email in the database. The number of users per email is limited to four. If there are more than two users, the app's start page will allow the selection of a user's name to begin using the app. The feature provides flexibility in switching users, allowing users to easily switch between profiles and personalize their experience on the platform.

V. ARCHITECTURE DESIGN & IMPLEMENT

1. Overall Architecture

Fig 1. Overall Architecture



L•Garana application is structured into four main architectural components:

1. **App Frontend:** The frontend of the application is developed using Flutter. Flutter is chosen for its versatility, allowing developers to write code once and deploy it on both iOS and Android platforms. This cross-platform compatibility significantly reduces development effort and time. Additionally, Flutter offers a rich set of libraries and widgets that enable the implementation of various features and user interface elements, enhancing the user experience.
2. **App Backend:** The backend of the application is built using Node.js. Node.js is selected for its ease of learning, as it uses JavaScript, a widely-known programming language. Node.js also provides access to a vast ecosystem of modules and libraries, including MySQL for database interactions and Nodemailer for email-related functionalities. The decision to use Node.js is driven by its ability to handle asynchronous tasks efficiently, making it well-suited for building responsive and scalable server-side applications.

The server is hosted on an Amazon Web Services (AWS) EC2 environment, enabling the setup of a domain and allowing external access to the application. AWS EC2 provides scalable compute capacity, and the use of this cloud environment ensures that the application can handle varying levels of traffic and maintain high availability. It also allows for easy scaling as the user base grows.

3. **Database (DB):** MySQL is chosen as the relational database management system (RDBMS) for the L•Garana application. MySQL is well-suited for this application for several reasons:
 - **Structured Data:** MySQL excels at managing structured data, which is crucial for storing user information, hair-related data, and other structured records.

- **Data Integrity:** MySQL ensures data integrity through features like constraints, foreign keys, and transactions, ensuring that the data remains accurate and consistent.
- **Query Capabilities:** MySQL offers powerful querying capabilities, enabling efficient retrieval and analysis of data.

The application's MySQL database is hosted on AWS RDS (Relational Database Service), which provides managed database services. AWS RDS handles database administration tasks such as backups, software patching, and scaling, allowing the development team to focus on application development.

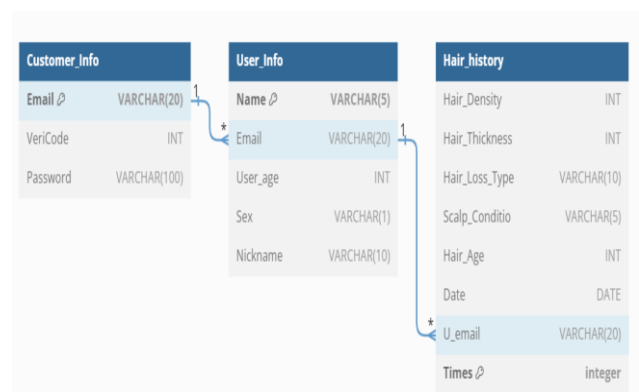
4. **ML Backend:** The machine learning (ML) backend utilized the efficientnet-b7 library for ML model development, leveraging Transfer Learning capabilities. Three AI models were constructed for the application:

- **Hair Loss Type and Severity Analysis Model:** This model helps classify and assess the severity of hair loss based on input data. It assists users in understanding their hair loss condition.
- **Hair Thickness Analysis Model:** This model analyzes hair thickness, providing insights into the user's hair characteristics.
- **Hair Density Analysis Model:** This model evaluates hair density, which is valuable information for understanding the user's hair health.

Google Colab is chosen for its accessibility and ease of use in the machine learning field. It provides a cloud-based environment with pre-installed libraries, making it convenient for ML model development without the need for extensive setup. Additionally, Google Colab offers GPU support, accelerating the training of machine learning models.

In summary, the architectural choices made for the L•Garana application are driven by the need for versatility, ease of development, scalability, data integrity, and efficient machine learning model development. These components work together to create a robust and user-friendly application that provides valuable insights into hair health and related information.

Fig 2. Database



1. The backend server is implemented using Node.js and is executed through Express. It connects to the MySQL database using the Node.js MySQL library. To achieve this, the necessary database connection information is stored in a .env file and retrieved as follows:

```
var connection = mysql.createConnection({
  host: config.database.host,
  port: config.database.port,
  user: config.database.user,
  password: config.database.password,
  database: config.database.database
});
```

The choice of Node.js for the backend server is made for several reasons. Node.js is known for its non-blocking, event-driven architecture, making it highly scalable and efficient for handling asynchronous tasks, which is crucial in web applications. Express is a popular web application framework for Node.js, offering a robust set of features and middleware for building RESTful APIs and web services. These technologies enable us to build a fast and responsive backend server that can handle a high volume of requests and database interactions.

1. L•Garana's application uses MySQL as its database system to store data. The decision to use a relational database like MySQL is driven by the need to manage structured data and relationships efficiently. Relational databases provide data integrity, consistency, and support for complex queries, making them suitable for applications that involve data with well-defined structures and associations.

2. User's hair loss information, including hair density, thickness, loss type, scalp condition, hair age, date, user email, and times, is stored in the Hair_history table. The choice of using a separate table for hair loss information allows for organized data storage and efficient querying based on specific attributes. This structured approach makes it easier to analyze and retrieve hair-related data for user profiles and assessments.

3. During the registration process, user information is stored in the Customer_Info table. The Customer_Info table includes columns for email, verification code, and password. Storing user registration information separately provides security and access control, ensuring that sensitive data such as passwords are properly protected.

4. After registration, the initial user information is stored in the User_Info table. This information includes the user's name, email, age, sex, and nickname. Additionally, this table is used to assess the user's hair loss severity by comparing it to the average hair loss severity for their age group. Storing this information separately enables personalized assessments and recommendations based on the user's profile and hair loss status.

5. All backend components are deployed on the Amazon Web Service (AWS) cloud computing platform. The main server and the second server are deployed on separate AWS Elastic Compute Cloud (EC2) instances, while the database is hosted on AWS Relational Database Service (RDS). This cloud-based deployment offers scalability, reliability, and

accessibility, ensuring that the application can handle varying workloads and provide high availability to users.

6. The use of AWS services, such as EC2 and RDS, offers various advantages, including automatic scaling, data backup, and security features. AWS's infrastructure-as-a-service (IaaS) and database-as-a-service (DBaaS) offerings simplify the management and maintenance of the backend components, allowing the development team to focus on building and enhancing the application's features and functionality.

Table name	Column name(Datatype)	Constraints
Customer_Info	Email(VARCHAR(20)) VeriCode(INT) Password(VARCHAR(100))	Email : PK, Not Null VeriCode : Not Null Password : default/NULL
Hair_history	Hair_Density(INT) Hair_Thickness(INT) Hair_Loss_Type(VARCHAR(10)) Scalp_Condition(VARCHAR(5)) Hair_Age(INT) Date DATE) U_email(VARCHAR(20)) Times(INT)	Times : PK, Not Null U_email : UQ, Not Null Others : default/NULL
User_Info	Name(VARCHAR(5)) Email(VARCHAR(20)) User_age(INT) Sex(VARCHAR(1)) Nickname(VARCHAR(10))	Name : PK, Not Null Email : Not Null Others : default/NULL

2. Directory Organization



a. Front-end

Directory	File name	Library
SE_project /	.dart_tool android assets build ios lib linux macos test web windows .flutter-plugins .flutter-plugins-dependencies .metadata analysis_options.yaml pubspec.lock pubspec.yaml README.md	package:flutter/material.dart dart:async package:http/http.dart dart:convert dart:io package:image_picker/image_picker.dart package:fl_chart/fl_chart.dart package:webview_flutter/webview_flutter.dart
SE_project /assets/ima	analysis.png Analyzing.p	

ges/	ng background.png backimage.png ng boldman.png chatbot.png Googleimage.png hairlossman.png history.png Kakaoimage.png loadingnam.png myphoto.png Naverimage.png product_recommend.png product.png	
SE_project /android/	app gradle build.gradle gradle.properties local.properties settings.gradle	io.flutter.plugins androidx.annotation.Keep androidx.annotation.NonNull io.flutter.Log io.flutter.embedding.engine.FlutterEngine
SE_project /ios/	Flutter Runner Runner.xcodeproj Runner.xcworkspace	UIKit Flutter
SE_project /ios/Runner	Asset.xcassets Base.lproj AppDelegate.swift GeneratedPluginRegistrant.h GeneratedPluginRegistrant.m Info.plist Runner-Bridging-Header.h Runner.xcodeproj Runner.xcworkspace	GeneratedPluginRegistrant.h image_picker_ios/FLTImagePickerPlugin.h webview_flutter_wkwebview/FLTWebViewFlutterPlugin.h
SE_project /lib/	analysisloding.dart	

	analysispage.dart analysisresult.dart camera.dart chatpage.dart findpassword.dart graph.dart registrationscreen.dart loadingscreen.dart loginpage.dart main.dart mainpage.dart noticepage.dart profile.dart recordpage.dart remotecontrol.dart re_password.dart settingpage.dart surveypage.dart	package:flutter/material.dart dart:async package:http/http.dart dart:convert dart:io package:image_picker/image_picker.dart package:fl_chart/fl_chart.dart package:webview_flutter/webview_flutter.dart
--	---	--

b. Back-end

Directory	File name	Library
Back_server/	.env config.js index.js node_modules package-lock.json package.json	express nodemailer body-parser mysql crypto

c. AI

Directory	File name	Library
AI/	HairLoss_classification.ipynb 탈모레벨.ipynb 탈모예측최종.ipynb	Pandas Numpy cv2 sklearn.model_selection. train_test_split tensorflow.keras.models. Sequential tensorflow.keras.layers. Conv2D, MaxPooling2D, Flatten, Dense tensorflow.keras.preprocessing.image.

	img_to_array, load_img tensorflow.keras.utils. to_categorical torch.nn torch.optim torch.optim.lr_scheduler torchvision.datasets torchvision.transforms
--	--

C. Modules

a. Front-end

1. Purpose

To develop L•Garana, we used Flutter so that it can be used in a cross-platform for both Android and iOS environment. Frontend serves as a role in providing interface to a user. It connects user and server by providing input fields that a user can enter information. Once this job is done, the values are delivered to backend. Also, Frontend brings data in the database and provides it to the user after changing it to a data that a user can understand.

2. Functionality

L•Garana application, developed using Flutter, encompasses a wide range of features for comprehensive user engagement. It begins with a robust login page, ensuring secure access with stringent criteria for email and password inputs. Users can also navigate to the 'Forgot Password' and 'Sign-up' pages for account recovery and registration, respectively. The registration process is email-based, featuring email verification and secure password storage. The User Information Entry page collects essential personal data for tailored hair loss assessment. The Main Page offers various functionalities, including hair analysis, record reviews, chatbot interaction, access to a hair loss community, and product integration. The Hair Analysis Page enables users to capture and analyze hair images, receiving personalized recommendations based on the results. Users can review their analysis records on the Hair Record Page. The Remote Control Page simplifies Medihair device operation, and the Product Recommendation Page suggests dietary and product choices for addressing hair loss. The Settings section offers connection status checks, manuals, and dark mode. The Alarm Page facilitates alarm management for timely Medihair usage reminders. Profile management allows multiple user profiles, enhancing personalization. These features collectively provide a comprehensive and user-friendly platform for hair health management and treatment.

3. Location of source code

- https://github.com/SEproject-Medihair/Front_End

4. Class component

- ios folder : This is a folder containing a file that replaces the Dart-written Flutter code with the iOS-only swift code.

- Android folder : This is a folder containing a file that replaces the Dart-written Flutter code with the Android-only java&Kotlin code.
- lib folder : This folder contains Dart code, what was implemented the core logic and user interface of L•Garana app.
- assets folder : In the assets folder there are stored images, fonts, and other resource files that L•Garana app uses.
- lib/analysisloading.dart :

1. Libraries Used and Their Purpose:

- import 'package:flutter/material.dart';: This library is used to import Flutter's UI components and Material Design for building the user interface. It's essential for creating the visual elements and structure of the app.
- import 'dart:async': The Dart async library is imported to handle asynchronous operations. In this code, it's used to implement a timer for navigating to another screen after a specified delay.
- 'analysisresult.dart': This import references another Dart file, likely defining the Analysisresult widget, which is used to display analysis results. It enables code modularity and separation of concerns.

2. Code Functionality:

- initState(): This method is called when the widget is initialized. Here, a Timer is set to execute a function after a 4-second delay. The function navigates to a replacement route using Navigator.pushReplacement. In this case, it likely directs the user to the Analysisresult widget, passing the email as a parameter.
- build(): This method is responsible for building the widget's UI. The UI consists of a black background (Colors.black87) with an animated GIF displayed on top. The Image.asset widget loads a GIF image, and it's positioned using a Stack with Positioned widgets to create the loading animation effect.

3. Code Purpose:

- The primary purpose of this code is to create a "Analysisloading" widget, which represents a loading screen during a data analysis or processing task. The widget displays an animated GIF and a black background to indicate to the user that the app is actively working on a task. After a 4-second delay, it automatically navigates the user to the Analysisresult widget, likely to show the results of the analysis. This loading screen enhances the user experience by providing visual feedback during potentially time-consuming operations.
- lib/lib/analysispage.dart :

1. Libraries Used and Their Purpose:

- import 'package:flutter/material.dart';: This library is essential for building the user interface using

Flutter. It provides widgets and tools for creating the UI components, layouts, and styling.

- 'analysisloading.dart': This import references another Dart file, likely defining the Analysisloading widget, which is used to display a loading screen during analysis. It allows for code modularity and separation of concerns.
- 'remotecontrol.dart': This import references another Dart file, probably defining the Remotecontrol widget, which seems to be related to controlling some remote functionality within the app.

2. Code Functionality:

- The code creates a user interface for the "Analysispage," which appears to be related to hair analysis.
- It displays information such as the title "모발분석" (Hair Analysis) and the name of a connected device "MEDI HAIR-HGN1."
- There is a graphical representation of the user's previous analysis score and status, along with buttons for starting a new analysis and accessing remote control.
- The "분석 시작" (Start Analysis) button navigates the user to the Analysisloading widget when pressed, likely to initiate a new analysis.
- The replay button (an icon) navigates the user to the Remotecontrol widget, which may control some remote functions.
- Information about the previous analysis score and hair conditions is displayed below, providing users with insights into their hair health.

3. Code Purpose:

- The purpose of this code is to create the user interface for the "Analysispage," where users can initiate a hair analysis, view their previous analysis results, and potentially control remote features related to hair care.
- It provides a visually appealing and informative screen for users interested in monitoring and improving their hair health.
- The buttons allow users to take actions related to hair analysis and remote control, enhancing the overall functionality and user experience of the app.

- lib/lib/analysisresult.dart :

1. Libraries Used and Their Purpose:

- import 'package:flutter/material.dart';: This library is essential for building the user interface using Flutter. It provides widgets and tools for creating the UI components, layouts, and styling.
- import 'package:hairapp/mainpage.dart';: This import references another Dart file, likely defining the Mainpage widget, which is used to navigate back to the main page of the app.

- import 'package:http/http.dart' as http;: This import is for making HTTP requests to a remote server to fetch data. It is used to send an email and receive hair analysis results from a server.
- import 'dart:convert';: This import allows for encoding and decoding JSON data, which is useful for handling data fetched from the server.

2. Code Functionality:

- The code creates a user interface for the "Analysisresult" page, where the results of a hair analysis are displayed.
- It sends an HTTP POST request to a server to retrieve hair analysis data based on the provided email address (widget.email).
- The retrieved data is displayed on the screen, including the user's name, hair density, hair thickness, hair loss type, scalp condition, and more.
- The page also suggests recommended hair care based on the analysis results.
- There is a button labeled "메인으로" (Back to Main), which allows the user to navigate back to the main page of the app (Mainpage widget) when pressed.

3. Code Purpose:

- The purpose of this code is to present the results of a hair analysis to the user in a user-friendly manner.
- It sends an email to a server, receives the analysis results, and updates the UI with the retrieved data.
- Users can view details about their hair health, such as hair density, hair thickness, hair loss type, and scalp condition.
- The "메인으로" button provides a convenient way for users to return to the main page of the app after viewing their analysis results.
- Overall, this code is part of an app designed to provide users with insights into their hair health based on analysis data and recommend appropriate hair care based on those results.

- lib/camera.dart : (기능 추가 후 수정 필요)

1. Libraries Used and Their Purpose:

- dart:io: This library is used for working with files and directories. In this code, it's used to handle and display images from the device's camera or gallery.
- package:flutter/material.dart: This is the core Flutter library for building the user interface (UI). It provides widgets, themes, and tools for creating UI components.
- package:flutter/services.dart: This Flutter package provides access to the device's platform-specific services and methods. In this code, it's used for setting the preferred screen orientation.

- package:image_picker/image_picker.dart: This package provides an easy way to access and pick images from the device's camera or gallery.

2. Code Functionality:

- This code creates a Flutter widget called "Camera" that allows users to take a photo using the device's camera or select an image from the device's gallery.
- It uses the ImagePicker class from the image_picker package to interact with the device's camera and gallery.
- When the user taps on the camera icon button, it opens the device's camera for capturing a photo.
- When the user taps on the wallpaper icon button, it opens the device's gallery for selecting an image.
- The selected or captured image is displayed in the UI using the showImage method.

3. Code Purpose:

- The purpose of this code is to create a simple Flutter app screen that allows users to interact with the device's camera and gallery to select or capture images.
- It's often used as part of a larger app where users need to provide images or photos for various purposes, such as profile pictures, document scanning, or image-based tasks.
- The code's primary goal is to provide a user-friendly interface for image selection and capture.

- lib/chatpage.dart : (추후 GPT 추가 후 코드 설명 추가)

- lib/findpassword.dart : (추후 설명 추가)

- lib/graph.dart : (추후 설명 추가)

- lib/legistrationscreen.dart :

1. Libraries Used and Their Purpose:

- package:flutter/material.dart: This is the core Flutter library for building the user interface (UI). It provides widgets, themes, and tools for creating UI components.
- package:http/http.dart as http: This package is used to make HTTP requests to interact with a server. In this code, it's used for sending registration and verification requests to the server.
- dart:convert: This library is used for encoding and decoding JSON data. In this code, it's used to handle JSON responses from the server.
- dart:async: This library is used to work with asynchronous operations. It's used for implementing timers.

2. Code Functionality:

- This code creates a Flutter widget called "RegistrationScreen" for user registration.
- It includes several text input fields for email, verification code, password, and password confirmation.
- Users can request a verification code via email, verify the code, and then register with their email and password.
- It implements a timer to control the resend verification code functionality.

3. Code Purpose:

- The purpose of this code is to create a user registration screen for an app.
- Users can enter their email, receive a verification code, verify their email, set a password, and register for the service.
- The code handles various validation checks, such as password matching, length, and character requirements.
- It also displays informative dialogs to users in case of errors or successful registration.

In summary, this code is designed to provide a user-friendly registration experience within a Flutter app, including email verification and password setup, and it communicates with a server to facilitate the registration process.

- lib/lodingscreen.dart :

1. Libraries Used and Their Purpose:

- dart:async: This Dart library is used for working with asynchronous operations. In this code, it's used to create a delay (4 seconds) before navigating to the login page.
- loginpage.dart: This is a user-defined module (assumed to be part of your Flutter project) that likely contains the login page widget. It's imported so that the application can navigate to it when the splash screen is done.

2. Code Functionality:

- This code creates a Flutter widget called "SplashScreen," which serves as the initial screen displayed when the app is launched.
- Inside the initState method, a Timer is set to wait for 4 seconds. After this delay, it navigates to the login page using Navigator.pushReplacement.
- The Navigator.pushReplacement method replaces the current screen (the splash screen) with the login page, ensuring that users cannot navigate back to the splash screen using the back button.

3. Code Purpose:

- The purpose of this code is to create a splash screen for the app, which is typically used to display a loading indicator, logo, or any other introductory content when the app is launched.

- The splash screen provides a smooth transition to the main content of the app, in this case, the login page.
- By delaying the navigation to the login page, it gives the impression of a brief introduction or branding display before users access the app's core functionality.

In summary, this code is designed to create a splash screen that briefly appears when the app is launched, and after a 4-second delay, it automatically navigates the user to the login page. The purpose is to enhance the user experience and provide a polished entry point to the app.

- lib/loginpage.dart :

1. Libraries Used and Their Purpose:

- package:flutter/material.dart: This is the core Flutter framework library for building user interfaces. It's used to create the visual components and structure of the login screen.
- package:http/http.dart as http: This library is used to make HTTP requests to a remote server for user authentication and login.
- dart:convert: It's used for encoding and decoding JSON data, which is commonly used in communication between the Flutter app and a server.
- dart:async: This Dart library is used for handling asynchronous operations such as setting timers for delayed actions.
- registrationscreen.dart, findpassword.dart, analysispage.dart, recordpage.dart, chatpage.dart: These are user-defined modules (assumed to be part of your Flutter project) that contain various screens or components used for navigation.

2. Code Functionality:

- This code creates a Flutter widget called "LogIn," which represents the login screen of the application.
- Users can enter their email and password, and upon pressing the "Log in" button, the app sends a POST request to a remote server for authentication.
- If the login is successful, a dialog is shown with a success message, and the user is navigated to the "Analysispage" screen.
- The screen also provides options for password recovery ("비밀번호 찾기") and user registration ("회원가입").

3. Code Purpose:

- The purpose of this code is to create the user interface for the login screen of the mobile application.
- Users can log in by providing their email and password, and the app communicates with a server for authentication.

- If the authentication is successful, the user is directed to the "Analysispage" screen.
- The screen also offers options for password recovery and new user registration.
- The "LogIn" widget serves as the entry point for user authentication and access to the app's features.

In summary, this code is responsible for creating the login screen of the mobile application, handling user authentication, and providing navigation options for password recovery, user registration, and social login. It plays a crucial role in the user onboarding process and app security.

- lib/mainpage.dart :
- lib/noticepage.dart
- lib/profile.dart
- lib/recordpage.dart
- lib/remotecomtrol.dart
- lib/re_password.dart
- lib/settingpage.dart
- lib/surveypage.dart
- pubspec.yaml : This file includes app dependencies and configuration information. define metadata like the app's name, version, and list the Flutter packages your app relies on.

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- [3] Sanghee Park, trends in cosmetic patents related to hair loss prevention and hair growth, report Gun Industry Technology Trend, p.24-32, 2003