Custom House

A platform that enables customizable operations of home appliances

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***Abstract*—'내멋대로ㅎLG' is a platform that enables a user to customize their routines. Core values of '내멋대로ㅎLG' are 'personalized experience', 'convenience', and 'data-based'. According to the Korea Communications Commission, the ownership rate of digital television was 94.9% in 2021. Also, as reported by the Korea Power Exchange, the number of refrigerators owned per household was 1.01 in 2019. These numbers indicate that home appliances are already widely distributed. Thus, offering user-customizable services has become a crucial factor for consumers in choosing products. As a result, making 'smart appliances' which offer personalized experiences has become an important market. The platform, '내멋대로ㅎLG', can attract potential customers by maximizing user convenience. '내멋대로ㅎLG' utilizes not only preset time, but also the user's voice as a trigger, using an AI speaker. Users can operate several smart appliances by speaking commands. According to Research and Markets, the global smart appliances market is estimated to reach US$65.3 Billion by 2027, with a compound annual growth rate of 14.1% throughout 2020-2027. Moving on, the platform '내멋대로ㅎLG', utilizes massive user data. Users can share their routines, and recommend several patterns using the acquired data. These data will accumulate into big data, which can be a significant resource for corporations. As a result, '내멋대로ㅎLG' can be a crucial factor for corporations in the future.**

Role Assignments

Roles	Name	Task description and etc.
User	Na Rim	Her daily routine is pre-planned and efficient. She orders a simple phrase and the application does the dedicated job. She customizes and shares her routine to the '내멋대로ㅎLG' application.
Customer	Jo So Youn	She is interested in the newest technologies and their convenient features. She uses the latest LG home appliances equipped with Wifi connection. Her morning routine is quite complex but she is only given a limited amount of time. Executing each device takes up too much time.
Software developer	Yang Kyung Hun	He is the one who creates the application's code. He stays up all night to keep up with the rapid growth of users.
Development manager	Hyun Gyu Won	He oversees the application's general development. He manages timetables and responds to feedback from clients and other developers.

I. INTRODUCTION

Motivation

According to the Korea Communications Commission, the customer ownership rate of digital TVs in 2021 was 94.9%, and according to the Korea Power Exchange, the number of refrigerators owned per household in 2019 was 1.01. These numbers show that home appliances are widespread nowadays. Without a doubt, home appliances are an indispensable part of our lives. According to the Korean Statistical Information Service, Korea's GNI has exceeded $30,000. As a result

of this economic growth, living standards have improved as well. Therefore, consumer expectations for home appliances have also changed. In the past, home appliances used to be tools that solely performed the tasks that were assigned to them. For instance, the washing machine was simply used to do the laundry and wash clothes, the vacuum cleaner was simply used to vacuum dirt, and the television was simply used to display TV programs. However, people no longer want appliances to perform only simple functions. People hope that more convenient and innovative features will be used together in the future.

While factors such as design and color have been the criteria for selecting home appliances until now, connectivity between devices and ease of use are expected to be emphasized in the future. In particular, the purchase pattern of choosing between products of different brands with their respective strengths, such as refrigerators from Company A and TVs from Company B, is also expected to shift to favoring a single brand that focuses on connectivity between devices. An industry official stated, “In the past, there was a clear preference for each product, such as favoring company A for TV and company B for refrigerator, but recently, more and more people are looking for a single brand.” In other words, consumers are focusing on the ‘convenience’ of devices being ‘connected’ to each other when purchasing home appliances.

At the ‘World’s Largest Consumer Electronics: IT Exhibition CES2022’, which opened an offline exhibition in Las Vegas, USA, the core idea of this year’s CES 2022 was ‘connection and expansion’. The main keywords were space tech, eco-friendly, artificial intelligence, robot, and metaverse, and regardless of various industries such as mobility, mobile, and home appliances, the most important part at this year's CES was 'future scalable technology based on connectivity. Regarding the home appliance market, Geun-ho Jeong, director of Atlas Research & Consulting Co., Ltd., commented that “The smart home is changing into health, convenience, entertainment, stability and security, commerce, communication and connection” at the KMA Global Trends Forum. In other words, homes are now developing smartly as complex cultural spaces for individuals rather than simply a place of residence, and artificial intelligence and robot technology are at the center of this change. Home appliances are linked to each other, increasing the convenience of consumers in their daily lives, such that TVs and tablet devices that become hubs are being customized to the user. In this way, everyday life in a smart home will naturally become a part of our society. We will join this trend by developing custom home appliance execution services and connecting them to AI.

As the form of furniture becomes more diverse, the lifestyle of each household is also becoming more unique rather than having common characteristics. Some people want multiple home appliances to operate automatically at a certain time, some want to operate with a simple command, while others want home appliances to operate automatically according to their location or status. A common recommendation system and a manual system provided by a company cannot satisfy each individual's preferences and needs. Our service respects and accepts the uniqueness of individuals, allowing users to create their own home appliance operation manuals. The goal is to increase consumer convenience by linking devices beyond simple control through mobile applications. This will provide users with more convenience than directly operating the product, and will allow users to have a positive experience with smart homes and personalized systems.

Problem statement (client’s needs)

- While using a voice assistant on a smartphone is prevalent and accessible, doing so with household appliances is not the case.

- It is a hassle to operate or set up each appliance in particular situations common in everyday use.

- It is difficult to execute routine tasks by using voice recognition in existing applications.

- There may be useful commands that people may not realize they need.

- Given the importance of data collection in the twenty-first century, it would be advantageous to make the most of this technique to target the needs of specific customers.

Research on any related software

A. Amazon Alexa

Alexa is a virtual personal assistant from Amazon. This program is similar to what our team is looking to build and improve on. It executes simple tasks such as "turn on the lights" to being able to create customizable routines with only a few words.

B. LG ThinQ

LGThinQ is an application for LG Smart Appliances. With recent LG home appliances being equipped with wifi connection, LG ThinQ allows the user to manage all related appliances with a single application. Also, the more you use your application, your patterns will be remembered and analyzed using machine learning, making your usage more convenient.

C. SmartThings

Samsung SmartThings is an umbrella control and automation platform for appliances. It does not only provide service for Samsung but just like what an umbrella symbolizes, it provides services to tons of first and third-party devices. Hundreds of brands and thousands of devices such as lights, cameras, voice assistants, and certain home appliances are compatible with this service.

II. REQUIREMENT ANALYSIS

A. Sign up

After users download and open the application, the splash screen will appear for a while. After the splash screen, users can move to the login page. If they are first-time visitors and non-members, they should go through the sign up process. There are two ways to the sign-up process. First is general sign-up. Users can sign up by typing their name, phone numbers, age, gender, the size of their households, email address, ID, and password. They also need to go through the identity verification process. The second way is by signing up with their social account. In this case, users must provide additional information on household size. Additionally, social login is possible using the social ID of Naver, Kakao, and Google.

B. Log in

After the sign-up procedure, users' data is stored in the database. If users enter their ID and password and this corresponds to the information in the database, their login is successful and the screen will move on to the following screen. If the information they entered is wrong, a message window will appear saying "Your ID or password is incorrect". If users forget their ID, they can find it by typing their name and email address. If they forget their password, they can reset their password after phone authentication.

C. Analysis of user's routines

This function enables users to receive recommendations from routines implemented multiple times under certain conditions. For instance, the platform will suggest the chance to add the trigger, "Cleaning at 11 PM every Sunday", if a user does the cleaning routine every Sunday at 11 PM for a specific period. Additionally, by analyzing the frequency and sequence of home appliance usage, the platform will recommend new routines based on the usage. For example, if the user tends to use the air-conditioning system after switching on the ventilation system, these steps will be recommended as a routine.

D. Set user's own pattern

If the recommended patterns are not satisfying, users can customize and add their own routines through a series of processes:

1. A user can select which household appliances to include in a new routine from the predefined product list.
2. After the first procedure, the user can set up some options. For instance, the user can power on and off the air cleaner, set the temperature of the air conditioner, and so on.
3. The user has to enter a keyword or a time as a trigger to operate predefined home appliances. For example, if the user sets a keyword as 'Cleaning', the home appliances operate by predefined settings when the user speaks the keyword, 'Cleaning'. Else, the user sets a time to 11 am, and the home appliances operate at the time, 11 am.
4. Press the 'Add' button to finish the setting process. The customized routine can be identified on the "My routine" page.

E. Operation using a speaker

Users can execute a preset command by giving an instruction to the speaker. The speaker recognizes the user's command and performs operations set in the corresponding command. That is, a specific pattern may be easily executed through a command preset at the desired moment by the user. The speaker provides a brief description of the operation followed by the execution. Speakers can not only perform commands but also can stop the operating process.

F. Recommend patterns to users

We know information about the user's gender, age, and household size. Using these three key pieces of information, our platform recommends a pattern suitable for each piece of information. Recommendations are made on the Routine List page. If the user's gender is a woman, our platform recommends patterns that women often use or like. Users can be recommended and used immediately for their situation without much effort. The user needs to add his or her favorite recommended routine to his or her list of routines.

G. Sharing routines amongst users

Through this platform, users can share their schedules and download those made by others. The ability to see trending routines in real time is also another feature. For instance, when the air quality is poor, the platform will advise utilizing the air purifier and styler since other users also carry out these actions.

H. Trending routines

Users can check real-time popular routines. Just like in *F. Recommend patterns* to users, they can add their favorite routine to their own routine lists. The ranking of *Trending routines* reflects the amount added by other users.

III. DEVELOPMENT ENVIRONMENT

A. Software Development platforms

- Development Platform

1) Android

Android is a mobile/desktop operating system based on a modified version of Linux kernel and other open-source software, designed primarily for mobile devices such as smartphones and tablets.

2) iOS

iOS is a mobile operating system for devices manufactured by Apple. Users can use iOS on their iPhones. It is also the most used smartphone operating system in the world along with Samsung's Android.

- Development Tool

1) React Native

React Native is a JavaScript framework, developed by Facebook, for creating native mobile applications. It is used to develop Android, IOS, Web, and UWP. It uses the rendering API through the UI library of the target platform.

2) Expo

Expo is a framework and platform for developing iOS, Android, and Web using JavaScript or TypeScript. More specifically, it is a build tool to develop a cross-platform application using React Native and is an XDE that makes native modules easier to use. Developing using this framework simplifies the initial setup, and a great advantage of this platform is that simulators can be used without installing each platform's IDE. Expo also offers a variety of APIs.

3) Visual Studio Code

Visual Studio Code is a source code editor developed by Microsoft for Microsoft Windows, macOS, and Linux. It is operated by the Electron framework developed by GitHub. It supports almost any programming language and provides convenient functions for each of them.

4) Git & GitHub

Git is an open-source version management system used for software development and source code management. GitHub is a cloud-based hosting service that manages git repositories. GitHub allows you to share source code with others on a cloud-based basis and extends the basic functionalities of git. In addition, multiple people can participate in a single project to control and collaborate on versions. Since several developers participate in one project, we managed the code version through GitHub and prevented the code from conflicting with each other.

5) Spring

Spring is an open-source framework for building Java applications that offer technologies such as Aspect-Oriented programming(AOP), Dependency injection(DI), and Plain Old Java Object(POJO). Spring is said to make Java programs faster, safer, and easier for developers but can cause confusion due to its wide range of options. We chose this platform because we were familiar with the Java syntax, and spring being compatible with Java, made the perfect match.

6) MongoDB

MongoDB is a source-available, cross-platform, and document-oriented database program. Classified as a NoSQL database program, MongoDB uses JSON-like documents with optional schemas. MongoDB is developed by MongoDB Inc, and licensed under the Server Side Public License which is deemed non-free by several distributions.

7) AWS

AWS is a cloud platform provided by Amazon. Cloud computing, Storage, and Database to AI and Machine Learning are some of the features they provide. Aside from the reliability, scalability, and flexibility; pay as you go, and no upfront cost is the key advantage of this service. Those features would be a crucial help to small businesses or projects, since it makes them focus more on designing and developing; leaving the rest to AWS.

8) Notion

Notion is an application that provides an integrated documentation service. It provides not only basic memo services such as writing, and modifying but also much more complex features in terms of summarizing and planning a project. For example, a project can be divided into small tasks. Also, it makes it easy to cooperate with other members and helps users to get the whole view of the project. In return, the document becomes well-structured.

9) Nugu Playbuilder

NUGU play builder is a development tool that enables and controls the creation of NUGU play. To simplify, NUGU play is a service or program which performs specific features. With the NUGU play builder, it is possible to identify the user's voice as a trigger, process the user's utterance, and conduct appropriate procedures by using a NUGU speaker, which is SK Telecom's Artificial Intelligence speaker.

- Programming Language

1) JavaScript

JavaScript is an interpreter language for the web and an object-based script programming language. JavaScript doesn't require a compilation process so we can write script code in a short time. It is also easy to learn because it has a simple structure and principle compared to other languages. JavaScript is essential because we are building a cross-platform application using React Native.

2) Java

Java is a popular high-level, object-oriented programming language. From its foundation date in 1995, Java has been loved and become a popular language for developers. Aside from it being relatively easy to learn, its ability to run on different types of computers captured the hearts of many minds. As we took a Java course last semester, we were highly aware of its features, which gave us no reason to not use this language.

B. *Software in use*

Alexa is a virtual personal assistant from Amazon. The main similarity between Alexa and our Custom house is the ability to create routines for home appliances. In

Alexa, users can create customizable routines. On the other hand, our group does not stop at simply users making their routines, but we analyze and recommend new routines. Additionally, we will provide a community where people can upload their routines; making people more connected with each other.

C. *Cost estimation*

Type	Content	Price
Laptop	MacBook Pro (13-inch, M2, 2022) * 4	7,160,000 KRW
Internet	SK Broadband Internet	39,600 KRW per month
Program	Overleaf	8 USD per month
Service	AWS	769 USD per month

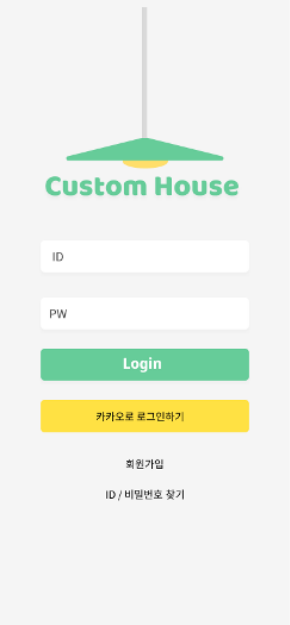
D. *Task distribution*

Name	Task Description
Na Rim	Frontend, Server develop
Jo Soyoun	Frontend, Data processing
Yang Kyunghun	Backend, Database
Hyun Gyuwon	Backend, ML/DL

IV. SPECIFICATIONS

A. Mobile Application

- **Login Page**



There are two input boxes and four buttons on the login page. The two input boxes receive an id and a password respectively. The password will be masked, appearing as a dot when users enter information. After entering the correct ID and password, press the Login button to automatically proceed to the 'Main Page'. ‘Custom House’ supports social login; users can use the yellow button to automatically go to the Kakao login screen, then run the login and automatically go to the 'Main Page'. If the user clicks on the ‘sign up’ and ‘finding ID/password’ buttons below, the user will be moved to the page corresponding to the buttons.

1. Login Successful

If users enter the ID and password and press the login button, the inputs are sent to the server. The server compares the information stored in the database with the values received in the input, then sends a success message if there is a match; the client receives the success message and hands the user over to the 'Main Page'. Users who have successfully logged in can access the 'Main Page'.

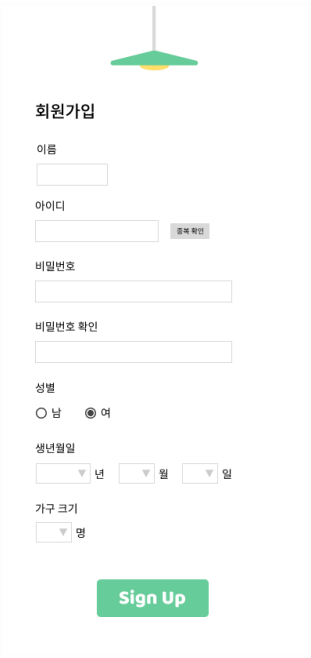
2. Login failed

If the input received is different from the value stored in the database, the server sends a failure message and the client displays a pop-up window stating that the entered information is invalid. If there is an error in the server itself, the message 'The server has encountered an error' is displayed in a pop-up window.

3. Find ID/password

It provides an ID and password search for users who have forgotten their information. Users who do not remember information can find their ID or password through this page. When users run the Find ID feature, users enter their default name and email. They can receive their ID information via email. When users run the ‘Password Finding’, they will enter their IDs and emails. Then will receive a 6-digit authentication number via email, enter the authentication number, and create a new password.

- **Sign Up Page**



Users need to press the ‘회원가입’ button in the Login Page and sign up before they can get access to the application. After entering their name, users must enter an ID consisting of numbers and at least an alphabet character. Korean characters, capital letters of English, and special characters are not available at this stage. After entering the ID, users should press the '중복 확인' button to verify the uniqueness of their ID data in the database. If there is no overlapping ID, users can move on and enter their password. Users need to enter the same password again in the ‘비밀번호 확인’ box to make sure that the password has been entered correctly. Then, they must choose their gender, birth date, and household size, which is the number of family members. If they filled in all the necessary information, the registration process is completed by pressing the 'Sign Up' button.

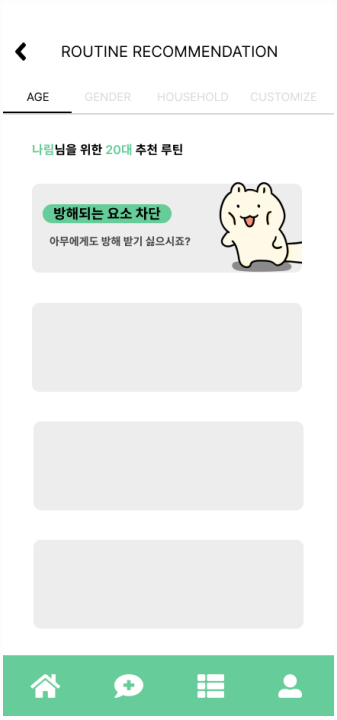
- **Main Page**

On the main page, users can see intimate greetings with their names. Users can also check the routines that the logged-in user is currently applying and the navigation bar that allows users to go to other pages. In addition to greetings, the characters of "custom house" are displayed randomly on the main page, making it visually enjoyable. When users click on the Applied Routine box, they are taken to the Manage Routines page, where they may view all of the applied routines at a glance and delete those that are no longer needed. If there is no applicable routine, a comment "There is no applicable routine." will be shown. From the main page, users can freely navigate to other pages using the navigation bar.

These navigation bars mean: (from left to right)

1. Main Page
2. Custom Routine Page
3. Routine Recommendation Page
4. My Page

- **Routine Recommendation Page**



The Routine Recommendation page is a list of frequently used routines according to 'age', 'gender', and 'number of households' for each user. At the top of this page, there is the title 'ROUTINE RECOMMENDATION' for users to see where they are. If users want to go to the previous screen, users can go back by clicking on the inverted arrow beside the title. Users can check the recommended routines for each category by touching the AGE, GENDER, and HOUSEHOLD buttons. To view a detailed description of the routine, users can click on the desired routine and also move on to the 'Add Routine Page' where users can add their routine. If users have numerous recommended routines, they can freely scroll down and scroll up to view various routines.

1) AGE

People share different lifestyles and lifestyles by age group. Just as generations are divided according to age, their lifestyles vary greatly. After collecting the user's age, ‘custom house’ analyzes the lifestyle by age group and provides routines that match the lifestyle of that age group.

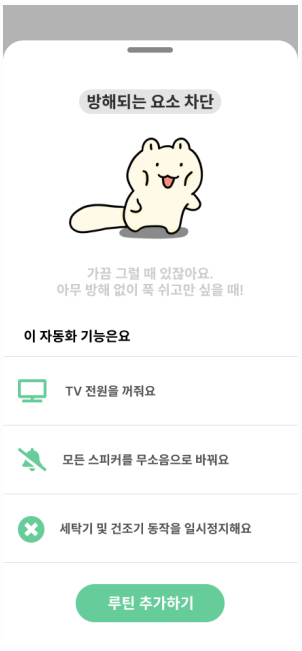
2) GENDER

Gender makes a huge difference in life. We realized that we need to pay attention to gender. We will analyze lifestyle according to gender and recommend routines for each gender.

3) HOUSEHOLD

Today, there are various types of households, such as single-person households, two-person households, and four-person households; life patterns and electronic products used vary depending on the type of household. We analyze lifestyle by household type and provide a list of routines that fit each household type.

- **Add Routine Page**



This page provides a detailed description of the routine and provides the Add Routine button.

1. At the top, the routine title is shown.

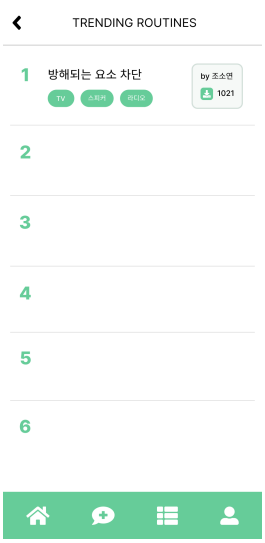
2. Under the routine title, an illustration of the routine is shown.

3. Below the illustration, there is a brief introduction to the routine.

4. Below the introduction, users will see a list of functions that the routine will perform in connection with the home appliance. Insert icons associated with features on the left side of each list to help users intuitively view features.

5. Pressing the 'Add Routine' button at the bottom will add the routine to the '**Applied routine**' and the user will be able to use it.

- **Trending Routine Page**



While the previous routine recommendation page recommended routines by age, gender, and household size, this page shows the ranking of routines based on the number of times added by entire app users, in real-time. It shows which appliances are used under each routine name. On the right, users can check the name of the person who customized it, and also the number of downloads. Users can add it to their list of routines by pressing the '루틴 추가하기' button, just like the previous recommendation page.

- **Custom Routine Page**

Users can customize their own routine through the following processes.

1. First, when they press each icon of appliances, a detailed setting window appears from below.

2. In this window, users can set the power on/off, manage modes and operate time in advance. The configuration list is different for each home appliance; for example, in the case of a heating and cooling device, users can set the temperature.

3. If you press the '완료' button after the setting is completed, the appliances are added to the operation routine as a set.

4. After setting each appliance, users can input the command words into the text box below. Additionally, home appliances can be activated at the time of reservation without speaking commands. In this case, users need to turn on the '시간 예약' mode and enter the desired time of operation.

5. After all these settings, users can add this routine to the 'My Routine' by pressing the '추가' button.

B. NUGU AI speaker

The NUGU AI speaker helps a user to operate the command with the user's voice. When the user speaks specific keywords, the speaker responds by using NLP, which stands for natural language processing. There are three specifications - start the routine by voice, start the routine by preset time, and stop the routine by voice.

- **Start Routine by voice**

To start a preset routine, a user has to speak the keyword, which is set by the user in the routine setting feature. If the NUGU AI speaker understands the user's voice, it responds, "OO 루틴을 시작합니다.' Else, it responds as "명령을 이해하지 못했습니다."

- **Start Routine by preset time**

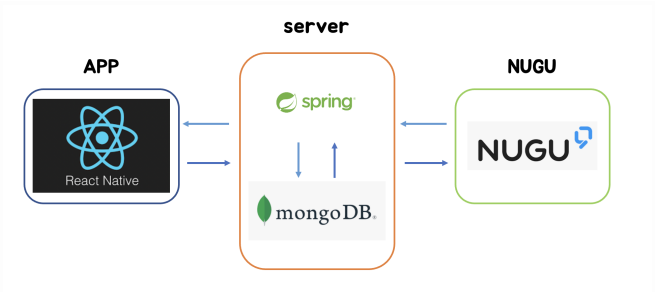
When the time set by the user comes, the NUGU AI speaker notifies the user as follows – "사전에 설정된 OO 루틴을 시작합니다.' Then, smart appliances operate as preset details.

- **Stop Routine**

When the user wants to stop the ongoing routine, the user has to speak "OO 루틴 중단". Then, the NUGU AI speaker responds, "OO 루틴을 중단합니다." The ongoing routine halts immediately and every smart appliance turns off. If the speaker does not understand the user, it responds as "명령을 이해하지 못했습니다.'

V. ARCHITECTURE DESIGN & IMPLEMENTATION

A. Overall Architecture



"내멋대로ㅎLG" consists of three main modules: : Application, server, NUGU speaker. Users can register commands through the "내멋대로ㅎLG" application and operate various home appliances through the commands.
The first module is the frontend. We made an application using React Native and Expo. Users can connect to NUGU speakers and servers through applications. The application helps users send data to the server and register commands to NUGU speaker. All data input to the user is made by the application, which allows the user to use all of the features of the "내멋대로ㅎLG". The second module is the backend. On the backend, there is a connection with the database, an interworking with the NUGU speaker, and an interworking with the front. The server is connected to mongoDB so that we can import or modify the data want from the database. The server receives information from the front end and stores it in the database. The server can provide the user's routine information or operation information. The third module is the NUGU speaker. Users can have the experience of executing commands they set through the Who speaker. The Nougat speaker executes a routine that fits your intention according to your intentions. It listens to a user's command and sends it to the server, where it finds and executes routine data that fits the command

B. Directory Organization

- Frontend

Directory	**File name**
/custom-house-client	.expo-shared assets components .gitignore App.jsx Loading.jsx README.md app.json babel.config.js package-lock.json package.json yarn.lock
/custom-house-client/components	customRoutine home hotRoutine login myPage routineList signup utils TabNav.jsx
/custom-house-client/components/customRoutine	CustomRoutine.jsx CustomRoutineStart.jsx ProductModal.jsx
/custom-house-client/components/home	Home.jsx
/custom-house-client/components/hotRoutine	HotRoutine.jsx
/custom-house-client/components/login	Login.jsx
/custom-house-client/components/myPage	MyPage.jsx
/custom-house-client/components/routineList	Age.jsx Gender.jsx Household.jsx RoutineModal.jsx TopNav.jsx
/custom-house-client/components/signUp	SignUp.jsx
/custom-house-client/components/utils	atom.js data.js text.jsx

- Backend

Directory	**File name**

/custom-house-server/	Custom_House src target CH.iml HELP.md IgnoreThisFile mvnw mvnw.cmd pom.xml
/custom-house-server/ Custom_House/	Custom_House.iml
/custom-house-server/ src/	Main test/java/Custom_HOUSE/CH
/custom-house-server/ src/main/	java/Custom_HOUSE/CH resources
/custom-house-server/ src/main/resources/	application.properties
/custom-house-server/ src/main/java/Custom_HOUSE/CH/	Controller Repository Service Model AuthenticationRequest.java AuthenticationResponse.java ChApplication.java SecurityConfiguration.java
/custom-house-server/ src/main/java/Custom_HOUSE/CH/Controller/	MemberController.java NuguController.java RoutineController.java
/custom-house-server/ src/main/java/Custom_HOUSE/CH/model/	Member.java Routine.java
/custom-house-server/ src/main/java/Custom_HOUSE/CH/Service/	MemberService.java RoutineService.java
/custom-house-server/ src/main/java/Custom_HOUSE/CH/Repository/	MemberRepository.java RoutineRepository.java

C. Module 1: frontend

1) Purpose

The front end provides a user interface. It connects the user to the server. It receives information from users, hands over the information to the server, and so on. It also allows users to view information received from the server.

2) Functionality

"My Own LG" provides functions such as signing up, logging in, logging out, adding custom routines, checking working appliances, showing trend routine lists, and showing personalized recommended routine lists. To permanently store the information you enter, send the input to the server to help you store it in the database. Also, the information of the user who logged in once is stored on the phone, so you don't have to log in again.

3) Location of Source Code

/custom-house-client

4) Class Components

i) Loading Page

It shows the logo and character of "My Own Way LG" during the loading time before the application starts. If the previous login information remains, show the loading page and proceed to the main page, and if there is no login information, proceed to the login page.

ii) SignUp Page

This helps users register information on "LGB". This provides several input compartments through which the user can input his or her information. The user will enter the user's name, ID, password, phone number, gender, number of households, and age and press the "Membership" button. When the user presses the membership button, the information entered by the user is handed over to the server, and if there is no problem, the user is registered as a normal user in "My Own LG." The user can use the login function through the information registered as a member.

iii) Login Page

This is a page that helps users go to the main page and use the main functions of "LG as they please." The user can correctly write down the ID and password he/she wrote down when signing

up and press the login button to move on to the "Home Page". If the user enters incorrect information or enters information that is not in the database, the login page is loaded again with a notification of login failure. At this time, the user can search for the forgotten information by pressing the "ID, password search" button.

iv) Home Page

This is the main page of "My Own LG". On the upper left, you can see a simple application logo, and in the middle, the biggest is the phrase "Hello!" along with the user's name, allowing the user to become familiar with the application. Below the greeting phrase is a column showing the routines currently being applied by the user. And below that, there's a compartment that shows what kind of home appliances are working. The user can easily check which routines he or she is applying and which home appliances are in operation through the corresponding compartments. If the user clicks on the currently applied routine section, it goes to the "Manage My Routines page" where the applied routines can be deleted. At the bottom, there is a navigation bar that allows you to go to various pages. The user may move to the desired page by pressing the desired button.

v) Custom Routine Page

It is a page that provides custom routine production, a key feature of "My Own LG." A user may set detailed operation details for each device by pressing a desired device among nine home appliances. When a user presses a home appliance, a detailed operation content that can be applied to each home appliance and a space where the desired value can be entered are displayed. The user can add home appliances to the routine by selecting and setting the desired detailed operation contents. After the home appliance is set up, the user can create the routine as desired by writing the name of the routine in the input column and selecting the operation execution trigger from the command and time. When the user presses the Add Routine button, the information set by the user is handed over to the server. By operating in this way, the custom routine produced by the user may be permanently stored.

vi) Trending Routine Page

This is a page where the user can check what routines other users often use and add the desired routines. It lists routines with a high number of downloads in order and shows the user a list of routines. When the user presses the routine, the user can check exactly what function the routine provides, and if it is the function the user wanted, the user can easily add it to my routine by pressing the Add button. This page receives data from the server in real time, allowing users to identify trends and find and use routines that are useful to them.

vii) My Page

This is a page that allows users to check their subscription information, manage personal routines, or execute logouts. On this page, the user can perform the desired function by pressing the button of the desired function. If the user presses 'My Information', a modal window containing the user's subscription information opens to check his or her subscription information. If the user presses the "Manage My Routine" button, he or she can go to the "Manage My Routine" page to look at the routines that the user is applying at a glance, and delete the routines that are not in use. Finally, if the user presses the logout button, an alarm window appears asking if the user really logs out, and if the user presses the "Yes" button, the logout proceeds and switches to the login page.

viii) RoutineList Page

This page is a page that shows appropriate recommendation routines according to the user's information (age, gender, and number of households). When a user accesses the page, a list of recommended routines suitable for the user is retrieved from the server and displayed. When the user clicks on the desired routine, it displays a modal window showing details of the routine. The user may check detailed information of the routine through the modal window. When the user presses the Add button at the bottom of the modal window, the information is sent to the server and the corresponding routine is added to the user's list of routines that sent the request.

5) Where it’s taken from

This provides an interface that allows users to intuitively check various information. It also provides a screen that allows users to enter various information, and helps users' information to be transferred to the server and stored. Ultimately, it is used to allow users to consume "LG" services.

6) How/Why you used it

We used React Native and Expo to implement the front end. Each screen and frequently used parts were componentized and separated, and the API

code for communication with the server was written to send the user's information to the server, and the user's information could be obtained from the server.

D. Module 2: server

1) Purpose

Our server responds to the various requests sent from the front end and NUGU Playbuilder. It connects with the database to access the data and retrieves the necessary details. Storing, Authenticating, Retrieving, and Manipulation of data are the main purpose of our server.

2) Functionality

The server saves, manipulates, optimizes, retrieves, and authenticates requests sent from its clients. When the user inputs data and sends data from the SignUp page, the data will be sent to the server and into the database. The same goes for retrieving, authenticating, and manipulating data. Also, our server is used as a backend proxy for our NUGU Play Builder. In order to get the correct response from our request to the AI speaker, the Play Builder accesses the database with the help of our server.

3) Location of Source Code

/custom-house-server

4) Class Components

i) MemberController

This class handles with the GET/POST requests and responses of our users. /new-member is a post request which handles with the sign up. When the user inputs their information in the sign up page, the data will be saved into our database passing through this api. /login is a post request for login. After the user registers their account, they are able to verify if they entered the valid information in the login page. The /login api authenticates the information received by the customer to the data stored in the database. /member-info{userId} is a get request for retrieving member/user information. The userId will be passed onto the server and the server will match the userId in the database and bring back the necessary information. /users is a get request retrieving all information of all users.

ii) Routine Controller

This class handles the GET/POST requests and responses of the routines. It contains several functions dealing with routines. First is a post-request handling with routine registration. When the user clicks on the Add Routine button on the CustomRoutine Page, the information will be sent to this function. After receiving the data, it will save the data into the database. Next is a get request for retrieving all information of all routines. Followed on is a get request for getting routines used by a certain user. After a user inputs a routine or multiple routines, this function can be used to show the applied routines on the Home Page. /trending-routines is a get request for returning the top 10 routines with the highest number of downloads. This api goes over the database and retrieves 10 routine informations in order. /routine-incrementation/{routineName} is a Post request requesting that the number of downloads of a certain routine to increase by one. When a user downloads a routine in the Trending Routine Page, the number of downloads of the certain routine will increase by one.

iii) Nugu Controller

This class handles the POST request of the NUGU Play Builder. After receiving information from the Play Builder, the server manipulates the data in order to compare it with the data in the database. If a match is found, the data will be parsed into the necessary format and sent back to the Play Builder, leading the speaker to respond with the necessary information.

iv) Member & Routine Models

These classes are used to manage the data for Members and Routines. The getters and setters for each variable will be initialized together with its data type. This connects the values received from the front end to the database. It gives a format of how the database should look and gives easier access.

v) Member & Routine Repositories

These classes are used to manage the data for Members and Routines in a different way than with models. Finding specific data or all data from the database is possible with the use of repositories.

5) Where It’s taken from

The data is requested and responded to from the front end, and NUGU Play Builder. The database is accessed by the server to add, alter and access the required information.

6) How / Why you used it

Our team was able to connect users and their data using our backend server. Users can add, alter and access information using our application or the AI speaker, and our server functions as the link between them all. We used Java and Spring Framework as our backend server to reduce development time and increase productivity.

E. Module 3: NUGU speaker

1) Purpose

내멋대로ㅎLG utilizes Nugu play builder to maximize user convenience. Using the nugu AI speaker, users will be able to execute routines via voice command. The routine will be performed if the initiated routine is in the database. If not, an error message will be returned.

2) Functionality

Users can use the nugu AI speaker to initiate routines from the routines they've saved in the 내멋대로ㅎLG application. From the predefined intents in the NUGU Play Builder, the Play Builder receive information about the routine by sending a request to the server, which will then send the NUGU Play Builder the needed data along with a response from the speaker.

3) Location of Source Code

/custom-house-server/src/main/java/Custom_HOUSE/CH/

4) Class Components

ask.routineStart - The ask.routineStart intent detects if the user is initiating the routine command. Once it determines that the user wants to start a routine, it will be linked to answer.routineStart to connect with the backend server and return the desired values.

answer.routineStart - answer.routineStart is the reply to the query from the user. The answer.routineStart will verify the data provided with the backend server and return the corresponding response. If the routine information is in the database, the speaker will respond that certain home appliances have started. If not, it will send out an error message.

5) Where It's taken from

The user executes a command using voice control. The backend proxy sends the appropriate return value to the play builder.

6) How / Why you used it

Our application uses the NUGU Play Builder provided by SKT. With this platform, we can set Intents, Entities, and Actions. With Intents and entities, we can request for a task to be done. The Action will respond to the request and respond by returning a value or performing certain tasks. In order to enhance user comfort and fully utilize the smart home system, we connected our application 내멋대로ㅎLG with a smart speaker.

F. Module 4 : Machine Learning

1) Purpose

Our service provides services to automatically automate appliances according to the users' needs, and gives them another routine that fits their needs. Machine Learning used to implement a recommending function that reflects users' personal information

2) Functionality

'내멋대로ㅎLG' recommends the proper routine for each user by analyzing age, number of households, and sex of the user for this service. It also reflects the combination of routines that the user is currently applying. Users can add it to their own routine list after checking their recommendation.

3) Location of Source Code

/custom-house-AI

4) Class components

i) train_test_split

'Train_test_split' is a function provided by scikit-learn for easy separation of train data and test data

ii) sklearn.metrics

'Sklearn.metrics' is a function that evaluates the quality of predictions, and it is provided from the 'scikit-learn' library. We used a confusion matrix, which is a technique that expresses the number of matches between the actual class and the prediction label in a matrix format.

iii) Decision Tree

Decision Tree is a decision support tool that uses a tree-like model of decisions and their possible consequences, including chance event outcomes,

resource costs, and utility. It is one way to display an algorithm that only contains conditional control statements.

iv) RandomForest Classifier

RandomForest Classifier is an ensemble learning method for classification, regression and other tasks that operates by constructing a multitude of decision trees at training time.

5) Where It's taken from

After users enter their information of age, sex, and the size of household when they sign-up, and add their own routines later, it brings these user data from the database and makes a comprehensive analysis to recommend the routine.

6) How/Why we used the module

i) pandas

Pandas is a software library written for the Python programming language for data manipulation and analysis. In particular, it offers data structures and operations for manipulating numerical tables and time series.

ii) numpy

NumPy is a library for the Python programming language, adding support for large, multi-dimensional arrays and matrices, along with a large collection of high-level mathematical functions to operate on these arrays.

iii) matplotlib.pyplot

Matplotlib is a plotting library for the Python programming language and its numerical mathematics extension NumPy.

iv) seaborn

Seaborn is a Python data visualization library based on matplotlib. It provides a high-level interface for drawing attractive and informative statistical graphics.

v) scikit-learn

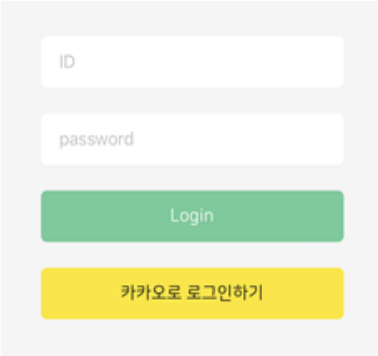
Scikit-learn is a free software machine learning library for the Python programming language. It features various classification, regression and clustering algorithms including support-vector machines, random forests, gradient boosting, k-means and DBSCAN.

VI. USE CASES

- Use Case 1 : Sign-up

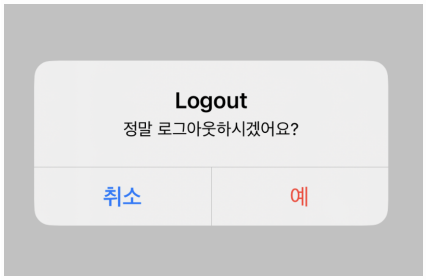
Users must create their account by entering their name, phone number, email, ID, password, gender, birthday, and the size of household. After finishing sign-up, the screen moves to the login page.

- Use Case 2 : Login



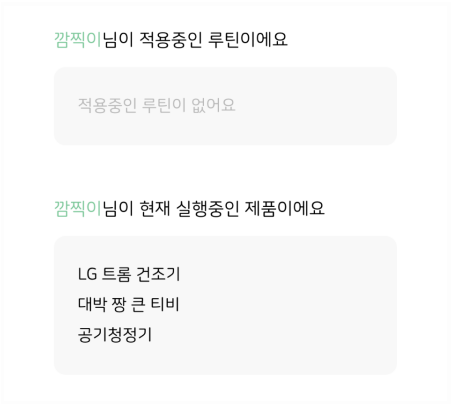
Users can log-in to 내멋대로ㅎLG by entering ID and password. When the log-in is successful, the screen moves to the Home page.

- Use Case 3 : Logout



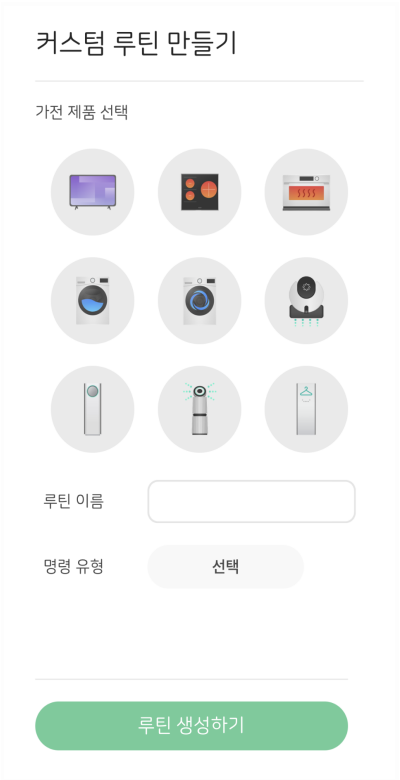
Users can log-out their accounts in the application by clicking the '마이페이지' in the bottom tab bar and clicking '로그아웃'.

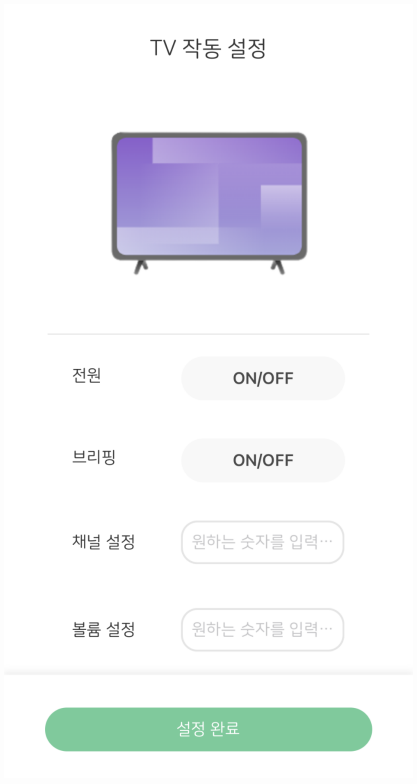
- Use Case 4: Check Routine



In the Home page, users can check the routines that they applied, and routines which are currently operating.

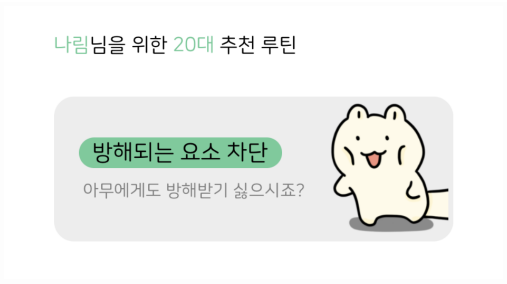
- Use Case 5 : Add Routine





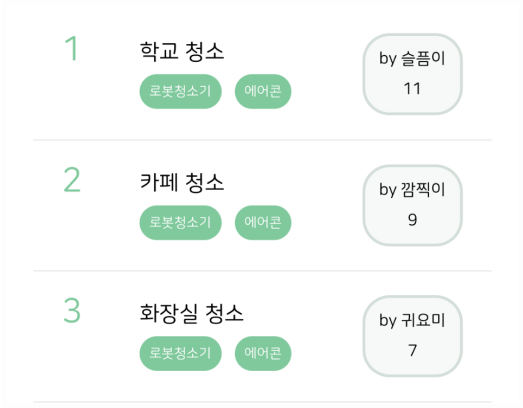
By clicking the '루틴 추가' in the bottom tab bar, users can make their own routine tailored to their needs. They should choose appliances they want to operate, between TV, electronic range, light oven, washing machine, dryer, robot cleaner, air conditioner, air cleaner, and styler. They can set different detailed options for each chosen device, and the user's own routine will be created after entering their desired command or reserving a time to operate.

- Use Case 6 : Get recommendation of routines



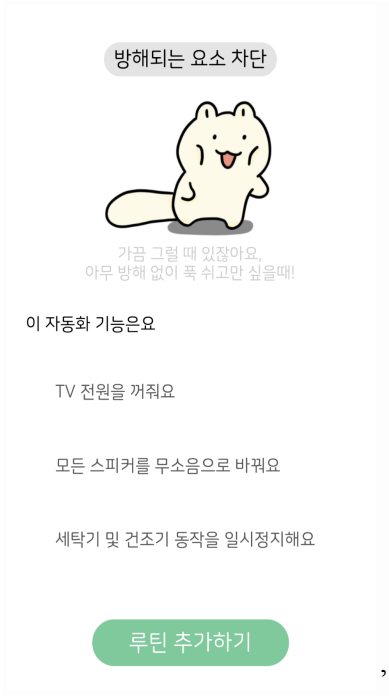
By clicking the '루틴 추천' in the bottom tab bar, users can be get recommendation of routines. This page shows the routine that fits each user, considering their age, gender, size of household, and features of their routines (combination of appliances). Users can check their recommendations and add them to their own routine lists.

- Use Case 7 : Check popular routines



By clicking the ‘인기 루틴’ in the bottom tab bar, users can find the real-time popular routine, which is ordered by the number of routine downloads. This is also possible to add to their own routine lists.

- Use Case 8 : Check explanation



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When users click the routine in the Routine Recommendation and Trending Routine page, they can check the description of each. If they want, they can add it by clicking the ‘루틴 추가하기’ button.

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