BloomMate

House Gardening with AI Chat using LG Tiiun

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Abstract—**BloomMate is a user-friendly gardening application tailored for beginners or individuals with limited gardening experience, particularly those who have acquired the LG Smart Cottage and intend to optimize their gardening with the LG Tiiun. This app simplifies the gardening process by allowing users to register their plants and access a range of personalized guidance to enhance their gardening skills.**

The standout feature of BloomMate is the unique capability to communicate with your plants. Through generative AI technology, this app facilitates direct interaction with plants, creating a personalized and engaging experience for users. Moreover, it exploits AI to identify and diagnose plant diseases, offering valuable insights to maintain the health of your pet plants.

Index Terms—**gardening, generative AI, Matter, AI**

I. ROLE ASSIGNMENT

Below is the table of role descriptions. Due to the small members in the team, some roles are distributed to the same person in order to harmoniously progress the project.

Roles	Name	Task description & etc.
User	Shin Hyunah	She plays the role of a plant grower. She has little experience growing plants and doesn't know how to water and nourish them. Additionally, she often kills her plants because she doesn't have time to take care of them, so she needs a service that takes care of her plants automatically.
Customer	Yoon Yongsung	He is a person who owns a house, and in particular, he has purchased an LG Smart Cottage or has an LG Tiiun. He goes to his house on the weekends, enjoys country life, and takes care of plants. He wants software that automatically manages his plants even on weekdays when he is away or on weekends when he cannot be there.
Software developer	An Soonho	As a software developer for our project, he designs and creates APIs and databases, and builds the AI that can implement the requirements of the service we plan.
Development manager	Kim Donghyun	He is responsible for the overall management of our project, distributing each task, setting and managing task deadlines. Additionally, he helps resolve any issues between the backend and frontend.

II. INTRODUCTION

A. motivation

a. Customer Trend Analysis

1) positive effect of pet plant
Pet plant is known for positive effect to give psychological/emotional stability and inspiration about life satisfaction. Especially, it is showing clear tangible results in several areas like overcome stress and depression, therapy various physical illnesses, air purification.[1]

2) The appearance of Green Hobby
As interest in planterior increases, sales of flower gardens/flowers increased compared to the previous year (2019). The search volume of 'planterior' on Naver, a search portal site, also increased significantly during the pandemic compared to pre-COVID-19, especially during the April 2020 pandemic. Also, attention in urban farmer, self-gardening, weekend farm is growth. An indicator that can confirm this is the number of Instagram hashtag posts, with the home gardening tag exceeding 520,000 and the planterior tag exceeding 163,000. [2]

3) Impact of COVID-19
Pet plant has long received attention to relieve loneliness in single-person households or the elderly, and the home gardening market, including pet plant, has grown rapidly as restrictions have arisen on outdoor activities since the COVID-19. Compared to before COVID-19, sales of flowerpots increased by 20%, gardening supplies increased by 48%, and seedlings increased by 92%. March to April 2020, SSG.com saw a 97% increase in home gardening category sales, and Enuri.com saw a 491% increase in garden set sales. Accordingly, the Rural Development Administration predicted that domestic home gardening sales will increase rapidly after COVID-19, reaching 500 billion won in 2023, an eight-fold increase from 60 billion won in 2020. [3]

4) Expanding the market size of plant cultivation machines
The market for plant growers that allow you to grow flowers and vegetables at home becomes larger. The market size, which was 10 billion won in 2019, increased to 60 billion won in 2020 and is expected to reach 500 billion won in 2023. [4]

5) Urban agriculture
The number of 'urban farmers' in Seoul, who farm on rooftops, verandas, and weekend farms, increased 14-fold from 45,000 in 2011 to 640,000 in 2019. During the same period, Seoul's urban agricultural space also increased 6.9 times from 29ha to 202ha. [5]

6) Desired residential space after retirement
In 2021, the real estate platform 'Zigbang' conducted a survey on the residential space desired after retirement, and 'country house, townhouse' ranked first with 38%, beating apartments (35.4%). When comparing housing transactions in the first half of the year by housing type, apartment transactions decreased in June compared to January, while house transactions increased. [6]

Considering these data, interest in horticulture such as home gardening and planterior is steadily increasing, and along with this, interest in weekend farms, vacation homes, country houses, etc. is also steadily growth. Therefore, it can be expected that the demand for gardening or growing plants in country houses will gradually get larger. At the same time, sales of plant-related home appliances will also become greater.

b. Company Analysis

1) Regulations related to the companion plant industry
As interest in pet plants grew, the Seoul Metropolitan Council passed the 'Ordinance on Fostering and Supporting the Pet Plant Industry' at the plenary session in May, laying the foundation for the growth of the pet plant industry and focusing on expanding supporting projects.[7]

2) LG Electronics: Innovation for a Better Life
LG Electronics is currently trying to change from being a company that only sells simple home appliances to a company that provides a lifestyle that can change customers' lives to be smarter through applications such as ThinQ.
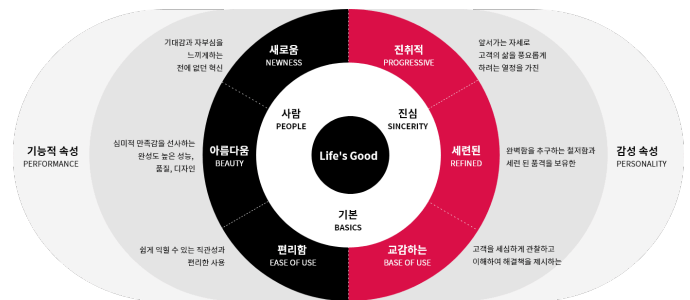

Fig. 1. LG electronics Brand Goal

Customers are always at the center of the LG brand story. LG makes an incredible contribution to the lives of its customers and always strives to make their lives more valuable.

i. PEOPLE
Just as important as a good product is the customer experience using that product. Customers' lives are improved with new products through creativity

and innovation, and a richer life is completed by experiencing products with excellent aesthetic satisfaction. Every product we create must be able to play that role in our customers' lives. Creating a better life is how we do our best for our customers.

ii. SINCERITY

How to make life new and more convenient, our technology always starts with sincerity toward customers and their lives. It is an attitude of constantly making passionate efforts and pursuing sophistication through thorough perfection rather than flashiness, and the most important factor when creating products is sincerity.

iii. BASICS

Rather than being different for the sake of being different or flashy for show, we focus on the core values that customers who use the product expect. The core value refers to offering important value to customers' lives beyond the product's functions. [8]

c. Product Analysis

1) LG Smart Cottage

It is a small modular house in the form of a second house that combines LG Electronics' advanced energy, heating, and cooling technology, and differentiated premium home appliances, with a two-story one-room structure measuring 31.4m^2. The 4kW solar panel installed on the roof can cover a significant amount of the electricity used per day by two adults, and the heat pump cooling and heating system 'Therma V Monobloc' is installed to significantly reduce energy consumption. A home energy solution was implemented that stores used power in a home ESS system. There is a charger for electric vehicles (EV) outside the Smart Cottage, and the inside is equipped with premium home appliances equipped with various technologies to increase energy efficiency, such as the Objet Collection Wash Tower Compact, a dishwasher, an induction electric range, and a water purifier. Through the 'LG ThinQ' application, you can check home appliances, heating, cooling, and air conditioning (HVAC) systems, and energy storage and consumption. It has a premium interior with a warm atmosphere, with a sophisticated design based on the concept of walnut wood tone and an exterior finished in light beige.

Fig. 2. LG Smart Cottage

2) LG Tiiun

숙박업소의 소형 냉장고 만한 크기다 (출처=LG전자 홈페이지)

Fig. 3. LG Tiiun

LG Tiiun is a home plant grower designed to target the home gardening market, which is expanding due to the impact of COVID-19. It can be said to be the culmination of LG's technologies, combining the temperature control technology of the Dios refrigera-

tor, the air conditioning technology of the Whisen air conditioner, the inverter compressor technology of the Tromm dryer, the water supply control technology of the PuriCare water purifier, and the LED lights of LG Display. You can easily and comfortably grow plants by filling them with water 6 times and adding nutrients 6 times in a month. The power consumption for one year is 42.5kWh, which is similar to that of a small refrigerator. LG Tiiun consists of two shelves (upper and lower compartments), and a total of six seed kits can be installed, three each. Seed kits limited to 2 types of herbs, 4 types of leafy vegetables, and 1 type of flower are being sold. Through the LG ThinQ app, you can check the operation/growing status on your smartphone and receive a notification when nutrients or water are insufficient.
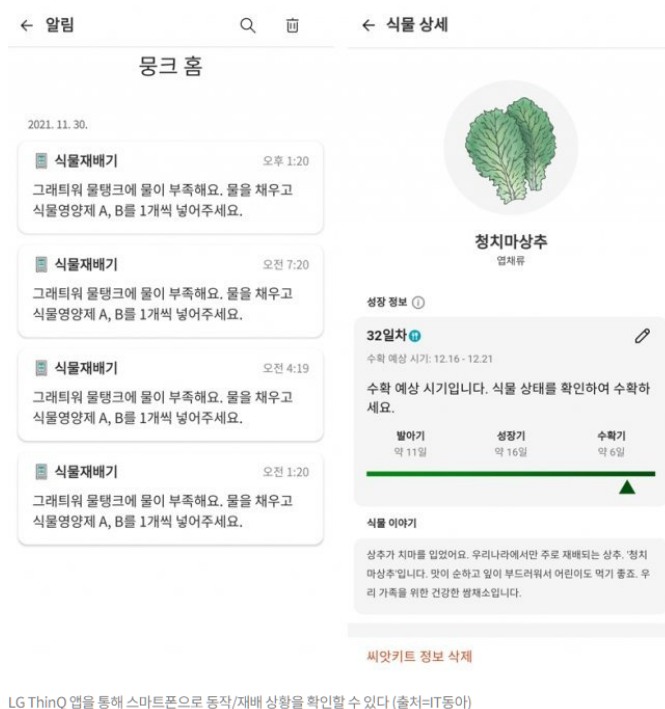

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뭉크 홈

2021. 11. 30.

📋 식물재배기   오후 1:20
그래티워 물탱크에 물이 부족해요. 물을 채우고 식물영양제 A, B를 1개씩 넣어주세요.

📋 식물재배기   오전 7:20
그래티워 물탱크에 물이 부족해요. 물을 채우고 식물영양제 A, B를 1개씩 넣어주세요.

📋 식물재배기   오전 4:19
그래티워 물탱크에 물이 부족해요. 물을 채우고 식물영양제 A, B를 1개씩 넣어주세요.

📋 식물재배기   오전 1:20
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← 식물 상세

청치마상추
엽채류

성장 정보 ⓘ

32일차 🅖   ✏

수확 예상 시기: 12.16 - 12.21

수확 예상 시기입니다. 식물 상태를 확인하여 수확하세요.

발아기   성장기   수확기
약 11일   약 16일   약 6일

식물 이야기

상추가 치마를 입었어요. 우리나라에서만 주로 재배되는 상추, '청치마상추'입니다. 맛이 순하고 잎이 부드러워서 어린이도 먹기 좋죠. 우리 가족을 위한 건강한 쌈채소입니다.

씨앗키트 정보 삭제

LG ThinQ 앱을 통해 스마트폰으로 동작/재배 상황을 확인할 수 있다 (출처=IT동아)

Fig. 4. Example of using ThinQ for LG Tiiun

B. Problem Statement

  a. LG Smart Cottage: absence of home turf
People live in house almost enjoy gardening. However, LG Smart Cottage that LG Electronics launched doesn't have home turf. So, we think LG Tiiun for outside to help with LG's brand goal is necessary. Especially in the case of smart cottages, many people buy them as a second home and are unlikely to be there every day. In this case, they may struggle to get information about the condition of the plants, unless they have restrictions

except for gardening with Tiiun.

  b. Brown Thumb
In abroad, the term, brown thumb, means the people who always kill the plant because of lack of skills. Like this, there are more things to worry about in growing plants than you think, so if you don't pay attention, you often kill the plants, and even if you care a lot, there are many cases where you kill the plants because you don't know how to grow them properly. Therefore, Software, to help all of the plant growers can grow them easily, is essential.

  c. Rasing Plants: absence of communication
Although raising pet plants is already known to help with various emotional stability, it was judged that there was less of a feeling of communication with each other compared to animals with which one could actually communicate. In order to grow plants well, constant attention is needed, and for this to happen, it is important to have affection for the plants. Therefore, in order to increase the fun of growing plants, it is necessary to be able to communicate with plants.

C. Solution

  a. Meeting the needs of more customers
Considering the aforementioned, the number of people interested in gardening, cottages, etc. will increase. To contribute to increasing the value of life for the growing number of caterers' customers who grow their own gardens in cottages, we have adopted LG Tiiun which can be used in the outside garden of LG Smart Cottage as a target appliance.

  b. Brown thumb turns into green thumb with LG
We have designed a software that allows people who are not talented in plant care to easily grow plants. To briefly introduce the features, customers can register their plants with the app and it will adjust the appropriate temperature, humidity, light, ventilation, etc. according to the plant species and automatically spray water and nutrients. Through the camera, the current health status of the plant (pest infestation, wilting, etc.) can be identified using AI, so that the customer can come and check the plant before it dies.

  c. Build a bond with plants
One of the disadvantages of growing plants is that customer can only get an idea of their condition by looking at the wilting of their leaves or the appearance of fruits or flowers, and can't communicate with them directly like animals. These disadvantages reduce the fun of growing plants. To overcome this, we devised a feature that allows customer to communicate with plants using generative AI. If customers can communicate

with their plants, they will be able to build a bond with them and give them more affection.

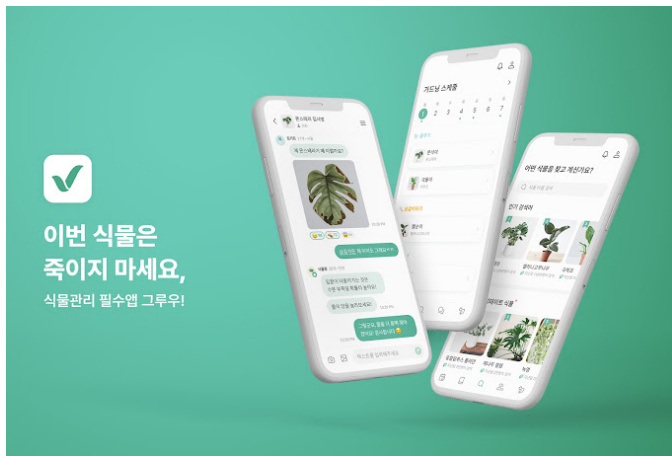### D. Research on Any Relative Software

a. Groo

Fig. 5. Groo

Groo is an application for plant care scheduling, community, plant books, and plant-related purchases. You can enter your experience with plants and where you grow them, and it will recommend the best plants for your space. You can also take photos of your plants to learn about their types and care, and use the plant guide to find out what to look out for. You can also communicate with other people who are interested in growing plants through the community and buy gardening supplies. What makes it different from other plant growing applications is that it uses vision AI to check the health and disease of plants.

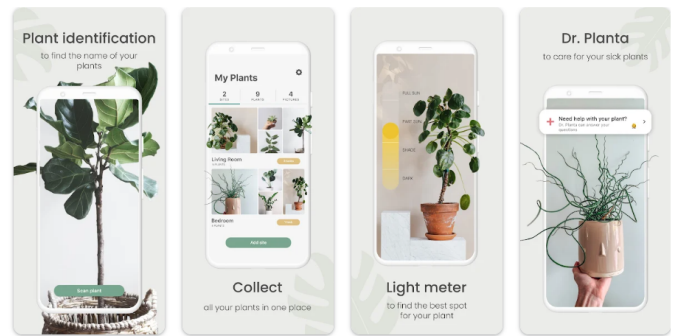Fig. 6. Diagnosis of plant health using vision AI

b. Planta

Fig. 7. Planta

Planta is an application that helps you grow plants, similar to Groo. You can add information about your plants to the app and it will automatically remind you when to water, fertilize, spray, clean, etc. based on an algorithm. You can even take a photo of your plant and get the information you need by identifying the plant's variety. You can also get plant advice, keep a diary to track your plants' growth, and more. One of the unique features is that the app also recognizes where you live and recommends plants that are suitable for your hardiness zone and adjusts the watering schedule according to the local weather.
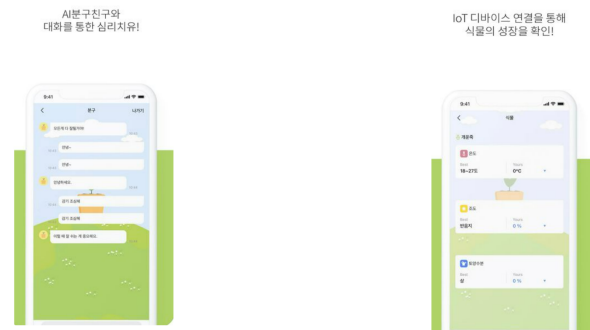
c. PlantLink

Fig. 8. PlantLink

PlantLink is an application that allows you to manage plants by connecting the Soil Module, an IoT device. Through the IoT device, you can record changes in soil humidity, illumination temperature, etc. to create a growth report. It is possible to talk to plants through chatbots and conduct psychological analysis through these conversations to provide mental health reports and receive plant management advice, but it is currently not working smoothly.
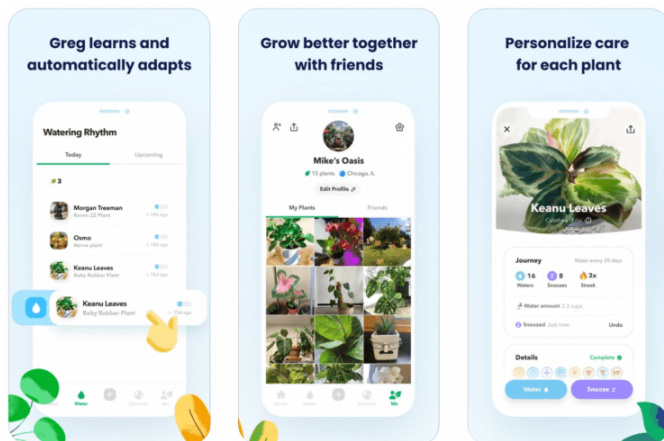
d. Greg

Fig. 9. Greg

Greg is the zero-guesswork plant care app & community. It makes growing indoor plants super easy and fun. If you scan any plant, Greg's plant vision will identify the species, tell you all about it, measure the pot, and even the distance to the nearest window. And it provides highly-personalized plant care, a custom watering plan based on each plant's species, size, plus the actual details of your home environment. Moreover, you can communicate with other veteran growers for answers to any plant questions you have.

III. REQUIREMENT ANALYSIS

A. Create an account

When you first install and run the application, you'll see a page where you can sign up or log in. If you click Sign Up, we'll ask you a few questions to get your information and create your account. The following information is required from users when signing up.

- Name
- Picture
- Experience and ability to grow plants
- Location of home
- The size of the garden
- ID and Password
- The serial number of users' LG Tiiun

After signing up, you'll be taken to the login page. You can edit all the information you received during the signup process on your My Page.

B. Log in

Logging in is an essential step for every member to access and manage their own garden on BloomMate, and it's the gateway to utilizing BloomMate's full range of features. The login process involves entering the ID and password you provided during registration. Once successfully logged in, you'll be directed to a screen that allows you to either add new plants or view the plants you have previously registered, depending on whether you have any plants registered. The login requirement is a fundamental aspect of the BloomMate platform. It empowers users to have a personalized gardening experience, enabling them to manage their garden with ease. The authentication through the use of an ID and password is crucial for maintaining account security and ensuring the protection of sensitive information.

C. Add own plant

Logged-in users who don't have any registered plants will be taken to the plant registration screen. The plant registration process is essential for managing plants and chatting with them. To register a plant, users need to enter some information. The following is a list of information required to register a plant.

- Name of plant
- Plant variety
- Photo of plant
- Planted date

At this stage, you have the following constraints.

- Limited plant types
  - Provide application services within a limited plant to provide optimal personalized information.

- Limited number of plants based on the size of your garden - Warns that planting more plants than the size of your garden can accommodate may result in poor gardening.

After entering the above information, the user can view their plants on the registered plants screen.

D. See the registered plants

Your registered plants will appear in a list, showing the name of the plant you entered when you registered it and how many days it has been with you based on the date you planted it. Clicking on each plant will take you to a page where you can view the plant's details. If there are no plants, the user will see a screen with a button to add a plant.

E. View details of a plant

You can click on each plant to view its details, and the first thing you'll see is a photo and name of the plant you've registered. Also, you can start chatting with the plant by clicking the chat button. The plant details page contains the following information.

- Name of plant
- Plant variety
- Planted date

- Basic information based on plant variety:
    - Appropriate temperature
    - Appropriate illuminance
    - Soil moisture
    - Cultivation difficulty
    - Flowering season
        etc.

You can also take a photo to detect the current status of a plant by clicking checkup button.

F. Chat with your plant

Users can converse with their plants using ChatGPT, a popular generative chat AI. This AI assumes the role of the plant, providing regular updates on its condition and growth. In addition to standard plant status and growth records, users can engage in daily conversations with their green companions. ChatGPT shares insights into the plant's current state, addresses questions and concerns, and offers care advice. Critical information, such as plant status and growth records, is automatically delivered daily and accessible on the chat screen. Users can easily search for past information by date in the chat history. This feature fosters a stronger connection between users and their plants, enhancing the gardening experience.

G. Examine plants through photos

Users have a convenient way to assess the health of their plants by simply taking a photo. When users capture an image of their plant, leaves and all, an AI model steps in to evaluate the plant's current health status and check for any potential diseases. This feature not only informs users about the plant's overall condition but also provides guidance on how to manage any issues that may arise. If there are any health concerns, the AI not only identifies the issue but also offers detailed information about the specific disease, if present. Furthermore, it goes the extra mile by suggesting effective methods for addressing the problem, whether it's a common issue that can be easily resolved or a more complex condition requiring special care.

H. My page

My page is where you can view your membership information. You can take the following actions from here.
- View user's name and picture
- Modify account information
- View about BloomMate

IV. DEVELOPMENT ENVIRONMENT

A. Choices of Software Development Platform

a. Development Platform
1. Windows
    Windows is an extremely popular and widely used operating system for software development, known for its versatility and user-friendly interface. Currently, Windows is the pre-installed OS on most computers in South Korea, far outpacing other OSes in terms of share. It offers a multitude of features and supports a vast array of programming languages and tools, making it the go-to choice for developers worldwide. With Windows, developers have the flexibility to utilize various development environments and frameworks, empowering them to create applications efficiently and effectively. Whether it's desktop applications, web development, or mobile app development, Windows provides the necessary tools and resources to meet the demands of any project. Additionally, Windows continually evolves and updates its platform, ensuring that developers have access to the latest technologies and advancements in the software development field. In conclusion, Windows is an indispensable platform for software development, offering a comprehensive ecosystem and empowering developers to bring their ideas to life.

2. MacOS
    MacOS is a popular operating system favored by many developers, especially those in the creative and design fields. Known for its sleek and intuitive user interface, MacOS offers a seamless development experience. It provides a wide range of powerful tools and frameworks, making it an excellent choice for building applications for various platforms. With MacOS, developers can take advantage of tools like Xcode, which is the primary integrated development environment (IDE) for Apple's platforms. This is especially important when the application we want to develop must also support IOS. To develop for iOS, Xcode is essential, and Xcode can only run on MacOS. Xcode offers a comprehensive set of tools and resources for developing iOS, macOS, watchOS, and tvOS applications. Additionally, MacOS has a strong integration with other Apple products and services, allowing developers to create a cohesive ecosystem across different devices. Overall, MacOS provides a robust and efficient development environment for developers looking to create software for Apple.

b. Tools and Language
1. JavaScript(JS)
    JavaScript is a widely-used programming language known for its versatility and its ability to create dynamic and interactive web applications. It serves as the backbone of modern web development and is supported by all major web browsers. With

JavaScript, developers can add functionality to websites, handle user interactions, and manipulate web page content. It is a high-level, interpreted language that allows for rapid development and prototyping. After the introduction of Google's V8 engine-based Node.js, JavaScript can now be executed in a non-browser environment as well. JavaScript also benefits from a vast ecosystem of libraries and frameworks, which enhance its capabilities and simplify the development process. These libraries and frameworks are published by npm, the Node Package Manager, and developers can easily download and utilize them in their projects. Some notable features of JavaScript include its single-threaded nature, prototype-based language structure, and its status as a script language. JavaScript is regularly updated by ECMA (European Computer Manufacturers Association), with the updated version being referred to as ECMAScript. Recent ECMAScript versions support object-oriented programming and functional programming. In summary, JavaScript is an essential language for web development, empowering developers to create engaging and interactive user experiences on the web.

2. TypeScript(TS) [9]
   TypeScript is a superset of JavaScript that provides static typing, making it a powerful tool for building robust and scalable applications. It was developed by Microsoft and first published to the public in 2012. With TypeScript, developers can catch errors during compile-time, resulting in fewer bugs and improved code quality. It offers advanced features such as interfaces, generics, and decorators, which enhance code organization and maintainability. TypeScript is fully compatible with JavaScript, allowing developers to gradually migrate their existing JavaScript codebases to TypeScript. It also seamlessly integrates with popular JavaScript libraries and frameworks, making it a versatile choice for web development. Nowadays, companies are compelled to adopt TypeScript instead of JavaScript, regardless of project size, due to its numerous benefits. Overall, TypeScript is a valuable addition to the development environment, offering enhanced type safety and productivity for developers.

3. yarn [10]
   Yarn is a JavaScript package manager that helps manage project package dependencies and facilitates package sharing among developers. Due to security and performance issues experienced with npm as their projects grew larger, Facebook developed Yarn as a replacement. Yarn offers improvements in performance and security compared to npm. One key advantage of Yarn is that it installs packages in parallel, unlike npm which installs them sequentially, resulting in faster installation times. Yarn also utilizes caching, further speeding up package installation. Additionally, Yarn utilizes semantic versioning to specify package versions. For this project, we have chosen to use Yarn due to its fast performance. This is especially important as we will be installing various frameworks and libraries for frontend development.

4. Eslint/Prettie [11]
   ESLint performs automated scans of your JavaScript and TypeScript files to detect common syntax and style errors. Prettier scans your files for style issues and automatically reformats your code to ensure consistent rules for indentation, spacing, semicolons, and quotes (single vs double). We use these tools on our teams for the following reasons:

   - They promote consistency by enforcing the same rules for everyone.

   - They save time in code reviews by allowing us to focus on code structure and semantics instead of style issues.

   - They catch errors, with ESLint being particularly effective at detecting syntax errors and basic type errors like undefined variables. Although Prettier doesn't catch errors, it still contributes to code quality.

   - Changes made by these tools are automatically applied to code when the file is saved in Visual Studio Code.

   While setting up these tools requires an initial time investment, the time-saving benefits accumulate over time.

5. React-Native [12]
   React Native is an open-source UI software framework developed by Meta Platform, Inc. It enables developers to use the React framework along with native platform capabilities to build applications for Android, Android TV, iOS, macOS, tvOS, Web, and Windows. Unlike web apps, React Native communicates with the Native Thread through native bridges, resulting in optimized performance. In terms of hybrid frameworks, Flutter has an advantage in making it easier for web developers to write React Native

code. Previously, there was a perception that Flutter was much faster and lighter. However, with the introduction of Fabric in React Native 0.68, which supports faster communication between Android and iOS, that perception has become a thing of the past. That being said, React Native does heavily rely on other libraries, even for core features like the camera function in mobile applications, which requires the use of third-party libraries. Nevertheless, due to the aforementioned advantages, it is difficult to find a better option than React Native for creating fast and cross-platform applications that support both Android and iOS.

6. React Query [13]
   React Query is a library that simplifies the process of fetching, caching, and keeping your React application's server state synchronized and updated. Unlike other data fetching methods that require complex and verbose code, React Query provides a simple and intuitive API that can be used within React Components. Previously, managing state in React applications lacked clear distinction, leading to confusion when writing code. Specifically, determining which state should be continuously fetched from the network and which state is solely dependent on the client required a thorough understanding. However, with the introduction of React Query, you can easily differentiate between server state management and client state management in your React application. This distinction enables efficient collaboration and simplifies cache operations, loading operations, and the implementation of difficult asynchronous operations in network state management.

7. Recoil [14]
   In React, it can be challenging to directly pass data between two different components unless they have a parent-child relationship. In such cases, you need to send the data to the parent component and then pass it back to the component that requires it. This process, known as props drilling, can make it difficult to keep track of the props being passed around. That's why having a global state management library is crucial for modern React applications. React's own Context API requires implementing it from scratch and requires significant effort to prevent unnecessary re-rendering. On the other hand, Redux, which was the most popular choice until 2020, has a steep learning curve and a complex architecture that can make it challenging to understand the code flow quickly. In contrast, Recoil is relatively easy to use if you understand the basic syntax of

React. It is also free from re-rendering issues and provides various optional features for global state management. Additionally, Recoil is lightweight and does not significantly impact application performance.

8. Python [15]
   Developed in 1991 by programmer Guido van Rossum, Python is known for its readability and easy syntax, making it quicker to learn compared to other programming languages. As a result, it has gained popularity among non-programmers and is utilized in various fields such as statistics, data analysis, modeling, deep learning, and artificial intelligence. Python's intuitive and user-friendly syntax makes it highly recommended for beginners in programming. Additionally, it is the most widely adopted language, meaning that many libraries necessary for application development are readily available. Therefore, we have chosen Python for building the backend and training machine learning models.

9. Django [16]
   Django is a popular and widely used web application framework written in Python. It offers robust features and components for efficient website and web application development. One of its key advantages is simplifying and accelerating the development process. Django provides pre-built components for user authentication, an admin panel, forms, and file uploads. User authentication is made simple with a few lines of code, ensuring secure sign up, log in, and log out. The admin panel allows easy content and data management. Django's form handling system simplifies the implementation of complex forms with validation and error handling. Handling file uploads is effortless with Django's built-in capabilities. Additionally, Django has a vast ecosystem of libraries and extensions, such as djangorestframework for creating RESTful APIs. Overall, Django is a versatile and powerful framework for building robust and scalable web applications, suitable for both beginners and experienced developers.

10. SQlite [17]
    Since SQLite doesn't run as a server process, it's a ready-to-use database. It's lightweight but has all the necessary features. It supports transactions and is platform-agnostic. Since it's a locally run DB, it's also highly portable. However, it is not an isolated environment, so the server must also handle the burden of the DB. Additionally, you can't authorize users, only assign basic access

rights based on the operating system. We decided to use SQLite because it is supported by Django and our application doesn't have a complex database structure or require various features of a database management system.

11. AWS EC2 [18]
    Amazon Elastic Compute Cloud (Amazon EC2) offers scalable computing capacity on-demand in the Amazon Web Services (AWS) cloud. By using Amazon EC2, you can accelerate application development and deployment while reducing hardware costs. Instead of purchasing physical servers, our team has decided to utilize a cloud system for its economic benefits and flexibility for future expansion. With Amazon EC2, you can deploy multiple virtual servers, configure security and networking, and manage storage. It allows you to increase capacity (scale up) to handle compute-intensive tasks such as monthly or annual processes or spikes in website traffic. Conversely, when usage decreases, you can decrease capacity (scale down). One of the great advantages of Amazon EC2 is that it is free for the first year. Since our application needs to be built urgently and will not run for more than a year, Amazon EC2 is an excellent choice.

12. Jupyter NoteBook [19]
    Jupyter Notebook is a popular open-source web application that provides an interactive environment for writing code, visualizing data, and documenting. It supports various programming languages, including Python, R, and Julia. Jupyter Notebook is organized into code cells and markdown cells. In code cells, you can write and run Python code, while in markdown cells, you can write documents, formulas, or insert images. This combination of code and documentation is especially useful for projects like data analytics and machine learning. One of the advantages of Jupyter Notebook is the ability to run Python code line by line and view the results, which is helpful for debugging and testing. The output is immediately displayed below the code, allowing you to see visualized graphs, tables, and more. Additionally, Jupyter Notebook can be easily used online. Google Colab, provided by Google, is a cloud-based Jupyter Notebook environment. For our project, we will utilize Jupyter Notebook to run machine learning tasks using Python. Machine learning often involves writing lengthy code, and it is crucial to check and debug the results along the way. Jupyter Notebook is the ideal tool for this purpose.

13. Tensorflow / Tensorflow light [20]
    TensorFlow is a library created by Google that provides features for implementing deep learning programs. It is primarily implemented in C++, but supports multiple languages including Python, Java, and Go. However, Python is prioritized as it is most suitable for our application. Machine learning is a complex field, but with machine learning frameworks like TensorFlow, implementing a machine learning model has become more accessible and less complicated. These frameworks simplify tasks such as data acquisition, model training, making predictions, and refining results. Additionally, TensorFlow Lite is a mobile library designed for deploying models on mobile devices, microcontrollers, and other edge devices. When running a machine learning or deep learning model through TensorFlow Lite, it produces a small file of less than 3MB. This allows us to use trained models on mobile without any capacity constraints. In our application, we will use TensorFlow Lite to ensure immediate model availability on mobile devices.

14. Yolo V8 [21]
    Object detection is a technique used in the field of image processing and computer vision. It encompasses various techniques such as multi-labeled and key point, which have emerged due to recent advancements in computer vision. The YOLO model is the most representative model among object detection techniques. YOLO (You Only Look Once) is a state-of-the-art real-time object detection system. It is renowned for its faster and more accurate data processing compared to traditional models. YOLO adopts a deep learning-based approach for object detection and recognition. Its efficiency lies in its avoidance of complex pipelines, which makes it particularly suitable for real-time decision-making tasks. In simple terms, YOLO divides the input image into regular segments called grids. It then passes these segments through a neural network to generate bounding boxes and class predictions, ultimately determining the final detection output. Multiple instances are trained on the entire dataset before testing on real images and videos. As of March 23, 2023, this is the most recent version of YOLO, developed by Ultralytics in January 2023. A new repository for YOLO models has been released, serving as a unified framework for training object detection, instance segmentation, and image classification models.

15. Material Design [22]
    UI/UX is crucial in modern mobile and web

applications, and a unified UI can greatly enhance the user experience. This unified UI is achieved through the use of a design system. However, implementing a design system on your own can be challenging. Therefore, it is common practice to utilize publicly available design systems, with Google's Material Design being the most prominent one. Material Design is a design approach that combines the benefits of flat design with the use of shadows to create a sense of depth. It also provides a comprehensive design system that includes typography and primary-secondary color schemes. This design can be easily implemented in the Figma library and seamlessly integrated into code using react-native-paper.

16. Git [23]

Git is an effective version control system that allows you to manage versions and incorporate changes and updates seamlessly. But before delving into Git, let's first discuss what a "version control system" is. It is a system that records changes to a file over time and enables you to retrieve that file later when needed. When working on a document, there are usually multiple revisions and updates from the initial draft to the final version. Along the way, we often rename the file to "final," "_final," "finalized," and so on, thus overwriting the previous versions. This can make it difficult to go back to a specific point in time and understand the changes that were made. However, with a version control system, this becomes possible. By using a version control system, you can manage multiple versions of the same information. This allows you to track changes over time and identify the individuals who made them. You can easily revert back to previous versions or the original version, and quickly identify the person responsible for any issues that may arise.

B. Software in use

1. Visual Studio Code

Visual Studio Code is a lightweight text editor developed by Microsoft, which is excellent for web development. Nowadays, it offers a wide variety of powerful plugins that make it as lightweight and powerful as other IDEs. Our team exclusively uses Visual Studio Code for all of our code development. For front-end development, there are plugins available for React-Native and for seamlessly transferring work from Figma to code. Furthermore, there are plugins for Eslint and Prettier that automatically apply code formatting when you save a file, greatly enhancing the overall developer experience. In

addition to front-end development, Visual Studio Code is also used for backend and machine learning tasks. The Python and Jupyter Notebook plugins are highly regarded, and the debugging capabilities are excellent.
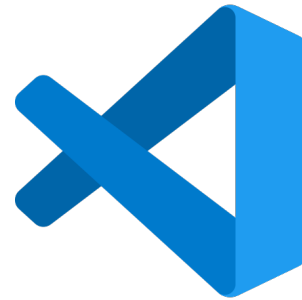

Fig. 10. Visual Studio Code

2. Xcode

XCode is an integrated development environment (IDE) developed by Apple. It is essential for developing an iOS application using React Native. While we write the code in Visual Studio Code, we need to compile it as an iOS application using XCode.

Fig. 11. Xcode

3. Android Studio

Android Studio is an integrated development environment (IDE) for Android, developed by Google. Similar to Xcode, Android Studio is essential software as it handles the final compilation of an Android application.

Fig. 12. Android Studio

4. Github

Github is a program that supports projects using Git, acting as a remote control center for Git. It serves as a platform for version control and collaboration among developers, offering a cloud-managed version control system. Git and Github are often used interchangeably for collaboration in modern software development. However, the capabilities of Github go beyond that. Firstly, Github is the preferred platform for open-source software, providing access to the source code of various tools used by our team. Additionally, any issues or bugs with open libraries can typically be found on Github. Github also offers other collaborative features. Pull requests allow us to review work in different Git branches before merging them. Furthermore, Github actions simplify the process of implementing continuous integration and continuous deployment (CI/CD). In our team, we utilize Github actions to check for errors in TypeScript on the frontend and to instantly reflect code changes to AWS EC2 on the backend.

Fig. 13. Github

5. Figma

Figma is an application for UI/UX design, available as a cloud-based SaaS program. One of its main advantages is its real-time nature, allowing users to see immediate modifications to the UI within Figma. This eliminates the traditional process of a planner or de-

veloper reviewing a designer's file, requesting changes, waiting for updates, and then reviewing and modifying it again. Now, anyone can receive instant confirmation and immediate feedback, regardless of their job title. Another great aspect of Figma is the extensive collection of plugins and communities available. Many people have created useful design components and shared them with the Figma community. This allows users to leverage high-quality UIs without having to create them from scratch. Lastly, Figma offers the functionality to create prototypes. These prototypes can be used to demonstrate button interactions within Figma, providing developers and planners with a clearer understanding of the application flow.

Fig. 14. Figma

6. Notion

Notion is a web-based SaaS application that functions as a wiki. One of its advantages is the ability to create articles in the form of MD files and see real-time changes. Recently, with various updates, it has become a valuable tool for managing meeting minutes and projects.

Fig. 15. Notion

7. Slack

Slack is a communication tool that offers several advantages. One of the biggest advantages is the ability to create separate channels for different teams and topics. This helps to avoid crowded conversations and keep discussions organized. Additionally, within a channel,

you can use the thread feature to have focused discussions on specific topics. Threads allow users to send messages within a message they've sent, creating a threaded conversation. Another powerful feature of Slack is huddles. Huddles enable instant online meetings with just a push of a button. During a huddle, users can collaborate by writing on a shared computer screen using their mouse, making it easier to work together. Lastly, Slack offers a variety of plugins. One notable plugin is the Github plugin, which allows users to automatically post messages to Slack using tags, such as code review requests.

Fig. 16.   Slack

8. Overleaf
Overleaf is an online platform that facilitates collaborative writing and editing of LaTeX documents. It offers a user-friendly interface for creating scientific and technical documents such as research papers, reports, and thesis papers. With Overleaf, multiple team members can work on the same document simultaneously, enabling seamless collaboration and change tracking. Additionally, it provides built-in features for managing references, equations, tables, and figures, making it a preferred choice for researchers and academics. This document was written using Overleaf's IEEE specification.

Fig. 17.   Overleaf

9. Postman
Postman is a SaaS (Software as a Service) tool that facilitates faster and easier API development. It is a platform that enables you to test, document, and share your developed APIs. It is particularly useful for testing RESTful APIs. When it comes to testing backend functionalities like authorization, headers, and caching, it can be challenging. However, Postman automates these tasks

and allows for easy customization, making testing a breeze. Additionally, Postman allows you to share tested URLs, simplifying collaboration between front-end and back-end developers.

Fig. 18.   Postman

10. ChatGPT
ChatGPT is an AI-powered tool that enables real-time conversations with an AI. For GPT-3.5, it is trained on data up to 2021, while GPT-4 is trained on more recent data. ChatGPT has revolutionized generative AI, offering enhanced capabilities for tasks such as report generation, article summarization, problem-solving, and even coding. In our team, we will utilize ChatGPT to simulate plant conditions, allowing the AI to engage with users as if it were a plant.

Fig. 19.   ChatGPT

C. Cost Estimation

To create BloomMate, we take advantage of a diverse range of cost-effective programs that are available for free. This helps us minimize the expenses related to the development process. However, it's important to mention that using the ChatGPT API does come with a cost. Nevertheless, there is a provision that allows you to enjoy a free quota of approximately $18, which means you can ask around 300,000 questions without any charges. Therefore, you can be confident that the expenses associated with running the

application will be relatively low.

D. Task Distribution

TABLE I
TEAM MEMBERS AND THEIR TASKS

Tasks	Name
Frontend Developer	Shin Hyunah, Yoon Yongsung, Kim Donghyun
Backend Developer	An Soonho
UI-UX Designer	Yoon Yongsung
AI Developer	Kim Donghyun
Product Designer	Shin Hyunah

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