Smart Sleep System

Software Requirement Specification

2022.05.01

Introduction to Software Engineering 42

TEAM 14

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1. Introduction

1.1. Purpose

This document is a Software Requirement Specification for providing Sleep System product. The requirements for this product are organized, analyzed, and documented to this document and the product will be designed and implemented based on the contents of document.

The following chapters will outline and describe the overall requirements for the Smart Sleep system. Team 14 of Introduction to Software Engineering SWE3002_42, fellow students, TA's and the professor are the main readers of this document.

1.2. Scope

The Smart Sleep System is meant to help users improve their quality of sleep and subsequently life by providing the best possible tailored sleep experience. The system uses IoT devices such as smart lights, smart thermostats, sleep trackers, sound machines among others, as well as AI and science to ease and better the sleep experience.

1.3. Definitions, Acronyms, and Abbreviations

The following tables are about definitions, acronyms, and abbreviations of terms used in the document. The first table explains definitions of terms that may be unfamiliar to the reader and the second table explains the acronyms, and abbreviations.

[Table 1] Table of definitions of terms

Term	Definition
User	The person who uses the service
System administrator	The person who operates and maintains a computer system
Software	Program that runs and is used on a computer
Hardware	The mechanical devices that make up a computer
Open-Source Software	Code designed to be publicly accessible so that anyone can freely view, modify, and distribute it
Network	Two or more devices connected in order to share information. In this system, the network is usually the internet.

Main Hub/ Home Server	Main device in the system which stores information, connects with other smart devices, and performs real time adjustments based on user settings. The system administrator credentials are printed in this device.
Smart device/Furniture	Refers to IoT devices which are to be controlled via the network. Examples of such devices include light bulbs, thermostat, and humidity controller, etc.

[Table 2] Table of acronyms and abbreviations

Acronyms Abbreviations	Explanation
RAM	Random Access Memory
CPU	Central Processing Unit
OS	Operating System
PC	Personal Computer
SDK	Software Development Kit
ID	Identification

1.4. References

- IEEE Std 830-1998 IEEE Recommended Practice for Software Requirements Specifications, In IEEE Xplore Digital Library. http://ieeexplore.ieee.org/Xplore/guesthome.jsp
- Team 16. “Software Requirement Specification Team 16”. SKKU, Last Modified: October 31, 2021. https://github.com/skkuse/2021fall_41class_team16
- Introduction to Software Engineering. “SWE3002_Lecture4_Requirement Engineering”. Sooyoung Cha.

1.5. Overview

The following document contains four chapters and appendixes. The current chapter, chapter number one provides an introduction and overview of the service. Next, chapter number two contains an overall description of the product which accounts for the interfaces, important constrains, functionalities, and interactions. The third chapter specifies the requirement specifications, user cases, system architecture and specific performance requirements. Finally, chapter four consist of supporting documentation, a detailed timeline for the implementation of the system and a document history.

2. Overall Description

2.1. Product Perspective.

This product is intended to aid people in order to improve the quality of sleep. Sleep quality is affected by a wide range of factors such as light, temperature, sleep schedule and noise among others. Through the use of sensors, the system can receive feedback and adjust the IoT devices according to the user's preferences. Consequently, this product aims to facilitate the control of such factors using smart IoT devices.

2.1.1. System Interfaces

The current environment information is locally stored in the main hub and the user information is stored using firebase using a JSON format and synchronized over HTTP. Locally stored information includes current temperature, humidity, information from the light sensors, etc. All smart devices are connected over the network with the main hub where they exchange data, receive updates and the user's preferences are stored.

2.1.2. User Interfaces

An interface is displayed through a mobile device or a smartwatch. The users can set the parameters for the smart devices, as well as modify their accounts.

The system administrator has additional privileges such as allowing new users to register on the main hub, removing users and resetting the system.

2.1.3. Hardware Interfaces

The system is intended for mobile devices which run iOS systems or Android systems. Mobile devices must have at least Qualcomm Snapdragon 845 with 2GB RAM or A9 with 2GB RAM.

2.1.4. Software Interfaces

The system is intended for mobile platforms, specifically Android and iOS systems. Android systems must be ruining API 31 (Android 12) or above and iOS 14 or above. In case of wear OS, it should be API 31 or above, and in case of AppleWatch, it should be watch OS 8 or above.

2.1.5. Communication Interfaces

User device and server communicate with the different IoT devices via the network.

2.1.6. Memory Constraints

The system should run on mobile devices with least 2GB RAM for primary memory and the system requires at least 1GB for installation and execution

2.1.7. Operations

2.1.7.1. Administrator

- Management user's account
  - ✓ The administrator account is provided by the company from the beginning, like Wi-Fi admin, and the ID and password are written on the label of the router.
  - ✓ When the administrator account is logged in, the administrator's interface should appear.
  - ✓ The administrator has permission to creation of an account.

2.1.7.2. User

- Log in / Log out
  - ✓ Users log in to created account and log out from current account.
- Register smart device
  - ✓ User can register a new smart device.
  - ✓ User selects type of device, types of serial number of the device and verification code (which means paring code).
- Adjust personal settings

- ✓ User can change temperature and humidity of the room.
- ✓ User can adjust brightness of lightbulb.
- ✓ User can set sleeping time.
- ✓ User can set an individual setting value according to the type of added smart device

2.2. Product Functions

2.2.1. Account Creation/Deletion

For users to use the application, they must create an account. By pushing Sign up button located under Log In button, users face the account creation screen on their phone. Users then fill out required information such as ID, e-mail, and phone number. If same ID or e-mail or phone number already exist, an error message will appear. After the users finish inputting information, when the sign-up button is pressed, an account creation request with the input information is generated. Then users log in to the administrator account given at the time of purchase and create an account by accepting the new request.

Account deletion is quite simple. Users log in to an account that wants to delete. Then users select 'Profile' menu and tap on 'Delete Account' button.

2.2.2. Log in/Log out

Users who created their own account can enter correct ID and password. If users who have forgotten their ID or password can find their ID and password by tapping 'Forgot ID' or 'Forgot Password' button.

If Users want to log out from current account, they can touch menu and tap on 'Profile' menu. By touching 'Log out' button located just above the 'Delete Account' button, users face a message box that asks if users really want to log out. If users touch 'Yes' button, log out is processed and if users touch 'No' button, users return to the profile screen.

2.2.3. Register New Smart Device

If users successfully logged in, they could see a list of devices registered so far, and check a button to register a new device at the top. When users press the device registration button, they can see a screen displaying a selection box to select the type of device, a box to enter the device's serial number, and a box to enter the device's verification code. After filling out such requirements, by pushing ‘Register’ button, users can activate new smart device on their system.

2.2.4. Set Parameter

Users can check the list of devices they have registered on the screen immediately after login. Users also can directly adjust the value of each registered device by selecting each registered device.

2.2.5. Set Sleep Schedule

Users can set a sleep schedule which includes sleeping time and waking up time. User preferences such as temperature and humidity can be set so that the system maintains those conditions overnight.

2.2.6. Allow/Deny Registration

Before new users can control the smart devices, the system administrator must first authorize their account. Administrators can allow registration of those users that are known or deny registration of those unknown.

2.2.7. Change Password

Users can change their passwords once they have successfully logged in by going into the settings menu. System checks current password of the account and then users can change password they want.

2.3. User Characteristics

2.3.1. System Administrator

The System administrator refers to the user who logs into the system using the credentials which are given by default on each device. The main hub system comes with a pre-generated username and password which is displayed physically on the main hub. Login in with the administrator credentials grants the user the privilege to add or authorize new accounts (in order to associate them with the system), delete accounts and overwrite system preferences. They may also change their password or reset the system altogether.

2.3.2. User

Users of the System typically refers to the subjects who inhabit the space where the system is set up. It is necessary that the users have access to a smartphone and basic literacy skills such as mobile literacy and technology literacy to navigate the application. Users must be authorized by system administrators to make changes to the system such as temperature, humidity, light intensity etc.

2.4. Constraints

The system is to be designed and implemented based on the contents of this guidelines and any other implementation choices must comply with the following:

- Each system includes at least one main hub.
- Open source and Free License software should be considered over paid licenses.
- User friendliness and simplicity should be kept in mind.
- Consider Scalability and availability.
- Test operation of the should use the most used version of each operating system.

2.5. Assumptions and Dependencies

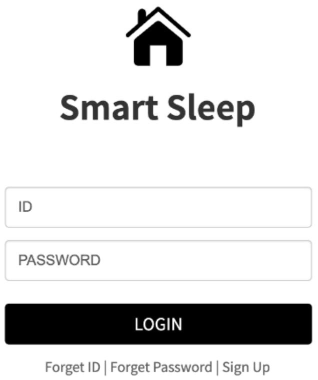
The interface application in this document was created based on the assumption that it will be designed and implemented with the aim of being used on Android and iOS mobile platforms. In the case of Android devices, they must contain at least a Qualcomm Snapdragon 845 with 2GB ram or a processor with similar capabilities, running API 31 (Android 12) or above, for Apple devices they must include A9 chip or newer, running iOS 14 or above. The interface is also available on Apple Watch watch OS 8 or higher and wear OS running API 31 or above.

3. Specific Requirements

3.1. External Interface Requirements

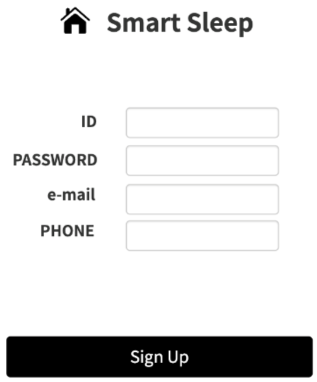
3.1.1. User Interfaces

[Table 3] User Interface – Login Screen for Smartphone Application

Name	Login Screen for Smartphone Application
Purpose/ Description	Users are able to login or sign up
Input source/ Output destination	User / Smart Sleep smartphone application
Range/ Accuracy/ Margin of error	N/A
Unit	Screen
Time/ Velocity	N/A
Relationship with other input/outputs	N/A
Format and configuration	 Smart Sleep ID PASSWORD LOGIN Forget ID | Forget Password | Sign Up 1. User who already has an ID can enter correct ID and Password to Login. 2. User who does not have an ID can register by clicking “Sign up” button. 2. User who has an ID, but forgot ID or Password can find the ID or Password by clicking “Forget ID” or “Forget Password” button.
Data type	Image, Text, Button

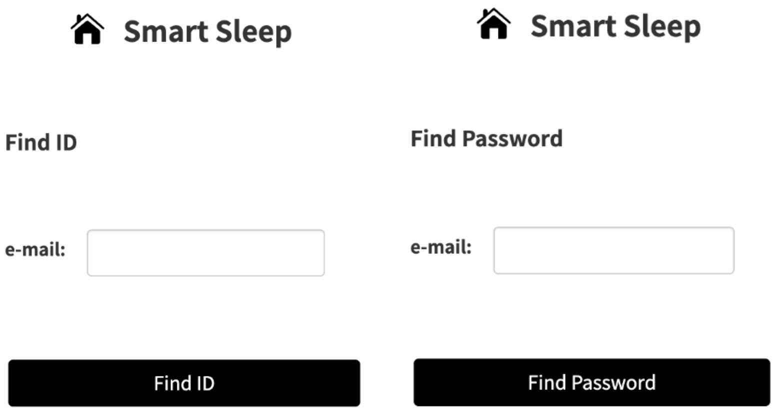
Name	Login Screen for Smartphone Application
Instruction type	N/A
Exit message	N/A

[Table 4] User interface - Create ID Screen for Smartphone Application

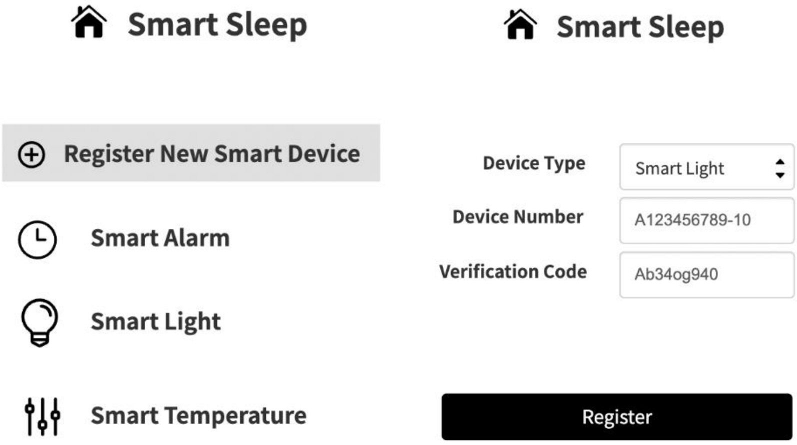
Name	Create ID Screen for Smartphone Application
Purpose/ Description	Users can create a new ID
Input source/ Output destination	User / Smart Sleep smartphone application
Range/ Accuracy/ Margin of error	N/A
Unit	Screen
Time/ Velocity	N/A
Relationship with other input/outputs	N/A
Format and configuration	 1. User can create a new ID by filling in the information and clicking "Sign Up" button. 2. If same ID, e-mail or phone number already exists, the error message will be shown.
Data type	Image, Text, Button
Instruction type	N/A

Name	Create ID Screen for Smartphone Application
Exit message	N/A

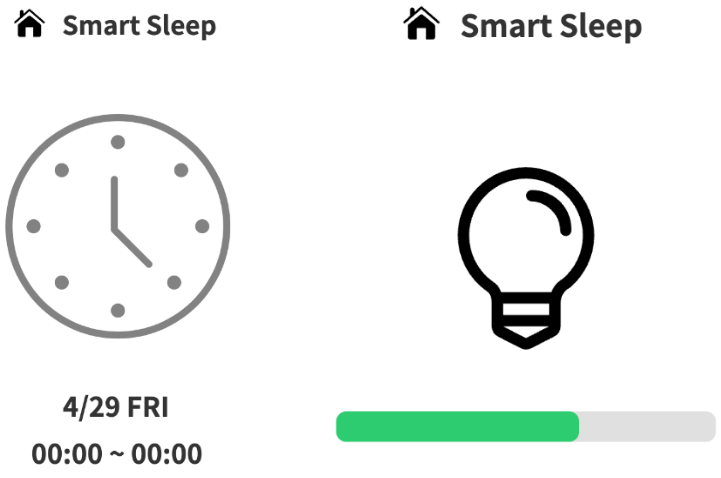
[Table 5] User interface – Forget ID/Password Screen for Smartphone Application

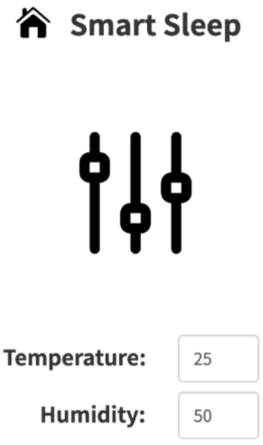
Name	Forget ID/Password Screen for Smartphone Application
Purpose/ Description	Users can find ID or Password if they forget it
Input source/ Output destination	User / Smart Sleep smartphone application
Range/ Accuracy/ Margin of error	N/A
Unit	Screen
Time/ Velocity	N/A
Relationship with other input/outputs	N/A
Format and configuration	 Smart Sleep Find ID e-mail: Find ID Smart Sleep Find Password e-mail: Find Password 1. Users can find id or password through their email they entered when they signed up.
Data type	Image, Text, Button
Instruction type	N/A
Exit message	N/A

[Table 6] User interface – Register Device Screen for Smartphone Application

Name	Register Device Screen for Smartphone Application
Purpose/ Description	Users can register smart devices to their account
Input source/ Output destination	User / Smart Sleep smartphone application
Range/ Accuracy/ Margin of error	N/A
Unit	Screen
Time/ Velocity	N/A
Relationship with other input/outputs	N/A
Format and configuration	 Smart Sleep Register New Smart Device Smart Alarm Smart Light Smart Temperature Smart Sleep Register Device Type: Smart Light Device Number: A123456789-10 Verification Code: Ab34og940 1. User can register a new smart device by clicking “Register New Smart Device” button. 2. To register a new smart device, user should enter the verification code attached on the smart device. 3. By clicking already existing smart devices, user can move to controlling screen and control the smart sleep system.
Data type	Image, Text, Button
Instruction type	N/A
Exit message	N/A

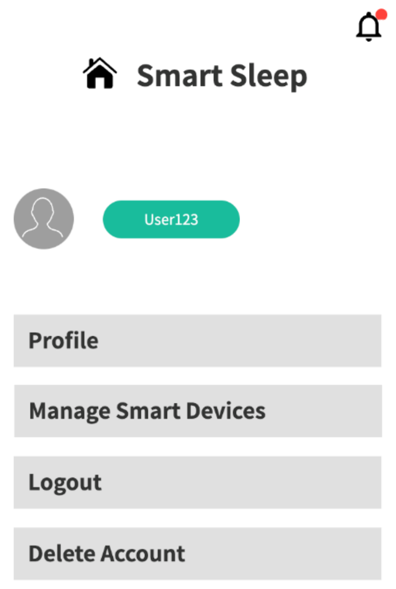
[Table 7] User interface – Controlling Screen for Smartphone Application

Name	Controlling Screen for Smartphone Application
Purpose/ Description	Users can control the registered smart devices to run the smart sleep system
Input source/ Output destination	User / Smart Sleep smartphone application
Range/ Accuracy/ Margin of error	N/A
Unit	Screen
Time/ Velocity	N/A
Relationship with other input/outputs	N/A
Format and configuration	

Name	Controlling Screen for Smartphone Application
	 Smart Sleep Temperature: 25 Humidity: 50 1. User can set the sleeping time by clicking date and moving the hands of the clock. 2. User can set the brightness to be maintained during sleep by moving the highlighting bar under the light bulb. 3. User can set the temperature and the humidity to be maintained during sleep by entering the value to the text box.
Data type	Image, Text
Instruction type	N/A
Exit message	N/A

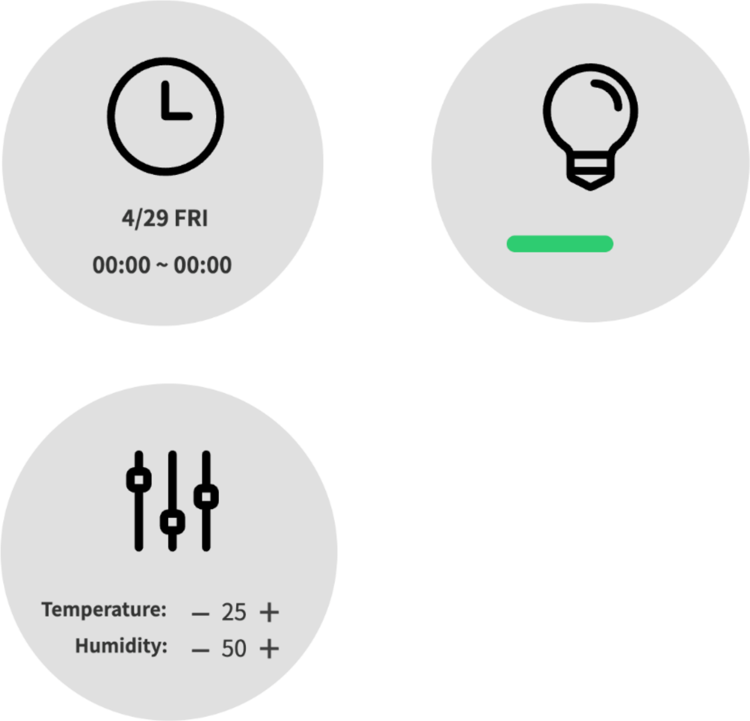
[Table 8] User interface – User Information Screen for Smartphone Application

Name	User Information Screen for Smartphone Application
Purpose/ Description	User can view the information and manage the account
Input source/ Output destination	User / Smart Sleep smartphone application
Range/ Accuracy/ Margin of error	N/A

Name	User Information Screen for Smartphone Application
Unit	Screen
Time/ Velocity	N/A
Relationship with other input/outputs	N/A
Format and configuration	 Smart Sleep User123 Profile Manage Smart Devices Logout Delete Account 1. User information can be viewed through “Profile” menu. 2. User can manage or delete registered smart devices through “Manage Smart Devices” menu. 3. User can logout or delete account by clicking “Logout” or “Delete Account” menu.
Data type	Image, Text, Button
Instruction type	N/A
Exit message	N/A

[Table 9] User interface – Controlling Screen for Smartwatch

Name	Controlling Screen for Smartwatch
Purpose/ Description	Users can control the smart device through their smartwatch
Input source/ Output destination	User / Smart Sleep smartwatch application

Name	Controlling Screen for Smartwatch
Range/ Accuracy/ Margin of error	N/A
Unit	Screen
Time/ Velocity	N/A
Relationship with other input/outputs	N/A
Format and configuration	 4/29 FRI 00:00 ~ 00:00 Temperature: – 25 + Humidity: – 50 + 1. User can set the sleeping time by clicking date and moving the hands of the clock. 2. User can set the brightness to be maintained during sleep by moving the highlighting bar under the light bulb. 3. User can set the temperature and the humidity to be maintained during sleep by clicking the plus and the minus button.
Data type	Image, Text, Button
Instruction type	N/A
Exit message	N/A

[Table 10] User interface - Managing Account

Name	Managing Account
Purpose/ Description	Admin manages the accounts. Admin can accept/deny account creation.
Input source/ Output destination	Admin / Smart Sleep smartwatch application
Range/ Accuracy/ Margin of error	N/A
Unit	Screen
Time/ Velocity	N/A
Relationship with other input/outputs	N/A
Format and configuration	1. User sends creating account request to system. 2. System receives it and store it as list format. 3. Admin can accept/deny account creation by accept/deny button.

3.1.2. Hardware Interfaces

[Table 11] Hardware interface of the device capable of running Smart Sleep System

Name	Device capable of running Smart Sleep System
Purpose/ Description	The system is intended for mobile devices which run iOS systems or Android systems. Mobile devices must have at least Qualcomm Snapdragon 845 with 2GB RAM or A9 with 2GB RAM.

3.1.3. Software Interfaces

[Table 12] Software interface of Smart Sleep

Name	Smart Sleep
Purpose/ Description	The system is intended for mobile platforms, specifically Android and iOS systems. Android systems must be ruining API 31 (Android 12) or above and iOS 14 or above. In case of wear OS, it should be API 31 or above, and in case of AppleWatch, it should be watch OS 8 or above.

3.1.4. Communication Interfaces

[Table 13] Communication interface of user and Smart Sleep server

Name	User and Smart Sleep server
Purpose/ Description	User device and server communicate with the different IoT devices via the network.
Input source/ Output destination	Smart Sleep server / User User / Smart Sleep server

3.2. Functional Requirements

3.2.1. Use Case

[Table 14] Use case of Create User

Use case name	Create User
Actor	User, System (database)
Description	A user tries to create an account to access all the functionalities of the product.
Normal Course	1. The user selects the button to create an account. 2. The user enters a username, password, email and phone number. 3. The entered information is verified: if there already exists a user with those credentials in the database, an error message is shown. 4. The account is created if the user administrator validates the account (use case Validate User).
Precondition	There is no user logged in at the moment, so all devices of the system have a default behavior predefined by the system: a default optimized sleep schedule that depends only of the region/location of the installation and environment conditions of the room (humidity, light intensity, temperature).
Post Condition	N/A
Assumptions	N/A

[Table 15] Use case of Delete User

Use case name	Delete User
Actor	User, System (database)
Description	A user tries to delete an account.

Normal Course	1. The user selects the button to delete the account that is logged in at the current session. 2. The user is asked to confirm its choice. 3. If the operation has been completed successfully, a success message is shown to the user.
Precondition	The user is logged in with one account.
Post Condition	After the account is deleted, all devices that were working at the moment under the user's session will stop their actions and wait with default behavior till a new user logs in.
Assumptions	Administrator's account cannot be deleted.

[Table 16] Use case of Log In

Use case name	Log in
Actor	User or Administrator, System
Description	A user or an administrator logs in the system. A person attempting to log in the system is an administrator if he enters the credentials of administrator that are stored by the system.
Normal Course	1. The user selects the button to log in. 2. The user fills in its username and password into the form. 3. If the credentials match, the user logs in successfully. If the entered credentials were administrator credentials, then the user is given an administrator's interface. 4. If the credentials did not match, an error message is shown.
Precondition	There is no user logged in at the moment. There is at least one created user (for normal users). Administrator's account is given with the product and doesn't need to be created.
Post Condition	If user had some activity of the system devices programmed at the time when he logs in, the devices will start working automatically at the moment.
Assumptions	N/A

[Table 17] Use case of Log Out

Use case name	Log Out
Actor	User or Administrator, System
Description	A user or administrator logs out of his account.

Normal Course	1. The user selects the button to log out. 2. The user is asked to confirm its choice. It should inform the user that all devices of the system that are working at the moment will stop their actions and change to stand by state. 3. If the operation has been completed successfully, a success message is shown to the user. 4. The user is logged out; the initial interface is shown.
Precondition	The user is logged in with one account.
Post Condition	N/A
Assumptions	Log out functionality works identically for normal users and administrators.

[Table 18] Use case of Set Parameter

Use case name	Set Parameter
Actor	User, System
Description	A user sets one parameter (light intensity, temperature, humidity) to his desired value through the application.
Normal Course	1. The user selects the option of setting the value for one parameter. 2. The user selects in the application interface the parameter he wants to modify. 3. The user enters the desired value for the parameter among possible values offered by the system. 4. If the related devices of the system that control the parameter are already working in the moment, it is reminded to the user. 5. The user is asked to confirm his choice. 6. After confirmation, the operation is sent to the related devices.
Precondition	A user should be logged in the system.
Post Condition	Parameters that are set with these options should be turned back to default mode also manually by the user using the same option (default value should be available among all possible values), unless the user logs out causing the same result (all devices to default night schedule mode). If the user does not do any of the two, the default values will be set again after a maximum time limit.
Assumptions	N/A

[Table 19] Use case of Set Timer for Parameter

Use case name	Set Timer for Parameter
Actor	User, System
Description	A user selects one date and hour where to turn one parameter (light intensity, temperature, humidity) to his desired value through the application. It is possible also to select a date and hour to turn the parameter back to default value.
Normal Course	1. The user selects the option of setting the timer for one parameter. 2. The user selects the parameter he wants to modify. 3. The user enters the desired value for the parameter among possible values offered by the system, and the date and hour where he wants the system to realize it. 4. The user is asked if he wants to set also a date and hour for the parameter to return to default. He enters his answer. 5. The user is asked to confirm his choice. 6. After confirmation, the operation will be sent to the related devices at the decided time.
Precondition	A user should be logged in the system.
Post Condition	If the user did not set a date for returning to default mode, the default values will be set again after a maximum time limit or if the user logs out.
Assumptions	If there is already a previous timer planned for the parameter that overlaps with the new one, the old will be cancelled and the new executed.

[Table 20] Use case of Set Sleep Schedule

Use case name	Set Sleep Schedule
Actor	User, System
Description	A user inputs his sleep and wake up hour, and the system plans the optimal values for sleep parameters during night time. The initial configuration planned by the system can be customized in some degree by the user.
Normal Course	1. The user selects the option of setting a sleep schedule. If a schedule was already set in the past, it can be modified instead of creating a new one. 2. The user introduces his sleep and wake up hours. 3. The user is shown the plan produced by the system (a table with values of parameters throughout the sleep interval entered). 4. The user can perform customizations on the schedule till he presses the confirmation button. Three customizations are available: modifying the average temperature value of the night, increasing or decreasing average humidity of the

	night and increasing or decreasing average light intensity of artificial sunset and sunrise. 5. After confirmation, the schedule is saved with an automatically created title that includes the sleep and wake up interval (e.g., “Schedule 10 PM ~ 7 AM”). The operation will be sent to the related devices at the decided times every night.
Precondition	A user should be logged in the system. If a user wants to store different sleep schedules for the same hour interval, he should make different accounts. Sleep schedules that do not overlap (for example midday nap and night schedule) are possible for the same user.
Post Condition	If the user did not set a date for returning to default mode, the default values will be set again after a maximum time limit or if the user logs out.
Assumptions	If there is already a previous schedule for that user that overlaps with the new one, the old will be canceled and the new one kept.

[Table 21] Use case of Allowing/Denying Registration

Use case name	Allowing/Denying Registration
Actor	Administrator
Description	It is a process that the admin allows new user registration or declines it. It is essential to make the system secure. Administrator can only allow registration whose user is known. The registration of unknown user will be declined.
Normal Course	1. Administrator touches account button in menu. 2. The account registration list pops up. Administrator can see who is the user, by email, or phone number. 3. Administrator can decide whether to allow or decline the registration. 4-1. Administrator knows the user. So, administrator clicks allow button. 4-2. Administrator does not know the user. Administrator clicks decline button. 5. If Administrator clicks allow button, System stores user ID/password in DB.
Precondition	The user tried to register in the system and the registration is sent to the system.
Post Condition	If the user is known, the user registers in system and login to it via his ID/password. But if user is unknown, he fails registering in system.
Assumptions	There is at least one user who registered.

[Table 22] Use case of Changing Password

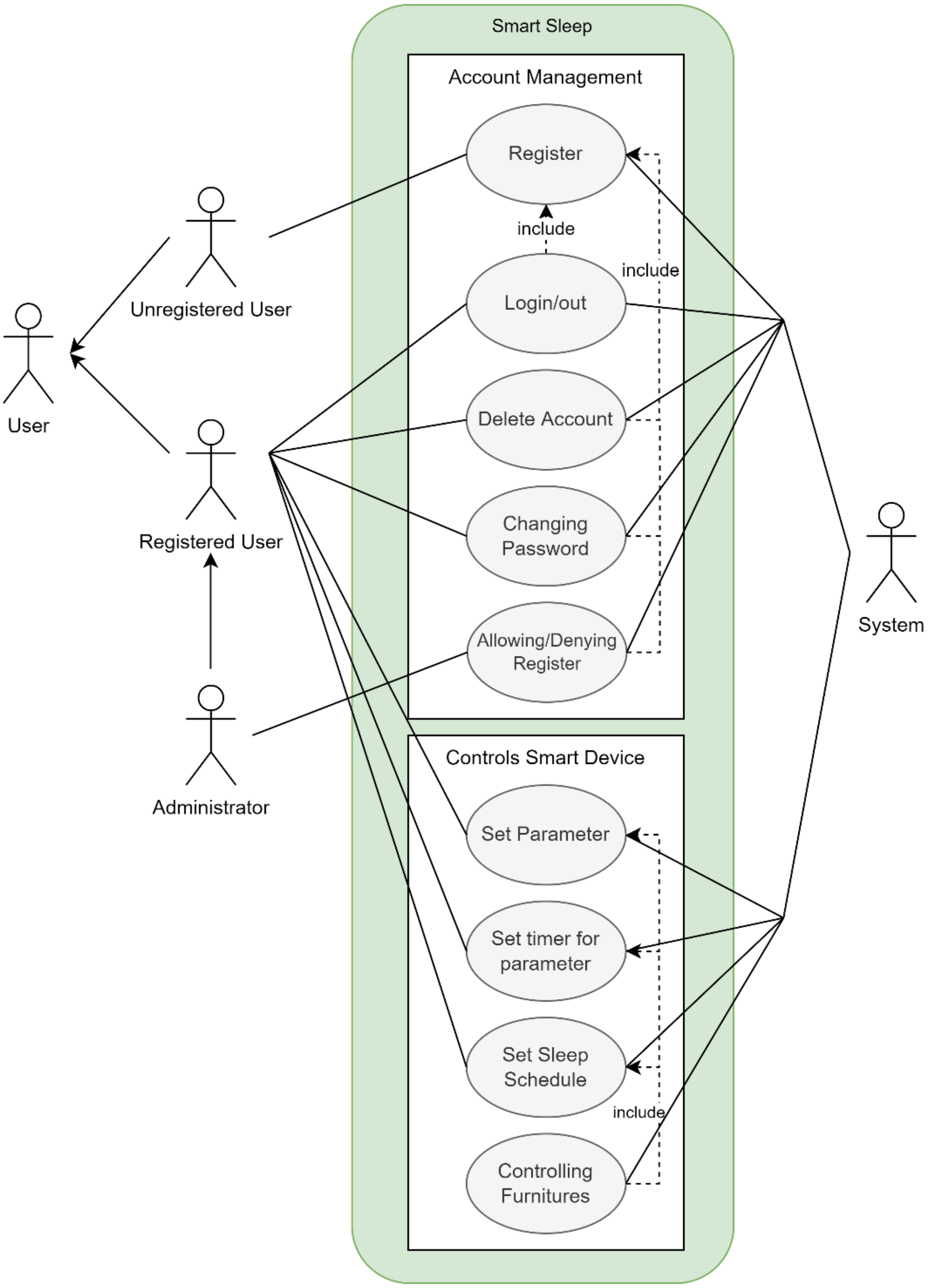
Use case name	Changing Password
Actor	User, Administrator
Description	It is a process that the user and the administrator change their password. Especially, in the case of administrator, initial default password will be randomly configured so the administrator is very likely to want to change it.
Normal Course	1. User clicks his profile button. 2. It shows user's profile and profile setting. User clicks profile setting. 3. Inside profile setting, user can change his password. User inputs new password. 4. System stores changed user password.
Precondition	The user is registered with old password. Especially, administrator is registered with initial password, which is hard to remember.
Post Condition	Password is configured as user wants.
Assumptions	Old password and new password will be not the same.

[Table 23] Use case of Controlling Furniture

Use case name	Controlling Furniture
Actor	System
Description	It is a process that the system controls the smart device/furniture. The smart sleep system includes light bulb, thermostat, and humidity controller. Each of them shall be controlled via network. The time when the system controls device is following: When it's sleep time, and when the user arbitrarily controls it.
Normal Course	<Sleep time> 1. When it's sleep time, the scheduler of system is triggered. 2. Once triggered, the system sends controlling requests to all controlled furniture via protocol that furniture use. 3. The state of furniture is changed. a. Light bulb turns off or reduces the brightness. b. Thermostat and humidity controller sets its value to value pre-configured by user. <User Adjusts>

	1. Once user sends operation to control the furniture, the system is triggered. 2. The triggered system controls the furniture to have value adjusted by user. 3. The state of furniture is changed.
Extended Course	When user already adjusted the value of devices and sleep time comes, the system prefers the sleep time condition.
Precondition	<Sleep time> The user already configured sleep time, and the parameters. (Use case of Set Sleep Schedule) <User Adjusts> The user adjusted the parameter of furniture. (Use case of Set Parameter, Use case of Set Timer for Parameter)
Post Condition	The conditions of furniture are adjusted.
Assumptions	The system is able to communicate with smart furniture.

3.2.2. Use Case Diagram



[Figure 1] Use Case Diagram

3.3. Performance Requirements

The following performance requirement is described by predicting the numerical value of the system performance.

3.3.1. Static numerical requirement

- One administrator account must exist on the system. This administrator account is not created, but is given from beginning like a Wi-fi administrator account.
- Like the Wi-fi administrator account, you can have one administrator account per device that is responsible for the home server and add users if you want.
- If you do not log in, it prevents you from connecting to the server.

3.3.2. Dynamic numerical requirement

- It does not require a large number of people to set the optimal environment for sleeping, so there is no problem if up to 10 people connect at the same time.
- When a user is created or deleted, it must be applied within 1 second of the database on the home server.
- Permission and decline which are administrator's authorities should be executed within 1 second.
- The login and logout process should be completed within 1 seconds.
- Accessing service should run within 5 seconds.
- The parameter (light intensity, temperature, humidity) which control by the user should be set within 1 seconds.
- The controlling furniture must be changed within 10 seconds to match the parameter set by the user.

3.4. Design Constraints

The smart sleep system should be able to control all furniture that can be controlled within the home by the registered user. For server security purposes, the administrator has given or deprived the user permission to connect to the server.

3.5. Standards compliance

Our goal is to make it easy for anyone to access smart sleep system through a smartwatch or smartphone. So, we will use wear OS and watch OS as development platforms for smartwatches, and we will develop smartphone services with flutter.

3.6. Software System Characteristics

Software system characteristics are described as functional and non-functional related to the function that provide by software(functional), service or product you are creating, or to the organization or requirement(non-functional). Non-functional requirements are directly related to the quality of the software. In the smart sleep system that we are trying to develop, non-functional requirements are very important because parameters such as temperature or light intensity are directly related to user satisfaction. Product requirements are non-functional requirements for the organizations involved in software development such as system processing speed and service reliability. Organizational requirements are a consequence of organizational policies and procedures. External requirements are non-functional external requirements that affect the software.

3.6.1. Product Requirements

3.6.1.1. Usability Requirements

Software must be created to make it easy for anyone to use the system. Also, when the user uses the system, the parameters set by the user must be performed accurately and consistently without errors. The user interface should be simple and intuitive to easily use all functions without a separate manual, and should increase usability by arranging objects with functions suitable for the purpose of the place.

3.6.1.2. Efficiency Requirements

The case that users accessing in same time is barely happens, performance requirements should run quickly and optimize to avoid errors.

3.6.1.3. Reliability Requirements

Good software should be less likely to fail when executing certain functions. Parameters which set by the user must be maintained during or after a system failure

3.6.1.4. Security Requirements

Administrator has an account that has administrative privileges from the beginning, such as a Wi-fi router. Administrator accounts should manage user registration and deletion. We should also create a login function to prevent users who are not registered with the server database from using the service. It should also prevent accounts which deleted from the server database from accessing the service.

3.6.2. Organizational Requirements

3.6.2.1. Organizational Requirements

Organization requirements must meet the policies, procedures, and implementation requirements promised by the organization. However, organizational requirements are not important in this project. In other words, we only need to focus on implementation to carry out the project.

3.6.2.2. Environmental Requirements

System users are stored in the server database as a user registration by the administrator and gain access to the service. To authenticate the user's identity, the authentication number must be entered through the smartphone to prevent unidentified users from being registered.

3.6.3. External Requirements

3.6.3.1. Safety/Security Requirements

The system must ensure that personal information cannot be accessed by external systems, external users, or unauthorized users. The Server Databases must protect data from system failures and external intrusions.

3.6.3.2. Regulatory Requirements

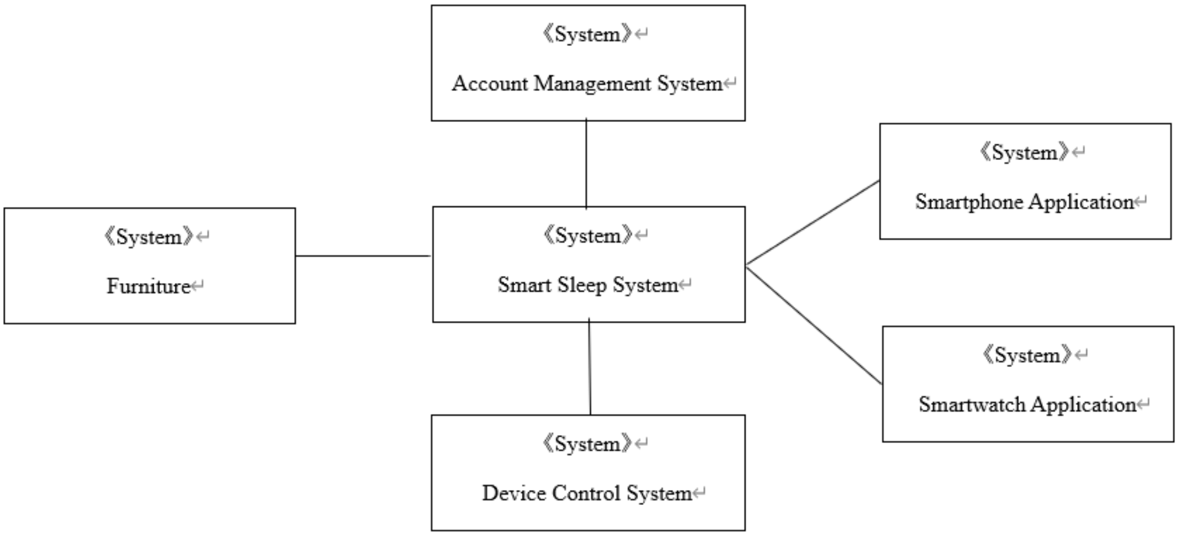
The system must be careful not to use unauthorized assets without permission. The system also carefully checks the content related to the distribution of each asset, taking care not to break the law.

3.7. Organizing the Specific Requirement

In this section, we describe the system model using graphical notation based on Unified

Modeling Language (UML) and tabular form.

3.7.1. Context Model



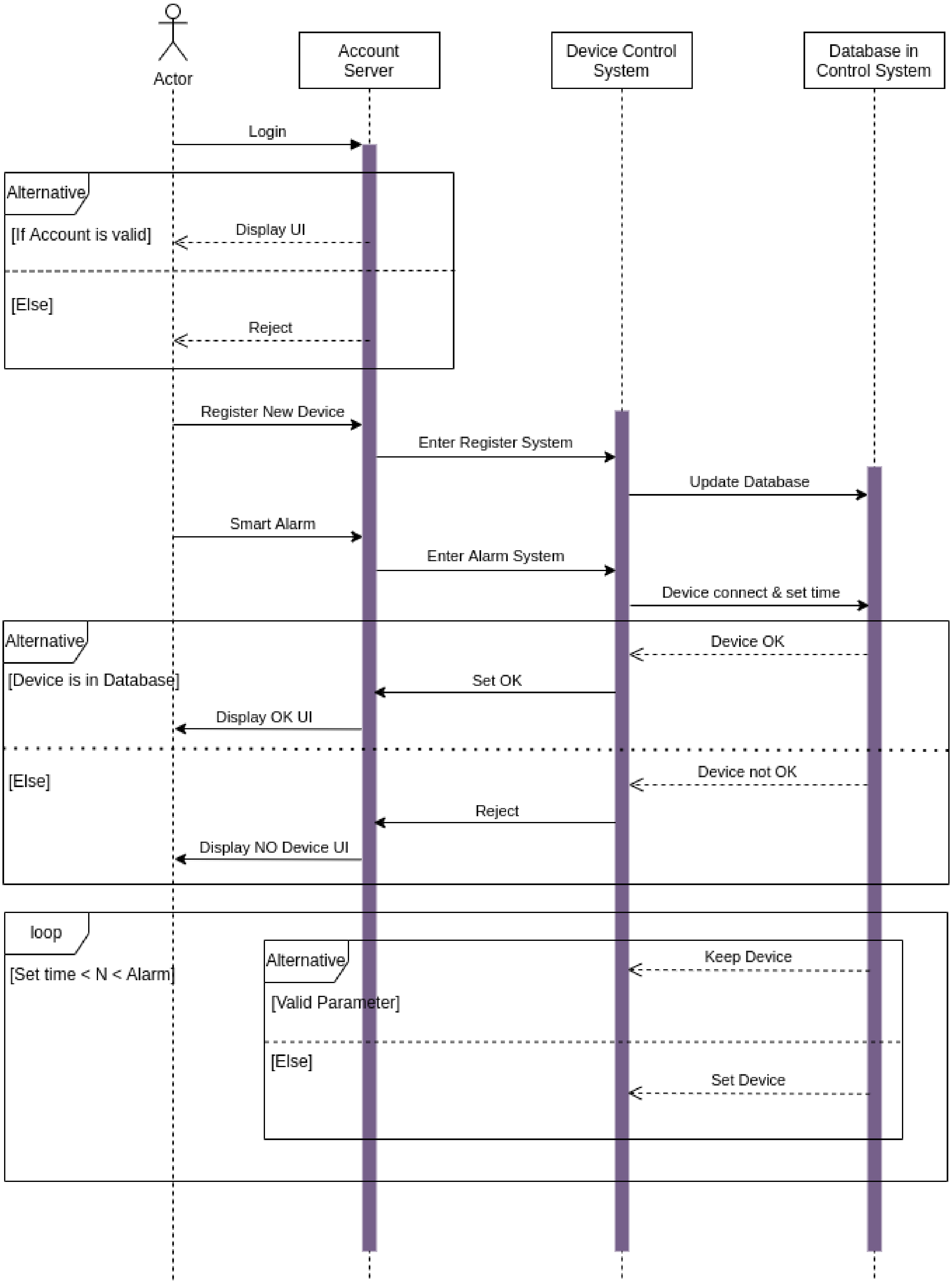
[Figure 2] Context Model

3.7.2. Interaction Model

3.7.2.1. Use Case Diagram

See 3.2.2 Use Case Diagram

3.7.2.2. Sequence Diagram

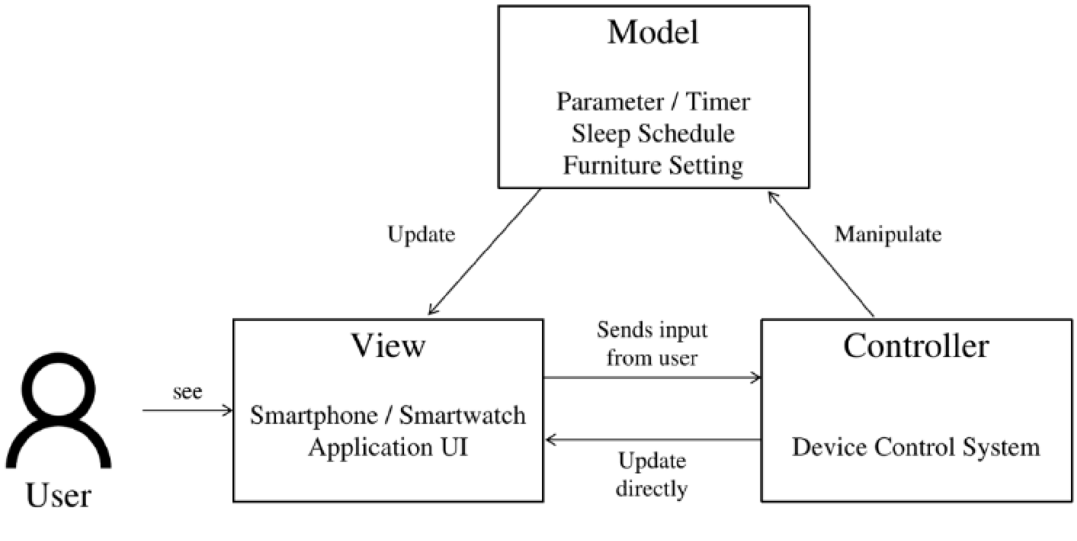


[Figure 3] Sequence Diagram

3.8. System Architecture

This section shows the system architecture using MVC(Model-View-Controller) pattern. In the smart sleep system, the user can set the desired environment through the smartphone and smartwatch UI. The UI allows the user to view information about the device that is currently working. By default, you can see devices for lighting, temperature control, and you can add and delete devices inside the space yourself. The key to the smart sleep system is the alarm system. It works based on data that can present fantastic sleep conditions to users, such as user-set sleep conditions, databases that can analyze existing user sleep patterns to recommend optimal sleep conditions, and device settings. Entering the scheduled sleep time through the alarm system sets the optimal sleep conditions based on the data in the database. This data will continue to be updated.

The sections described above can be plotted at a glance with MVC Pattern. The controller directly displays information such as the status of the current device, which allows users to view the UI directly through View and operate in real time without having to access the database. When the database needs to be modified, the controller requests the model to modify it, and the updates are visible to the user through View.



[Figure 4] MVC Pattern

3.9. System Evolution

In this section, we describe the fundamental assumptions on which the system is based, and any anticipated changes due to hardware evolution, software updates, and so on. This section is useful for system designers as it may help them avoid design decisions that would constrain likely future changes to the system.

3.9.1. Limitation and Assumption

A smart sleep system is a system for a single user. The surrounding devices are controlled for optimal sleep of one user who writes the application. It is assumed that one user sleeps in one space. If several people sleep together in one space, there will be difficulties in setting up the device. Factors such as temperature can be set for each user. For example, using a device such as an electric pad, each user may set a different temperature in a place where he or she lies down and sleeps. However, conditions that are difficult to fit individual users, such as humidity and lighting, are difficult to determine which environment is optimal. Systems that will be improved in the future will need to address this problem so that our system can be applied to a large number of users.

3.9.2. Evolutions of Software and Hardware

The potential for development of smart sleep systems is endless. If you continue to develop the user's UI and continue to stabilize the control system, you will be able to continue to provide the user with optimal sleep conditions.

For this purpose, compatibility with more diverse devices should be addressed. There are a wide variety of smart home devices in the market today, and hardware needs to be improved to allow users to register all commonly used devices in the system.

4. Supporting information

4.1. Software Requirement Specification

This document is written according to the IEEE Recommendation.

4.2. Document History

[Table 24] Document History

Date	Version	Description	Writer
2022/04/26	1.0	Make Skeleton	Younghoon Jun
2022/04/27	1.1	Addition of 3.2	Heegwan Son Aitana Morote
2022/04/27	1.2	Addition of 1	SanzBernal Maria
2022/04/27	1.3	Addition of 3.1	Seryeong Kim
2022/04/28	1.4	Addition of 3.3, 3.4, 3.5, 3.6	Yunseong Kim
2022/04/28	1.5	Addition of 3.7	Younghoon Jun
2022/04/28	1.6	Revision of 3.2	Heegwan Son Aitana Morote
2022/04/29	1.7	Revision of 3.1.1	Seryeong Kim
2022/04/29	1.8	Addition of 3.8 and Revision of 3.7	Younghoon Jun
2022/04/29	1.9	Addition of 2	Eunki Song
2022/04/29	1.10	Revision of 2.1	Eunki Song
2022/04/29	1.11	Revision of 3.3, 3.4, 3.5, 3.6	Yunseong Kim
2022/04/30	1.12	Addition of 3.9, 4.0	Younghoon Jun
2022/04/30	1.13	Revision of 2.4	Eunki Song SanzBernal Maria Yunseong Kim
2022/05/01	2.0	Revision of 2	Heegwan Son
2022/05/01	2.1	Revision of Style	Younghoon Jun