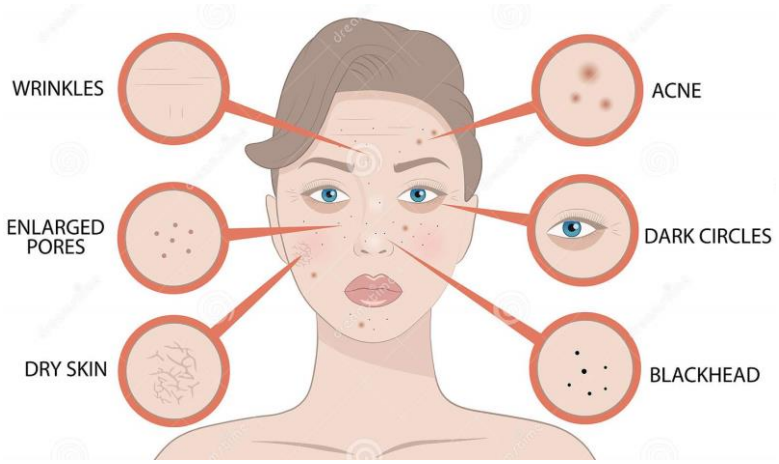
SOFTWARE REQUIREMENT SPECIFICATION

Facial Skin Problem Analyzer

Software for Analyzing Skin Problems on Face



March 2022

DUE DATES

	Scope of AD	Due Date	Length Limit
Interim Report	Chapters 1~4	4/07(Th) 9pm	30± Pages
Pre-Final Report	Chapter 5	4/17(Sun) 9pm	50± Pages
Final Report	Chapters 6~7	5/02(Mon) 9pm	70± Pages

CEP INSTRUCTOR

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Facial Skin Problem Analyzer

1. Purpose of the Document

The purpose of this document is to specify the requirement for developing the target system in this CEP. The requirement will become the basis for designing the software architecture of a target system, which is required as a fulfillment to acquire the Samsung Associate Architect (AA) certification.

2. Comprehensive Evaluation Project (CEP)

2.1. About Associate Architect (AA) Program

Associate Architect Program of Samsung Electronics is to provide participants with two sets of software architecture design proficiency.

- **Body of Knowledge (BoK) on Software Architecture**

  This set includes the fundamental theories and methods for designing SW architecture

- **Skillset for Designing SW Architecture**

  This set includes the practical skill for applying architecture design methods to a given SRS.

CEP is designed to fulfill the second set of AA program through an individual design project.

2.2. How is the CEP problem prepared?

The CEP problem is prepared by the instructor, based on the following principles.

- **Principle 1. Utilizing the Whole BOK of Software Architecture Design**
  - Utilizing Architecture Styles
  - Designing Architecture for multiple Views
  - Designing Architecture for Non-Functional Requirements
- **Principle 2. Handling the Complexity of Industrial Systems**

  The target system to design in CEP is an industry-level complex software system, i.e., not an academic problem appeared in books or literature.

- **Principle 3. Solution Not Available in Public**

  CEP problem is not a reproduction of already existing exercise problem in books, and hence the architecture design solution for the CEP problem is not available in public.

2.3. Architecture Design Reports in CEP

Each participant designs and submits the design of software architecture for the target system in incremental manner.

- Interim Report
  This report includes the context analysis model and the skeleton architecture design of the target system.
- Prefinal Report
  This report includes the architecture design for multiple views of the system; functional view, information view, behavior view, and deployment view.
- Final Report
  This report includes the architecture design for non-functional requirements and the validation of the architecture design.

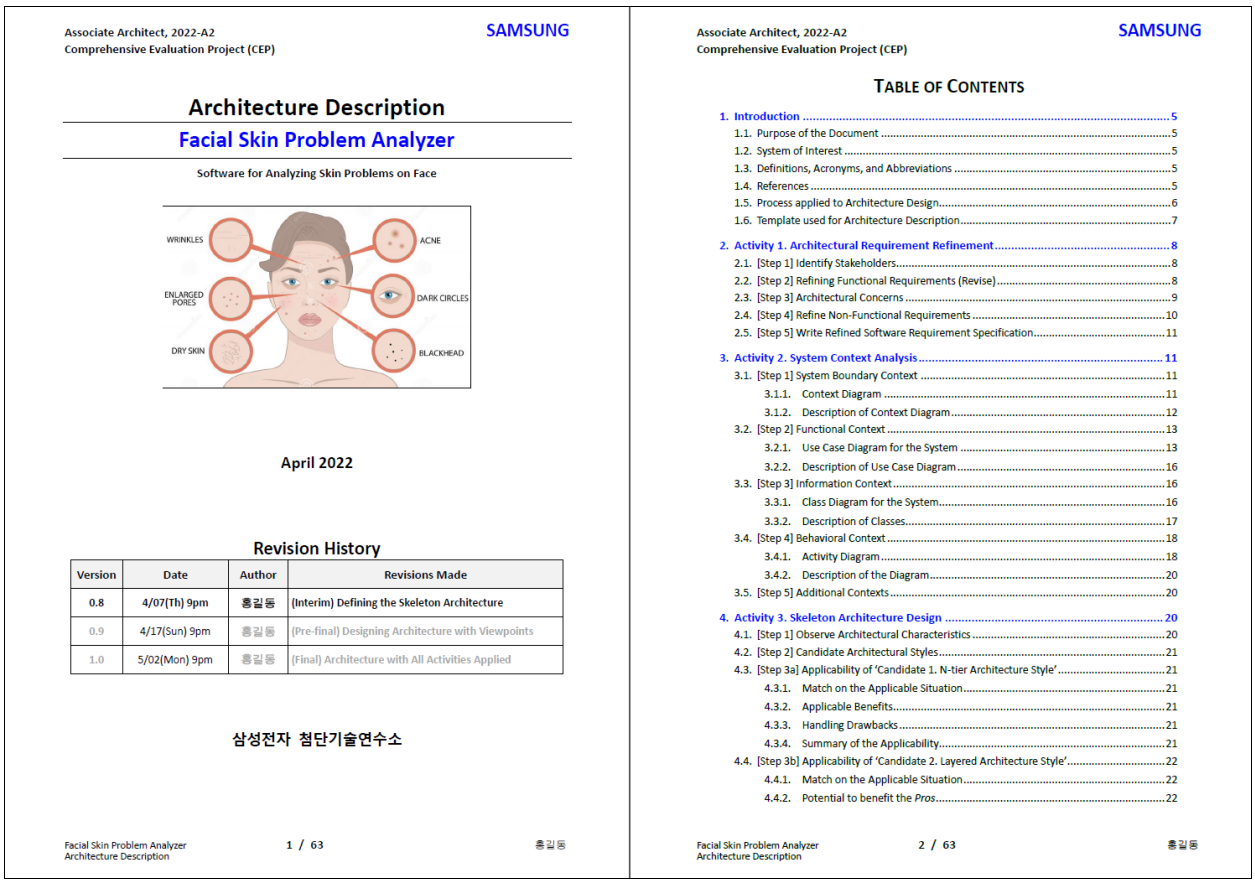
❑ **Weight Distribution of CEP Reports**

Interim Report	Prefinal Report	Final Report	TOTAL
30 points	30 points	40 points	**100 points**

2.4. Template for Architecture Design

A template for designing the software architecture in CEP is provided and hence participants can utilize the template in specifying the architecture design. The template is devised to be consistent with the architecture design methodology provided by the instructor.

❑ Table of Contents for CEP Report



Associate Architect, 2022-A2
Comprehensive Evaluation Project (CEP)
SAMSUNG

Architecture Description

Facial Skin Problem Analyzer

Software for Analyzing Skin Problems on Face

April 2022

Revision History

Version	Date	Author	Revisions Made
0.8	4/07(Th) 9pm	홍길동	(Interim) Defining the Skeleton Architecture
0.9	4/17(Sun) 9pm	홍길동	(Pre-final) Designing Architecture with Viewpoints
1.0	5/02(Mon) 9pm	홍길동	(Final) Architecture with All Activities Applied

삼성전자 첨단기술연수소

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Associate Architect, 2022-A2
Comprehensive Evaluation Project (CEP)
SAMSUNG

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3. Overview of the Target System

Facial Skin Problem Analyzer is a software system that analyzes various skin problems occurring on human faces. The users of the system upload their face photos and then the system identifies various problems on the facial skin. The result of the skin problem analytics is a comprehensive report on the types of observed skin problems, the severity of each skin problem instance, and the quantitative measure of each skin problem.

The result of the facial skin problem analytics provides users with a detailed diagnosis on his/her facial skin, which becomes the basis for deciding what skin cure and treatment methods should be applied to remedy the detected skin problems.

3.1. Perception on Facial Skin in Daily Life

The condition of the facial skin is perceived as an essential concern in our daily life. The facial skin condition is perceived as an essential basis for determining the age, healthiness, and beauty by many people.

- **Basis for determining the age**

  The condition of facial skin is the immediate means to predict the age of the person. That is, how the facial skin appears becomes an indicator of the person's age. For the reason, we wish our facial skin looks clean, shiny, smooth, and silky. The following figure shows two photos of the same person at different ages.

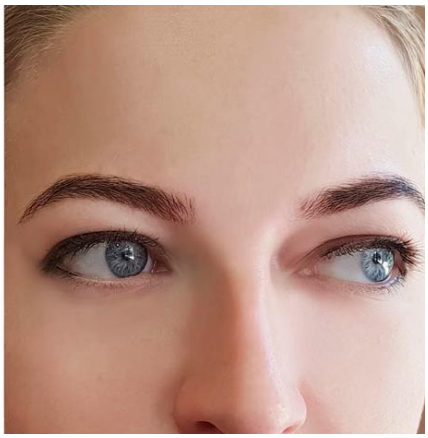
  The face appearance age, i.e., the age inferred from facial skin appearance, is often not same as the person's biological age. Some people look younger than their ages, and other look older. For the reason, we care our facial skin with various skin care cosmetics products and various treatment methods. Applying a moisture lotion after face wash is an example of caring our facial skin.

- **Basis for recognizing the healthiness**

  The condition of facial skin is the immediate means to predict the healthiness of the person. That is, how the facial skin appears becomes an indicator of the person's healthiness. If one's the facial skin looks pale and showing dark circles beneath the eyes, we often predict that the person may not be in a good health condition.


- **Basis for recognizing the beauty**

  The condition of facial skin is the immediate means to make people feel about the beauty of the person. For a same face shape, size, and layout, the appearance of the facial skin affects on the degree of beauty observed by people.

From the observations on the perception of facial skin, we can conclude that almost everyone has a high interest in assessing their facial skin conditions and planning effective methods to remedy their facial skin problems.

3.2. Types of Facial Skin Problems

The common types of skin problems on faces are the followings.

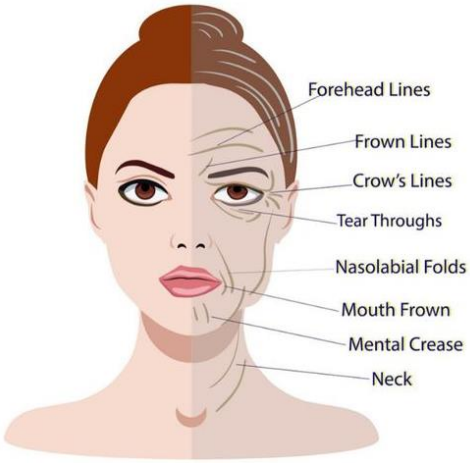
3.2.1. Acne

Acne is a common skin problem in young people, and it often lasts for several years, sometimes until mid-life. It appears as blocked pores, pimples and cysts and usually affects the oily skin areas of the face chest and upper back – and is also termed 'breakouts'

3.2.2. Wrinkle

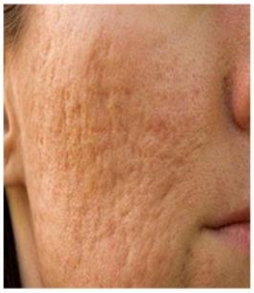
A wrinkle is the most prominent skin problem caused sun expose. It appears the face, neck, hands and forearms. Wrinkles naturally appear as people get older. The first wrinkles tend to appear on a person's face in areas where the skin naturally folds during facial expressions.

A wrinkle is shown as a line, and creases that form in the skin as shown in the following figure.

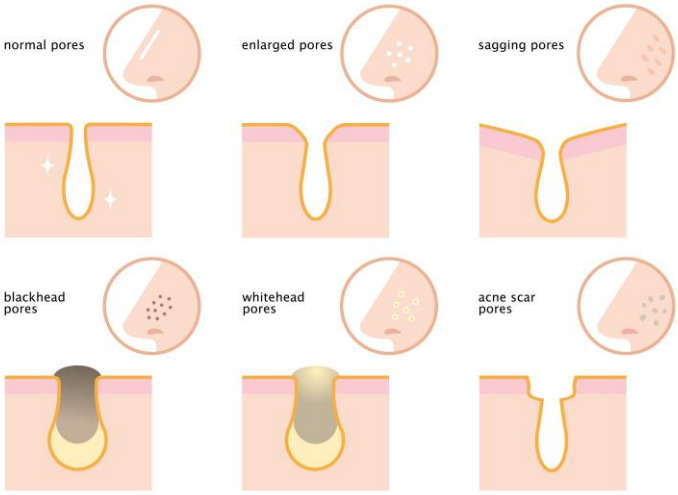


3.2.3. Enlarged Pore

An enlarged pore is the depression in the facial skin surface that contain one or more openings to the ducts carrying sweat and oil from their respective eccrine glands and sebaceous glands.




Enlarged pores appear in various forms as shown in the following figure.



3.2.4. Mole

A mole is a small dark brown dot on skin including facial skin and it is caused by clusters of pigment-forming cells. Most moles are harmless. Rarely, they become cancerous.


3.2.5. Face Flushing

Face flushing happens as a result of increased blood flow on a certain part of face. Whenever more blood flows to an area, the blood vessels enlarge to compensate.


3.2.6. Hyperpigmentation

Hyperpigmentation is a common, usually harmless condition in which patches of skin become darker in color than the normal surrounding skin. This darkening occurs when an excess of melanin, the brown pigment that produces normal skin color, forms deposits in the skin.


3.2.7. Dry Skin

Dry skin is an uncomfortable condition marked by scaling, itching, and cracking. Dry skin is usually harmless. But when it's not cared for, dry skin may lead to: Atopic dermatitis (eczema).


3.2.8. Blackhead

A blackhead is open bump on the skin that fill with excess oil and dead skin, due to clogged hair follicles. It is a severe type of acne.


3.2.9. Dark Circle

A dark circle is a dark blemish around the eyes, due to tiredness and a lack of sleep.\


3.2.10. Other Types

There are other types of facial skin problems, which are less common.

3.3. What is Facial Skin Problem Analyzer?

Facial Skin Problem Analyzer is a software system that analyzes various skin problems occurring on human faces. The users of the system upload their face photos and then the system identifies various problems on the facial skin. The result of the skin problem analytics is a comprehensive report on the types of observed skin problems, the severity of each skin problem instance, and the quantitative measure of each skin problem.

The result of the facial skin problem analytics provides users with a detailed diagnosis on his/her facial skin, which becomes the basis for deciding what skin cure and treatment methods should be applied to remedy the detected skin problems.

The functionality of the system is summarized as the followings.

- **Registering End Users**
- **Registering Skincare Professional**
- **Taking Facial Skin Photos**

- **Diagnosing the Condition of Facial Skin**
  - Determining Types of skin problems
  - Assessing the Stages of determined Skin Problems
  - Measuring Dimensions of determined Skin Problems
  - Predicting the Appearance Age
- **Determining the Face Skin Aging**
  - Assessing the Face Skin Age
  - Assessing the Face Skin Aging Rate
- **Evaluating the Performance of Analytics**
- **Generating Reports**

3.4. Benefits of the System

The benefits of the system are summarized as the following.

- **Archiving detailed Facial Skin Images for Analysis**

  Users can take detailed photos for analyzing their facial skin by using their mobile phones.

- **Assessing the Condition of Facial Skin**

  Users can acquire the quantitative assessment of their facial skin conditions without visiting skincare clinics. The provides a comprehensive and detailed analytics users' facial images.

- **Assessing the Appearing Age and Aging Rate**

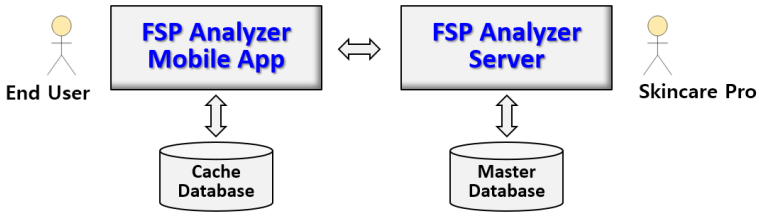
  Users can acquire their appearance ages and the rate of facial aging.

- **Means to plan Remedy Methods for Skin Problems**

  Users can better plan effective methods to remedy their skin problems with the facial skin assessment results.

3.5. Deployment of the Target System

The target system consists of a mobile app for end users and the server system that provides the common services to the mobile app, as shown in the following figure.



- **FSP Analyzer Mobile App**

  The mobile app provides the key functionality of the system to end users. The mobile app is available for Android and iOS platforms.

- **FSP Analyzer Server**

  The server system maintains the master database for users' facial images and analytics results.

4. Functional Requirements

The functionality of the software is classified into functional categories.

4.1. Registering End Users

An end user is a person who uses the system for taking facial skin photos and request the analysis of their facial skin conditions.

4.2. Registering Skincare Professional

A skincare professional is an expert who has an extensive and in-depth knowledge on the facial skin problems. The professional evaluates the results of analytics on the facial skin problems. If the system performs poor in the analytics, then the he or she notifies the system manager for enhancing the accuracy of the analytics.

4.3. Taking Facial Skin Photos

A set of detailed facial photos is required for analyzing the facial skin problems in detail. A single photo does not provide the enough details that are necessary in performing detailed and accurate analytics on the facial skin problems.

The system provides users with an online guidance for taking a series of photos for analytics purpose. The system asks each user to take the following 7 photos in sequence.

- Frontal Face Photo
- Left-side Face Photo
- Right-side Face Photo
- Forehead Photo
- Photo around Left Eye
- Photo around Right Eye
- Photo around Mouth

Each type of photo provides its specific detailed information on the facial skin.

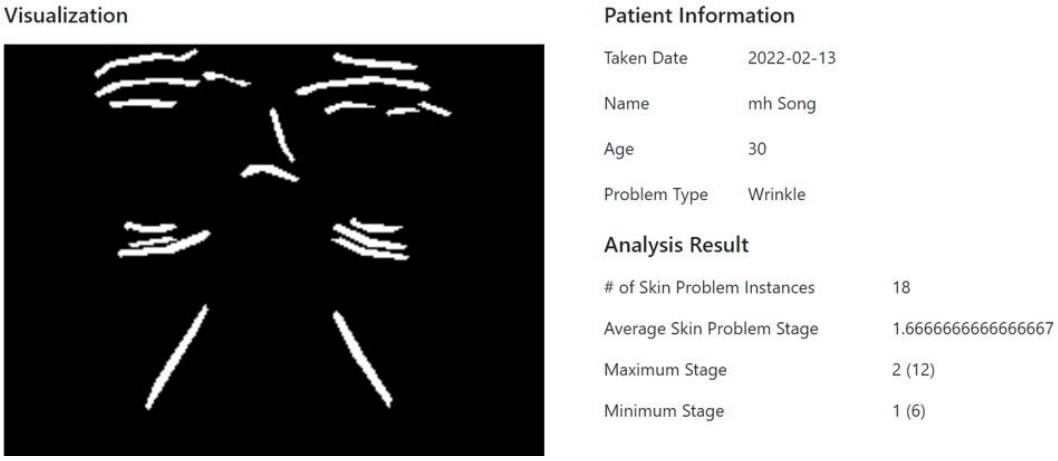
When taking photos, the system determines the right position of the face and informs the user to move the face in the right direction. When the face is positioned in the right angle and distance, the system takes and stores the photo.

4.4. Diagnosing the Condition of Facial Skin

The system performs the following diagnosis tasks using the facial image photos of each user.

- **Determining Types of skin problems**

  The system determines the facial skin problems appearing on the facial images. It classifies the face skin problems into the categories. The following figure shows the segmented areas of facial skin problems and the total number of problem instances and their stages.



  - Example with image_60

- **Example with image_85**

- **Example of Counting the number of Wrinkles**

Image / Wrinkle Type	img_85	img_62	img_58	img_60
Forehead Lines	4	2	1	1
Frown Lines	4	1	2	1
Tear Troughs	4	3	3	2
Nasolabial Folds	4	3	2	1

- **Example of Detected Color for Pixels**

Detected Skin Problems with its Masks

Pixels of the Problem Areas with RGB Color codes

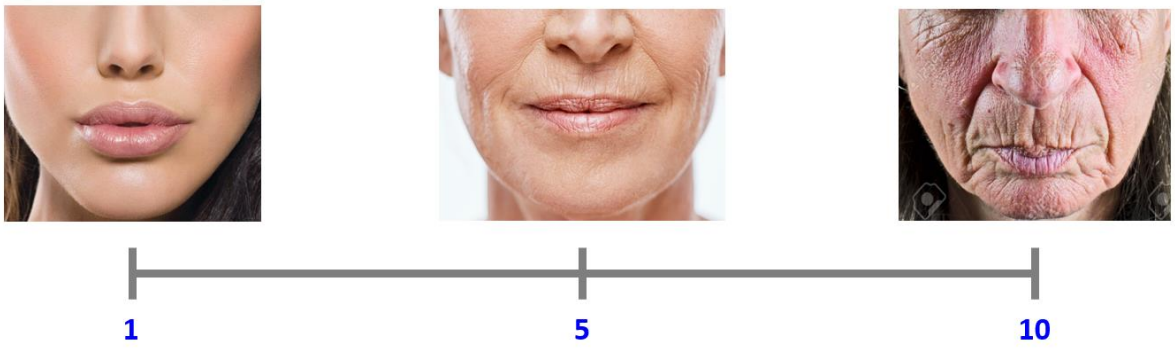
	Red	Green	Blue
2	94	108	137
3	70	84	113
4	51	65	94
5	87	101	130
6	46	60	89
7	60	74	103
8	47	61	90
9	72	85	117
10	52	66	95
11	74	87	119
12	59	73	101
13	82	94	128
14	78	92	120
15	72	84	118

- **Assessing the Stages of determined Skin Problems**

  The system evaluates the progress of each facial skin problem and determines its stage. The stage is ranged from 1 to 10.

  - Stage 1 is nearly-none, slight, and negligeable.
  - Stage 10 is highly severe, extreme, and worst on the degree of skin problem.

  The following figure shows face skin problems with wrinkles at state 1, 5, and 10.



  Devise a number of factors for determining the stage of skin problems. Consider all essential factors that are relevant to the severity and intensity of skin problem.

- **Measuring Dimensions of determined Skin Problems**

  The system measures the size and the depth of each facial skin problem by applying software methods. Each face skin problem is given its dimension in terms of length, width, and depth.

- **Determining the Color/Grayscale of determined Skin Problems**

  The system determines the color or grayscale of each facial skin problem by applying software methods. Each face skin problem is given its color code. The color or grayscale is a factor for determining the progress degree of the skin problem.

4.5. Estimating Face Skin Age

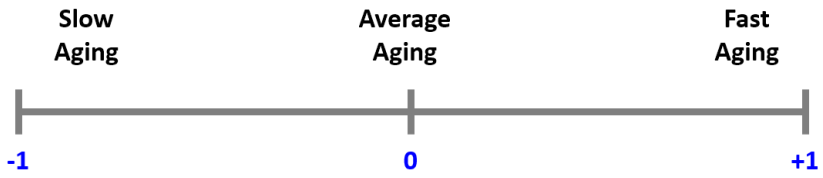
The system estimates the face skin age from the given face images and determines the rate of face skin aging.

- **Predicting the Face Skin Age**

  The system evaluates the age appeared on the facial skin. The face skin age is neither the user's birth year nor the face appearance age. The face skin age is a software-determined age that is inferred from the analysis on the face skin condition. That is, the face skin age is only determined by the condition of the face skin.

❑ **Assessing the Face Skin Aging Rate**

The system evaluates the rate of face aging progress. The FS Aging Rate is given in the range of -1 to 1.



❍ FS Aging Rate of 0 → Average Aging
The aging rage of 0 indicates the face skin aging of the user is about the average by considering the aging rates of other people.

❍ FS Aging Rate of +1 → Faster Aging
The aging rage of 1 indicates the face skin aging of the user is extremely faster than the aging rates of other people.

❍ FS Aging Rate of -1 → Slower Aging
The aging rage of -1 indicates the face skin aging of the user is extremely slower than the aging rates of other people.

Hence, we wish to have a lower value of the FS Aging rate, indicating a slower rate of face skin aging.

4.6. Evaluation by Skincare Professional

The system provides the functionality of evaluating the facial skin analytic results by the skincare professions. A skincare professional manually evaluates the result of facial skin problem analytics and leaves an evaluation report. The system determines the need for enhancing the analytics capability of the system by consulting the evaluation reports. And it delivers a notification to the system manager.

4.7. Generating Reports

The system generates a comprehensive report on the uploaded facial image photos and in-depth analytics on the facial skin conditions. The report is generated by the request of users.

The system also generates a system operation report for the system managers. It includes the summary of the user sessions for taking facial image photos and analyzing their facial skin conditions.

5. Non-Functional Requirements

There can be several non-functional requirements that are essential in the target system. For CEP, we consider only 2 NFR items.

5.1. NFR-1. High Accuracy of Diagnosing Facial Skin Problems

Design the system that provides a high accuracy of diagnosis on facial skin problems. The system would widely be accepted by users only when the accuracy of the diagnosis results is reliable enough to be accepted by users and skincare professionals.

The accuracy of facial skin diagnosis is applied to the following elements.

- High Accuracy of Detecting the Types of Facial Skin Problem
- High Accuracy of Determining the Stages of detected Facial Skin Problems
- High Accuracy of Measuring the Dimension of Facial Skin Problems

Apply any means and advanced software technologies to design the methods used to analyze the facial skin problems.

5.2. NFR-2. Accuracy of Evaluating Face Skin Age and Aging Rate

Design the system that provides a high accuracy of evaluating the appearance age and aging progress rate.

- Accuracy of Estimating Face Skin Age
- Accuracy of Computing the Aging Progress Rate

There is not yet a standard or de facto for estimating the face skin age and computing the rate of aging on face skin. Hence, the system should provide schemes and metrics to estimate the age and compute the aging progress.

Another challenge for making the estimation and the computation of progress rate is the variability of face skin aging among the people of different races and regions. This variability should be considered in the estimation.

6. Guidelines for Conducting CEP

6.1. Guidelines for Designing the Architecture

Apply the following guidelines for writing CEP Reports.

- **Conformance to the given SRS**

  The submitted AD should conform to the given SRS.

- **Conformance to UML Standards**

  The submitted AD should conform to the notational and usage standards of UML.

- **Consistency among various Artifacts in AD**

  There should be a high consistency among various artifacts (such as diagrams) in the submitted AD.

- **Comprehensibility of Textual Description**

  The textual elaboration of the architecture design should be written in accurate, precise, and condensed way. Hence, the understandability of the AD becomes high. The textual description can be written in English, Korean, or their mixture.

- **Readability of Figures and Tables**

  The figures and tables should be easily readable by applying good formats, right font size and special effects on them. For example, a use case diagram with 100 use cases should be well structured and enlarged if needed.

- **Reasonable Details of Machine Learning design**

  The submitted AD would include a design for managing machine learning models. The description of the machine learning model generation should be written in reasonably details. The description typically includes machine learning algorithms utilized, training sets used, the details for designing the model generation components.

- **Originality of the AD**

  The submitted AD should be an individual work. Any same or highly similar solutions would get a score penalty.

6.2. Guidelines for Submitting Reports

Apply the following guidelines for writing CEP Reports.

❑ **Due Dates for Submission**

The due dates and times for each CEP report are specified. The CEP reports should be submitted by the due. Late submissions of CEP reports are not accepted.

❑ **Format of the CEP Report**

Use the word processor, MS Word, for formatting your CEP reports. Submit the word files, not the PDF files.

❑ **Submission**

Submit your CEP report to the course manager, not to the instructor.

6.3. Evaluation Form for CEP Reports

The following form is used to evaluate the CEP report.

Evaluation of CEP Report

Name: 홍길동

Criteria	Max	Earned
Ch.1, Introduction	2	2
Ch.2, (A1) Architectural Requirement Refinement	2	2
Ch.3, (A2) System Context Analysis		
System Boundary Context	3	3
Functional Context	5	5
Information Context	5	5
Behavior Context	5	5
Ch.4, (A3) Skeleton Architecture Design		
Justification of Candidate Architecture Styles	6	6
Integrating Selected Styles into Architecture	2	2
Ch.5, (A4) Architecture with Views		
Applying Functional Viewpoint	8	8
Applying Information Viewpoint	8	8
Applying Behavior Viewpoint	8	8
Applying Deployment Viewpoint	6	6
Ch.6, (A5) Architecture with Quality-driven Design		
Design for NFR #1, Applying Process	8	8
Design for NFR #1, Quality Delivered	7	7
Design for NFR #2, Applying Process	8	8
Design for NFR #2, Quality Delivered	7	7
Ch.7, (A6) Architecture Evaluation		
Intermediate Steps of applying Evaluation	6	6
Correctness of the Evaluation	4	4
CEP Score	100	100

❑ **Strength**

❍

❑ **Weakness**

❍