SKKU Exam Manager

Software Requirement Specification

2021. 04. 25.

Introduction to Software Engineering 41

Team 2 (SKKUEM)

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1. Introduction

1.1. Purpose

This document is a Software Requirements Specification (SRS) for providing new online test program services. This requirements specification is written by Team 2 of the Introduction to Software Engineering at SKKU. This service is designed and implemented to design and implement new programs, and the system is designed and implemented based on the requirements specification.

The main reader of this document is Team 2 of the Introduction to Software Engineering at SKKU. Team 2 develops a new online testing program following this specification. Additionally, professors, assistants, and all students in the Introduction to Software Engineering class can be key readers. If the system is developed as a product in the future, all employees of the related companies may become additional readers.

The purpose of this document is for providing the Requirement Specification of the new online test program, analyze and define software requirements. Compared to traditional online test systems, Our new online test program supports easy UI, one-on-one services, and various functions to prevent cheating. This program uses AI open sources to detect their behavior and prevent them from cheating.

1.2. Scope

In the Covid-19 era, online non-face-to-face lectures are being conducted and online test programs have emerged. The new online test program provides functions that traditional online test programs could not do at a time. It provides an easy UI that can use anyone who gets a little knowledge about the program and a one-on-one system that is not disturbed by other people's noise during the examination. Using AI open sources, an abnormal behavior detection program in new online test programs that the existing system could not provide anti-cheating during testing. Above all, we would like to provide an online test program suitable for non-face-to-face lectures to provide a fairer and more convenient program to continue to use.

1.3. Definitions, Acronyms, and Abbreviation

The following table explains the acronyms and abbreviations used in this document.

[Table 1] Table of acronyms and abbreviations

Acronyms & Abbreviations	Explanation
SRS	Software Requirement Specification
CPU	Central Processing Unit
GHz	Gigahertz
Mbps	Mega Bits Per Second
AMD	Advanced Micro Devices
GUI	Graphic User Interface

RAM	Random Access Memory
SDRAM	Synchronous Dynamic Random Access Memory
UI	User Interface
OS	Operating System
API	Application Programming Interface
DB	Database
DBMS	Database Management System
PK	Primary Key
FK	Foreign Key
ER	Entity Relationship
AWS	Amazon Web Services
EC2	Elastic Compute Cloud
EBS	Elastic Block Store
LTS	Long Term Support
PC	Personal Computer
MP4	MPEG(Moving Picture Experts Group)-4 part 14
SKKU	Sungkyunkwan University

The following table defines certain technical terms used in this document.

[Table 2] Table of terms and definitions

Terms	Explanation
User	Someone who uses a system
System administrator	Someone who hosts class and exams like a professor.
cookies	Small piece of data stored on the user's computer by the web browser.
processor	Digital circuit which performs operations on some external data source, usually memory or some other data stream
Java	a class-based, object-oriented programming language that is designed to have as few implementation dependencies as possible
Active X	Deprecated software framework created by Microsoft that adapts its earlier Component Object Model(COM) and Object Linking and Embedding(OLE) technologies for content downloaded from a network, particularly from the World Wide Web
OpenPose	First real-time multi-person system to jointly detect the human body, hand, facial, and foot key-points on single images.
OpenCV	An open-source computer vision and machine learning software library.
WebRTC	An open-source project providing web browsers and mobile applications with RTC(real-time communication) via simple application programming interfaces.
Database	An organized collection of data, generally stored and accessed electronically from a computer system.
MySQL	An open-source relational DBMS.
iOS	A mobile OS developed by Apple Inc.
jQuery	An open-source JavaScript library designed to simplify HTML DOM tree traversal and manipulation, as well as event handling, CSS animation, and Ajax.

1.4. References

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1.5. Overview

The composition of this document is as follows. Overall Description provides a general overview of the new online testing program services. To that end, we look at the prospects of the deliverables and their detailed functions, user characteristics, constraints, assumptions and dependencies, and more. Specific Requirements explores the detailed requirements of new online testing program services. External interface requirements and performance requirements, design constraints, software system characteristics, and other requirements are discussed in each section. Functional requirements include data flow charts and process techniques, data structure specifications, and data dictionaries.

2. Overall Description

2.1. Product Perspective

This product is designed for complementing the non-face-to-face classes caused by Corona because programs such as the existing Webex are not suitable for taking tests. This program allows students to use a one-on-one system that allows them to access via the program and eliminate noise from other students when taking tests, which relieves students' inconvenience. The AI open source can also be used to capture students' eyes and movements through a cam installed on a laptop to determine whether they are doing cheating or not. Since the end of the test, recorded videos of students are stored in a database so that professors and assistants can understand this.

2.1.1. System Interfaces

Video conferencing-related functions are implemented in the form of API using WebRTC and OpenCV/OpenPose on the Backend side. This is linked to the AWS database via the Node.js server to store recorded images and motion detection and analysis data. It sends stored data to the school database so that professors and assistants can check the results. We also provide data through the Rest API so that these results can be seen within our new online testing program. We consider AWS servers and rds in preparation for future system growth.

2.1.2. User Interfaces

Users can be divided into users and administrators. First of all, users can be seen as students who use it to take the test, and students connect to the meeting with the link or number that the professor prescribed, such as using the existing video conference program. When I take a test in front of the camera, the motion detection function is automatically executed and my appearance is recorded.

In the case of administrators, they will be professors or assistants who host tests and manage lectures. When the system provides students with a meeting room link, and tests are conducted, administrators can automatically view motion analysis data and student images in real-time. Also, they can view recorded videos and data in the database afterward.

2.1.3. Hardware Interfaces

Server(AWS EC2 - T2)

- Instance: t2.large
- vCPU: 4
- CPU credit per hour: 36
- Memory(Gib): 8
- Storage: EBS exclusive use
- Performance of Network: Low to Medium

Client

- CPU: intel Core2 Duo CPU 2. XX GHz or AMD processor(2GB of RAM recommended)
- JavaScripts and cookies enabled.
- Activex enabled and unblocked for Internet Explorer(recommended)
- Java 1.6. 0_33 to Java 1.6. 0_35 or Java 1.7. 0_5 to Java 1.7. 0_7.

2.1.4. Software Interfaces

Server

- OS: Linux Ubuntu 18.04 LTS
- GUI and Development environment: Visual Studio Code, Javascript, AWS
- DBMS: MySQL 5.x, AWS Database, AWS EC2

Client

- OS: Anything like mac, windows, etc.
- GUI and Development environment: Development tools of Google Chrome browser

2.1.5. Communications Interfaces

Server: 100Mbps Ethernet

Client: 802.11/a/b/g wireless network(recommended)

2.1.6. Memory Constraints

Server: More than SDRAM 4GB

Client: More than SDRAM 2GB

2.1.7. Operations

2.1.7.1. System administrator

- Creating a video conference room link
    - To invite students, administrators should provide a link.
    - Can use functions such as one-on-one rooms and a full room link.
- Hosting an exam
    - Click the start test button to start the test.
    - Automatically activate screen motion detection and recording when the test is started
- Checked recorded video
    - After the test, recorded images and data can be viewed in the program.
- View User Screen
    - Check the user screen through the cam.
- Student administration during the exam.
    - Can check student motion through AI motion detection functions.
- Verifying user information

2.1.7.2. User

- Login : Users can log in using GLS login.
- Enter the video conferencing room for the test. : User can enter the room by typing test code
- Writing messages in the room.
- Sharing Screen
- Recording Screen
- Real-time motion detecting

2.2. Product Functions

2.2.1. Identity Verification

The user will be greeted with a login screen whether they accessed the service through the native mobile client or the web application. The login screen has two sections: one for the students, the other one is for the administrators. The users can then log in by entering their ID and password that they use for SKKU services.

2.2.2. Test Code Verification

After the user logs in as a student, the user has to enter the code they received from the administrator for the exam they are taking. The test code is generated by the program after the administrator creates the exam paper. If the given test code is stored in the database, it would share the screen of the student and show the student the exam questions if the student is accessing the service via a web client, or it would record a video if it is accessed through a phone.

2.2.3. Screen Sharing and Video Recorder

While taking an exam, the program would either take a video of the active screen of the student's computer or a video containing the student's face. The program is run as a web service and as a mobile application respectively. It sends the videos to the administrator.

2.2.4. Taking an Exam

The students answer the questions of the exam while being recorded (refer to 2.2.3) during the exam. At the same time, the administrators would supervise the exam.

2.2.5. Managing an Exam

Administrators can create a new exam, upload the questions, and save it. Any administrator can look at the questions and edit them even after the exam has been created.

2.2.6. Check recorded videos

During the exam and after the exam has been taken, the administrators of the exam can check the captured screen and the video of all the students.

2.3. User Characteristics

2.3.1. Administrator (User)

The administrator user refers to anyone in charge of the exam, who is usually a professor or a teaching assistant. They have enough knowledge of the system to manage an exam and supervise students during exams. They are assumed to have an existing account in the SKKU database. It is assumed that the administrator is in charge of the course that offers the exam online. It is assumed that the administrator can read or understand English or Korean, and that they can easily download an application or access a website.

2.3.2. Student

The student referred to in this document is any student who is currently enrolled in SKKU. The student is assumed to have an existing student account in the SKKU database. It is assumed that the student is taking a course where the exam is offered online. It is assumed that the student can read or understand English or Korean, and that they can easily download an application or access a website.

2.3.3. User

The user referred to in this document is any student or administrator who has an existing account in the SKKU database. It is assumed that the user is either taking or in charge of a course where the exam is offered online. It is assumed that the user can read or understand English or Korean, and that they can easily download an application or access a website.

2.4. Constraints

- The following are the constraints when developing the system:
    - Use free/libre open-source software as much as possible
    - Avoid the use of proprietary software when possible
    - Keep the system as dependable as possible
    - Optimize the system while minimizing premature optimization
    - Consider future scalability of the system where the system would be offered in other universities and institutions.
    - Test the system as much as possible to reduce any unexpected bugs
    - Make the system as secure as possible to prevent any exploits
    - Keep the “Don't Repeat Yourself” principle by using the same backend and mostly similar frontend for the system
- The following are the constraints for users:
    - An internet connection is required.
    - Access to a camera is required.
    - The minimum specifications required are an Intel Core 2 Duo CPU 2.XX GHz or an AMD processor, with at least 2GB RAM for the PC and the phone.
    - The operating system required for the PC is any operating system that supports screen-sharing and has a browser that is HTML-5 compliant and supports at least ES6. The operating system required for the phones is any operating system that is supported by React Native, which is Android and iOS. The minimum version required for Android is Android 5.0 (Lollipop) while the minimum version required for iOS is iOS 11.0.

2.5. Assumptions and Dependencies

The assumptions and dependencies for this system are the following:

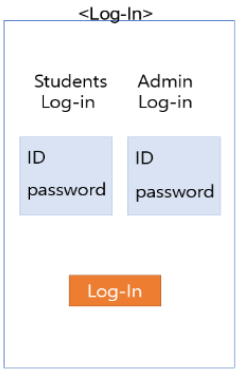
- Assumptions
    - It is assumed that the system is allowed to use the database of Sungkyunkwan University to authenticate the user.
    - It is assumed that the exam code would be given to the students by the administrators themselves via the iCampus system before the exam.
- Dependencies
    - As a web application, the user has to have access to the internet and have a client that supports the application. This client can be the native application for mobile devices and a web browser that is HTML5- and ES6-compliant for other devices.
    - The following are dependencies required for the project:
        - React would be used for developing the website.
        - React Native would be used to create a native application for mobile devices.
        - WebRTC, NodeJS, AWS, OpenCV, and OpenPose would be used for the backend server.

3. Specific Requirements

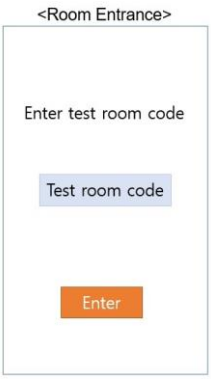
3.1. External Interface Requirements

3.1.1. User Interfaces

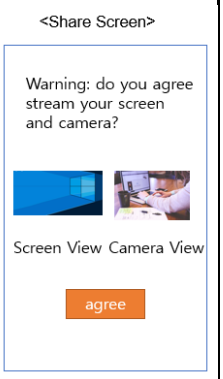
[Table 3] User interface of Log-in

Name	Log-in
Purpose/Description	Users are asked questions whether they are students or admin to determine the next operation Users are identified by entering their ID and password.
Input source/ Output destination	Client / Host server
Range/ Accuracy/ Margin of error	N/A
Unit	Page
Time/ Velocity	Asynchronous user input/ Communication time between the server and the user device
Relationship with other input/outputs	user identity affect exam paper access authority and make a test room option
Format and configuration of screen	1. There are two sections to Log-in, one is for students and the other is for admin 2. When the user clicks the Login button after typing their ID and password, they can start using the system. 
Data type	int type value of a button code
Instruction type	Instruction mapping according to the value of a button code
Exit message	N/A

[Table 4] User interface of Room Entrance

Name	Students Interface 1 - Room Entrance
Purpose/Description	Students are asked questions about the test room number to enter
Input source/ Output destination	Client / Host server
Range/ Accuracy/ Margin of error	N/A
Unit	Page
Time/ Velocity	After all the input data were received to the user device/Communication time between the server and the user device
Relationship with other input/outputs	When the user write down a test room code, it affects which exam paper data is shown and who is the users' admin
Format and configuration of screen	1. At the top of the screen, text notify students to write test room code 2. At the center of the screen, Empty text box to write test room code 3. At the bottom of the screen, Enter button exists. When the user clicks this button, test room code data send to the server 
Data type	int type value of a button code, text
Instruction type	Instruction mapping according to the value of a button code
Exit message	N/A

[Table 5] User interface of Share Screen

Name	Students Interface 2 - Share Screen
Purpose/Description	notify the user that the system will stream the user's current screen and camera view to other users and seek an agreement from the user.
Input source/ Output destination	Client / Host server
Range/ Accuracy/ Margin of error	N/A
Unit	Page
Time/ Velocity	After all the input data were received to the user device/Communication time between the server and the user device
Relationship with other input/outputs	N/A
Format and configuration of screen	1. At the top of the screen, warning text is exist 2. There are two sections, one show current screen and the other show camera view 3. At the bottom of the screen, agree button exists 
Data type	int type value of a button code, video
Instruction type	Instruction mapping according to the value of a button code
Exit message	N/A

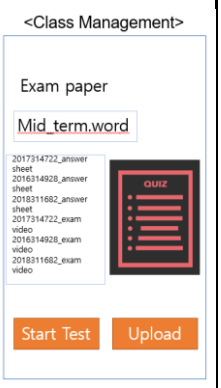
[Table 6] User interface of Test

Name	Students Interface 3 - Test
Purpose/Description	the user received a test paper and take an exam after the exam client send test data to the server
Input source/ Output destination	Host server / Client Client / Host server
Range/ Accuracy/ Margin of error	N/A
Unit	Page
Time/ Velocity	After all the input data were received to the user device /Communication time between the server and the user device
Relationship with other input/outputs	the test video is created in this phase.
Format and configuration of screen	1. Test section which is connected to the exam paper 2. Answer section which user write down their answer 3. camera view shows students feature 4. when the user finishes the test, the user click Submit button and then the Answer section data send to the server and the screen streaming data transition is over 
Data type	int type value of a button code, text, video
Instruction type	Instruction mapping according to the value of a button code, text
Exit message	Test is over

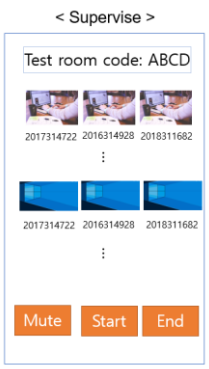
[Table 7] User interface of Choose Class

Name	Admin Interface 1 - Choose Class
Purpose/Description	Admin is asked which class you want to manage. If the admin selects one class, sand this data to the server.
Input source/ Output destination	Host server / Client Client / Host server
Range/ Accuracy/ Margin of error	N/A
Unit	Page
Time/ Velocity	After all the input data were received to the user device /Communication time between the server and the user device
Relationship with other input/outputs	It affects exam paper data
Format and configuration of screen	1. Grid format of Class which shows their information. (ex. class name, professor name) 2. User can click the class name, be directed to the class management page 
Data type	Query,text
Instruction type	N/A
Exit message	N/A

[Table 8] User interface of Class Management

Name	Admin Interface 2 - Class Management
Purpose/Description	Admin manages the specific class exam. Admin can upload test paper, or download recorded test video and answer sheet. Admin can open test room
Input source/ Output destination	Host server / Client Client / Host server
Range/ Accuracy/ Margin of error	N/A
Unit	Page
Time/ Velocity	After all the input data were received to the user device /Communication time between the server and the user device
Relationship with other input/outputs	It handles exam paper data, recorded test video, students answer sheet
Format and configuration of screen	1. There are three sections, one is for exam paper and another is for past test materials which are recorded test video and answer sheet and the other is a view for uploaded file 2. if the admin click the Upload button, the admin can upload the exam paper file from the admin`s device 3. if the admin click the Start test button, the admin can open a test room for that exam paper 4. In the past test material section, the admin can download recorded test videos or answer sheets by clicking the file 
Data type	Query,video,text,int type value of a button code
Instruction type	Instruction mapping according to the value of a button code
Exit message	N/A

[Table 9] User interface of Supervise

Name	Admin Interface 3 - Supervise
Purpose/Description	Admin checks test room code and announce it to students. Admin supervises students in the test room receiving students' test records on PC and smartphone. In the Host server, the motion-detecting program runs on time and alerts the Host if they got cheating.
Input source/ Output destination	Host server / Client Client / Host server
Range/ Accuracy/ Margin of error	N/A
Unit	Page
Time/ Velocity	Communication time between the server and the user device
Relationship with other input/outputs	the test video is transmitted to the admin from the user
Format and configuration of screen	1. Gridview of students' test video. 2. If the admin click one view of a student, then enlarge that view 3. If a motion detection alarm coming, highlight the suspicious view 4. There are three buttons, one is for mute, another is for start the exam and the other is for the end test room 
Data type	Query, video, int type value of a button code
Instruction type	Instruction mapping according to the value of a button code
Exit message	N/A

3.1.2. Hardware Interfaces

[Table 10] Hardware Interfaces of Applicable device for the system

Name	Applicable device for the system
Purpose/Description	minimum specification to use the service safely provided by the system//Android OS or iOS Enabled Smartphone which can use at least one camera. PC with at least Intel Core 2 Duo CPU 2. XX GHz or AMD processor (2 GB of RAM recommended). And the system supports all chrome devices.

3.1.3. Software Interfaces

[Table 11] Software Interfaces of AWS Real-time Database

Name	AWS Real-time Database
Purpose/Description	Query input/output for managing multimedia/metadata
Input source/ Output destination	Host server/ User, User/Host server
Range/ Accuracy/ Margin of error	Depends on the performance of the AWS
Unit	Query
Time/ Velocity	Instant reaction
Relationship with other input/outputs	Related to all inputs/outputs from the server
Format and configuration of screen	N/A
Format and configuration of window	N/A
Data type	Query
Instruction type	Query statement
Exit message	N/A

3.1.4. Communication Interfaces

[Table 12] Communication Interfaces of Client and Host

Name	Client and Host
Purpose/Description	Each client requests the connection to the host, requesting an exam paper and exam room code. The Host provides an exam paper and exam room information to the client. clients send their video to the other client. clients upload the exam paper to the host or send it to other clients.
Input source/ Output destination	Host server/ User, User/User, User/Host server
Unit	packet
Time/ Velocity	At least 100Mbps
Relationship with other input/outputs	Related to all inputs/outputs from the server
Format and configuration of screen	N/A
Format and configuration of window	N/A
Data type	Query,video,text
Instruction type	Query statement
Exit message	N/A

3.2. Functional Requirements

3.2.1. Use Case

[Table 13] Use Case of Log-In/Out

Use case name	Log-In/Out
Actor	Students, Admin
Description	Log-in is a process when a user tries to get into the system for using the service Log-out is a process when a user tries to get out of the system for using the service
Normal Course	<Log-In> 1. school members are already registered in SKKU DB 2. students or admin enter ID and password 3. If the information set is correct, the system allows the user to get into the system and the user is now able to take advantage of all the service provided by the system <Log-Out> 1. If the user closed the application without logging out, the system arbitrarily closes the session for that user
Precondition	<Log-Out> The user should be in a logged-in status
Post Condition	The user is connected to the Host server
Assumptions	N/A

[Table 14] Use Case of Room Entrance

Use case name	Room Entrance
Actor	Students
Description	This is a process that Students try to enter the test room
Normal Course	1. Admin announces test room code to students 2. Students enter their test room code

Precondition	Students should be connected to the Host server and logged-in status The test room should be opened by the admin
Post Condition	Students are connected to the test room
Assumptions	N/A

[Table 15] Use Case of Share Screen

Use case name	Share Screen
Actor	Students
Description	This is a process that warning students before sharing their screen
Normal Course	1. A text warning message is shown to students 2. Screen view and camera view are shown 3. If students are ready, click Agree button
Precondition	Students should be connected to the test room
Post Condition	The student`s current screen data and camera view should be delivered to the server
Assumptions	the camera device is available

[Table 16] Use Case of Test

Use case name	Test
Actor	Students
Description	This is a process that students take an exam in the test room.
Normal Course	1. Students enter the test room 2. When students are ready admin open the exam paper 3. Students write answers in the answer section 4. When students finish the exam students click submit button, then the answer section text is transmitted to the Host server

	5. Students video data transmissions which are computer screen and students feature both are over
Precondition	Students should be connected to the test room Student`s current computer screen data and students feature data should be delivered to the server
Post Condition	Students are disconnected from the test room Students' answer sheet is delivered to the server
Assumptions	N/A

[Table 17] Use Case of Choose Class

Use case name	Choose Class
Actor	Admin
Description	This is a process that admins can see their class information and choose what to manage
Normal Course	1. Admin can see classes that the admin manages and their brief information. if the admin doesn`t manage any class, it shows nothing 2. Admin click class what Admin want to manage
Precondition	Admin should be connected to the Host server and logged-in status
Post Condition	Chosen class data is delivered to the server
Assumptions	N/A

[Table 18] Use Case of Class Management

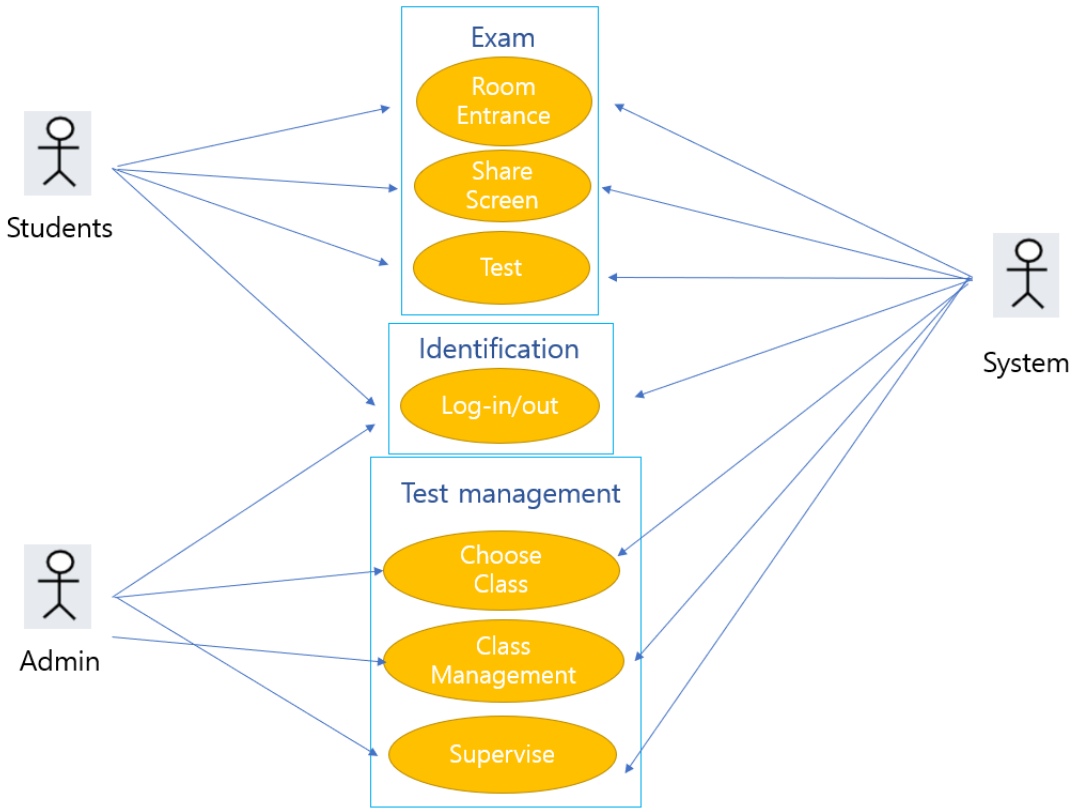
Use case name	Class Management
Actor	Admin
Description	In this phase, the admin can manage the class. Admin can upload an exam paper and see recorded test videos and answer sheets. Also, the admin can open a test room on this page

Normal Course	1. Admin click the upload button and search exam paper file, if there is an exam paper which is uploaded earlier then changed the new one 2. Exam paper file is delivered to server and uploaded in exam paper section 3. In the past test material section, admin can download test video or student answer sheet 4. Admin can start test room for uploaded exam paper
Precondition	the Host server should have chosen class data
Post Condition	Exam paper data is delivered to the server
Assumptions	Admin upload new exam paper There are past test Admin download test video and student answer sheet

[Table 19] Use Case of Supervise

Use case name	Supervise
Actor	Admin
Description	In this phase, the admin supervise students watching test video
Normal Course	1. Admin open test room in Class Management phase 2. Admin announces test room code to students 3. Students enter the test room and show their computer screen and feature 4. Admin check student`s test videos and if there is no problem, then start test 5. Admin supervise students one by one 6. When all students submit answer sheet or exam time is over, admin close test room
Precondition	the Host server should have chosen class data and exam paper data
Post Condition	The test room is closed Students answer test video is delivered to the server
Assumptions	N/A

3.2.2. Use Case Diagram



[Figure 1] Use case diagram

3.2.3. Data Dictionary

[Table 20] User_Student

Field	Key	Constraint	Description
ID	PK	Not NULL	student_user_id(i-Campus)
password		Not NULL	i-Campus student password
SSN		Not NULL	student own number
name		Not NULL	student name

[Table 21] Class

Field	key	Constraint	Description
ID	PK	Not NULL	Class ID
name		Not NULL	Class name

[Table 22] User_Administrator

Field	Key	Constraint	Description
ID	PK	Not NULL	Administer ID
password		Not NULL	Administer PW
name		Not NULL	Administer name

[Table 23] Administrator_Class

Field	Key	Constraint	Description
Class_ID	PK/FK	NOT NULL	table “Class” Class ID
Administrator_ID	PK/FK	Not NULL	table “User_Administer” ID

[Table 24] Exam paper

Field	Key	Constraint	Description
ID	PK	Not NULL	test “Exam paper” own id
Class_ID	PK/FK	Not NULL	table “Class” own id
Content		Not NULL	test
time		Not NULL	test due date and time

[Table 25] Test code

Field	Key	Constraint	Description
Class_ID	FK	Not NULL	table “Class” ID
Paper_ID	FK	Not NULL	table “Exam_paper” ID
Administrator_ID	FK	Not NULL	table “User_Administrator” ID
tc_code	PK	Not NULL	Test own primary code

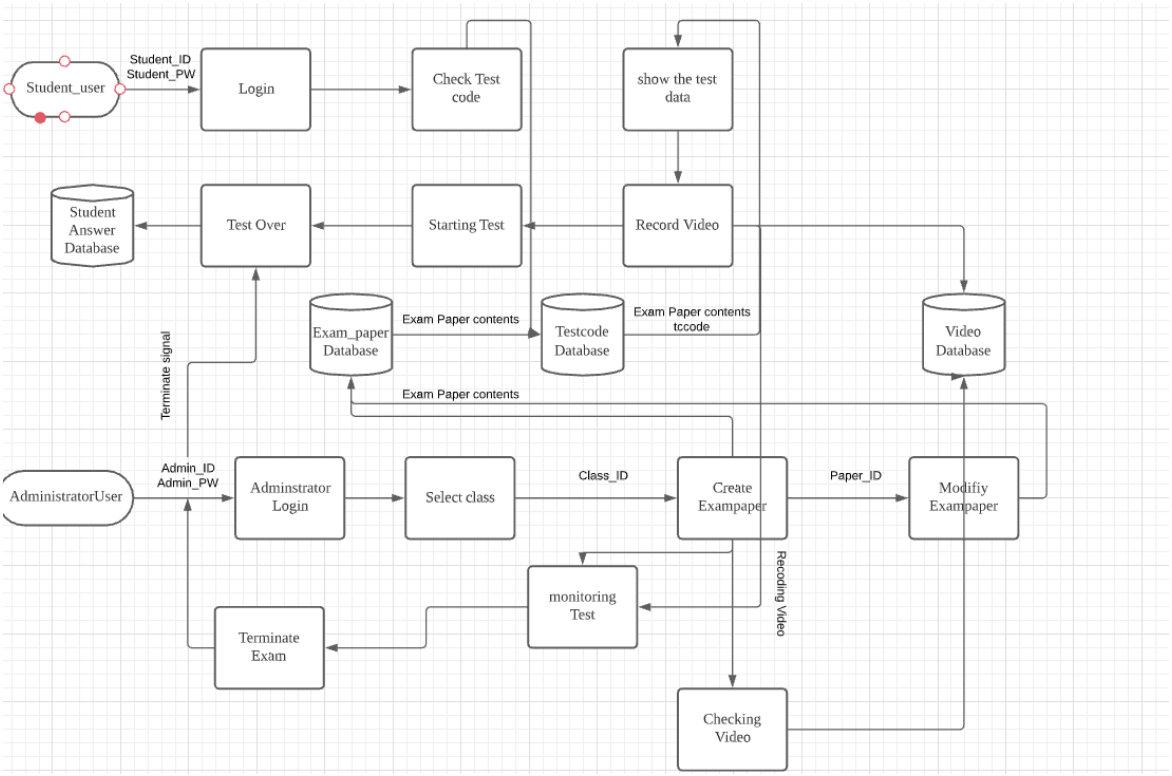
[Table 26] Video code

Field	Key	Constraint	Description
tc_code	PK / FK	Not NULL	table “test” own PK
Student_ID	PK/FK	Not NULL	table “User student” own PK
pc_contents		Not NULL	recorded video from PC.
phone_contents		Not NULL	recorded video from Mobile

[Table 27] Student_Answer

Field	Key	Constraint	Description
Class_ID	PK/FK	Not NULL	table “Class” own id
Paper_ID	PK/FK	Not NULL	table “Exam_paper” own id
Student_ID	PK/FK	Not NULL	table “User student” own id
content			student answer of test

3.2.4. Data Flow Diagram



[Figure 2] Data Flow Diagram

3.3. Performance Requirements

3.3.1. Static numerical requirement

- System management tools support only one administrator.
- The system supports simultaneously Administrator user and student user for each mobile and PC. The system supports 1:1 connections with the Administrator user's PC with the mobile and the PC of the student user.
- The system prevents the connection between student user's devices.
- The system should run smoothly on a PC with at least Intel Core2 Duo CPU 2. XX GHz or AMD processor (2 GB of RAM recommended). And the system supports all chrome devices.

3.3.2. Dynamic numerical requirement

- It should be able to accommodate about 5000 simultaneous connections. And the system has 30000 user profiles through i-Campus. (Number of Enrolled Students at SKKU in 2015 : 27000)
- Answers should be frequently backed up to the DB every 10 seconds between students taking an exam.
- Video information transmitted from PC and mobile must be backed up to DB once every 10 seconds.
- The application should run within 5 seconds when the test is started.
- The application should be closed within 5 seconds when the test is terminated.

3.4. Logical Database Requirements

For this system, AWS which provides a clouding web service will be used to manage and store data. It should accept data of students, teaching assistants, professors' basic information which includes name, student id, id, password, and class, test information, recorded videos. Videos will be recorded in real-time, so during exams, any other access to record test videos must not be allowed and test papers also cannot be allowed before tests except test administrators. If the students change to offline mode during the exam, the recorded video should be stored in each laptop until the network connection resumes and it cannot be transformed. Many students will use the program simultaneously, so a lot of queries can be required to one database. The number of queries should not affect the time to process and any other constraints must be satisfied.

3.5. Design Constraints

There are two types to be needed which one is for PC, and the other one is for mobile devices. But, for teaching assistants, all information from students' PC and mobile phone should be shown. The system should distinguish the information from PC and mobile phones. The system should be compatible with AWS. Also, for systems, OpenPose which is open source will be used. So this system should be granted a non-exclusive, non-transferable license.

3.6. Standards compliance

For developing systems, programs are written with JavaScript standard to use WebRTC and Node.js. This standard saves no configuration, automatically format code, catches style issues and programmer errors early. Also, all videos are stored as MP4 extensions for efficiency of the size of storage and support for streaming through the internet. For following JavaScript programming standards, the system should adapt jQuery guidelines.

3.7. Software System Characteristics

This part describes some non-functional requirements. There are product requirements, usability requirements, organizational requirements. These non-functional requirements can specify software system characteristics and affect overall architecture. Our system should satisfy the following requirements.

3.7.1. Product Requirements

A product requirements document contains all the requirements for a specific product. What the product should do is written so that people can understand. Our system should satisfy the following requirements.

3.7.1.1. Usability Requirements

This part is one of the most important requirements because our system must ensure stable, safe programs for users. Including network connection, the functions are organized to minimize errors. Also, for taking exams, time is the most important, so there shouldn't be time wasted by the user's immaturity. Therefore, the design of the system should be intuitive and easy to use, this means understanding the way to use should not be needed. Our system encompasses all about functions and processes step by step automatically while users use our system to minimize user's intervention, and this induces minimizing human behavior errors.

3.7.1.2. Performance Requirements

Our product should guarantee stable real-time connection regardless of the number of students who take an exam. All recorded videos have to be stored for the specified time in the designated database completely. Also, our analyzing motion program should work well, and there should not exist a time delay.

3.7.1.3. Usability Requirements

Tests can be opened whenever test administrators who are teaching assistants or professors want, and students have to access tests at only the proposed time. All students are ensured with a completely fair environment. The average ratio of network connection errors that occurred shall not exceed 1 percent.

3.7.1.4. Security Requirements

The users should be properly authenticated before using the system. People who are not Sungkyunkwan university students and who don't take classes cannot be accessed to tests. Also, the test paper should not be accessed except test administrators through any other ways and the test time specified by test administrators shall be maintained. All recorded videos and test answers for each student cannot be deleted and modified without the test administrator's command.

3.7.2. Organizational Requirements

Organizational requirements are a consequence of organizational policies and procedures like process standards used and implementation requirements.

3.7.2.1. Environmental Requirements

Our system gets information of students, teaching assistants, and professors' basic information like student id, i-Campus id, password, classes, etc through Sungkyunkwan university's i-Campus database. If there are information changes in a college's database, it has to be reflected in our database in real-time. Also, the college's database shall be maintained independently from our database, this means our data should not affect to i-Campus database. Our database will be evidence of grades, so the schema of the database should have a structure that fits it.

3.7.2.2. Operational Requirement

The system should ensure stable connections in real-time during the exam. Logging like when students start connection, recording environment, network error issue should be stored. Also, for efficiency of resource consumption, the past semester's videos can be deleted.

3.7.3. External Requirements

External requirements arise from factors that are external to the system and its development process like interoperability requirements, legislative requirements. External requirements are based on application domain information, organizational considerations, even basic natural laws such as the laws of physics.

3.7.3.1. Safety / Security Requirement

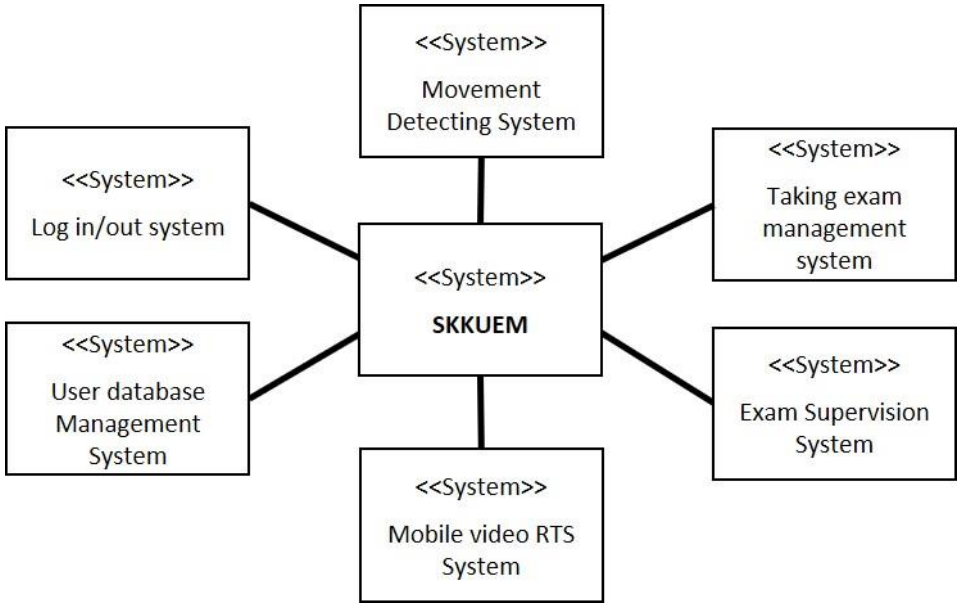
Confidential information should not be accessed by external systems. During exams, recorded videos cannot be modified, and before exams test papers cannot be accessed. After the exam, any modification authority shall be given to only test administrators. The system should accept any changes and protect confidential data from external damages.

3.7.3.2. Regulatory Requirement

This system should be managed by Sungkyunkwan University. All programs should be developed in college regulations. OpenPose which is open-source used to check strange behavior, by this open-source license, the licensor retains exclusive ownership of any copy of the software license and grants to Licensee a personal, non-exclusive, non-transferable license for noncommercial research purposes, without the right to sublicense, pursuant to the terms and conditions.

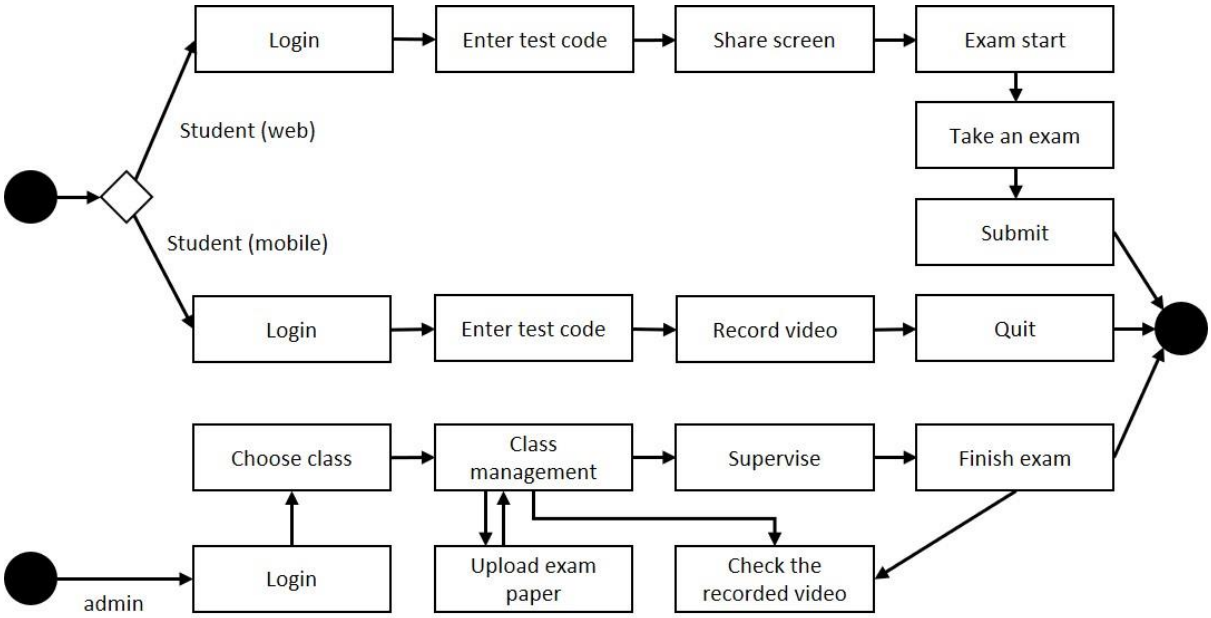
3.8. Organizing the Specific Requirements

3.8.1. Context Model



[Figure 3] Context Model

3.8.2. Process Model



[Figure 4] Process Model

3.8.3. Interaction Model

See 3.2.2. Use case Diagram

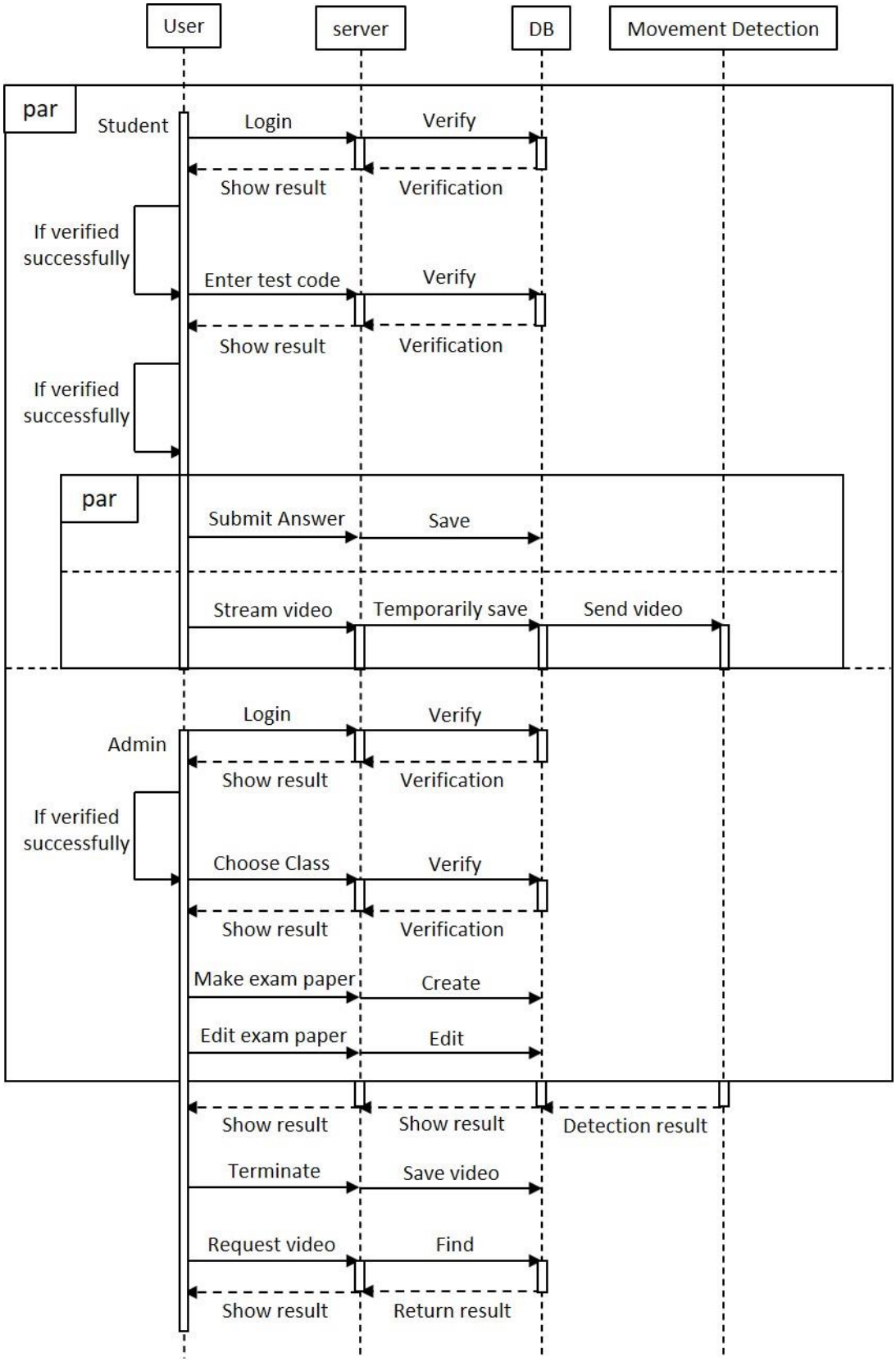
3.8.4. Behavior Model

3.8.4.1. Data Flow Diagram

See 3.2.4. Data Flow Diagram

3.8.4.2. Sequence Diagram

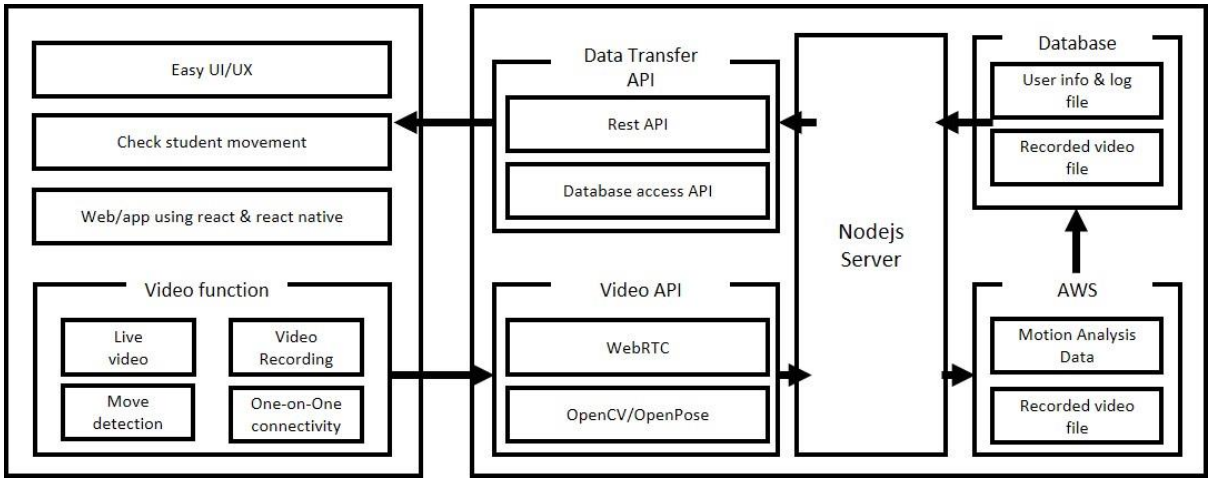
This diagram describes the sequence of main system processes during exam time.



[Figure 5] Sequence Diagram

3.9. System Architecture

This figure shows an overview of our system architecture.



[Figure 6] System Architecture

3.10. System Evolution

This section is about the limitations and assumptions on which our system is based. Also, anticipated changes of user requirements and evolutions of hardware. This will be helpful to design considering future changes.

3.10.1. Limitation and Assumption

It is assumed that Sungkyunkwan University's database is one of the foundations of our system. In other words, basic information about members, such as students' and administrators' IDs and passwords, is based on the university's database. Therefore, membership registration or admin class information cannot be modified or added in the own system.

Our system transmits the video required for real-time testing and supervision. However, it does not manage student's class information. This is because we assume that our system runs in parallel with the currently running i-campus notification method. Each test code is announced through i-campus, and students in the class access the test through it. Therefore, the task of checking the student's class information to see if he or she has permission to access the test code is omitted.

3.10.2. Evolutions of Hardware and Change of User Requirements

Computer-vision technology continues to evolve. Therefore, it is expected that continuous evolution of the details of the motion detecting system will occur. You need to be prepared for changes in this area.

When the Covid-19 situation ends, the frequency of online exams at universities is expected to decrease significantly. However, our system can be applied not only to online exams at universities but also to exams administered by other institutions, in case of unavoidable circumstances. When the user group is changed in this way, a new user requirement may arise to enable management through membership registration, linking an external database for member information. It would be nice to take this into account.

4. Supporting Information

4.1. Software Requirement Specification

This software requirements specification was written in accordance with the IEEE Recommendation (IEEE Recommended Practice for Software Requirements Specifications, IEEE-Std-830).

4.2. Document History

[Table 28] Document History

Date	Description	Writer
4/18	write 3.2.3. ~ 3.3. part	Seungyeon Cho
4/19	write 1. ~ 2.1. part	JeongMin Lee
4/19	write 3.8. ~ 3.9. part	Kyunghee Ko
4/21	write 3.10. part	Kyunghee Ko
4/21	write 3.4 ~ 3.7. part	Eunsu Kang
4/22	write 3.1. ~ 3.2.2. part	Hyungjoon Joo
4/22	write 2.2. part	Luke
4/24	Edit 3.8. diagram, correct overall typo	Kyunghee Ko
4/25	Edit 3.7.3.	Eunsu Kang
4/25	Edit 3.3.	Seungyeon Cho
4/25	write 2.3. ~ 2.5. part	Luke
4/25	Correct overall typo	Kyunghee Ko