Verification and Validation Report: SFWRENG 4G06 Capstone Design Project

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1 Revision History

Date	Developer(s)	Change
Mar 6	Qi Shu	Add "Comparison to existing implementations section" and "Changes due to Testing" section.
Mar 6	Anhao Jiao, Xunzhou Ye	Add "FR Eval" and "NFR Eval" section.

2 Symbols, Abbreviations and Acronyms

symbol	description
T	Test

[symbols, abbreviations or acronyms – you can reference the SRS tables if needed —SS]

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3 Functional Requirements Evaluation

FR-T1 **Initial State** Client application is running on the user's device, but the user didn't do any operations yet.

Input/Condition User clicks on the applicable identity(instructor/practitioner) button

Expected Output The live stream video window pops out on the user's screen.

Actual Output The live stream video window shows on the instructor's screen, it doesn't show on the practitioner's screen.

Result Fail

FR-T2 **Initial State** Application running on user's computer, and the user has clicked on "the instructor identity button" to indicate they are a TaiChi instructor. A window asking for permission to use the camera on the instructor's device popped out.

Input/Condition User allow/deny the webcam permission

Expected Output The webcam on the instructor's device is turned on

Actual Output The webcam on the instructor's device is turned on after allowing webcam permission, and the webcam is not turned on after denying permission.

Result Pass

FR-T3 **Initial State** both client applications and the server are running.

Input/Condition The user clicks on the applicable identity button to indicate they are an instructor or a practitioner.

Expected Output A log message indicates connection between the user's device and the server has been established.

Actual Output Log message confirms a successful connection between the user's device and the server for both instructor and practitioner.

Result Pass

FR-T4 **Type** Functional, Dynamic, Automated

Initial State The live stream Window for practitioners.

Input/Condition The user's device has established a connection with the server as a practitioner device.

Expected Output A request from the client device to the server for accessing the list of available annotation configuration.

Actual Output The client device sends a request to the server for the list of available annotation configurations.

Result Pass

FR-T5 **Initial State** The selectable list of the type of annotations is rendered on the user's screen.

Input/Condition Practitioner's selection on the list of types of annotations.

Expected Output A request(that reflects user's annotation selection) from the client device to the server for updating the annotation configuration, with a log indicating the request is sent.

Actual Output The client device sends the selected annotation configuration update to the server, and a log entry confirms the request was sent.

Result Pass

FR-T6 **Initial State** The system is running and actively connected to practitioners.

Input/Condition Practitioners initiate updates to annotation configurations.

Expected Output The system receives and processes the updated annotation configurations.

Actual Output The server gets the request and user sees the annotation they selected.

Result Pass

FR-T7 **Initial State** The server is running and actively receiving annotation configuration updates.

Input/Condition In a controlled test environment, the practitioner-client initiates the update of an annotation configuration. The update is sent to the server for processing.

Expected Output The expected result is that the server correctly processes the received annotation configuration from the practitioner-client.

Actual Output The server is not able to receive annotation configuration updates while the connection has been established.

Result Fail

FR-T8 **Initial State** The server has received and processed the annotation configuration.

Input/Condition The server uses the received annotation configuration to configure machine learning pipelines.

Expected Output The machine learning pipelines are arranged and configured based on the annotation configuration.

Actual Output The server successfully arranges and configures machine learning pipelines according to the received annotation configuration.

Result Pass

FR-T9 **Initial State** The machine learning pipelines are configured and active.

Input/Condition The instructor's video stream is processed with the annotation configuration.

Expected Output The instructor's video stream is rendered with annotations.

Actual Output The instructor's video stream is processed with the annotations.

Result Pass

FR-T10 **Initial State** The server is actively connected to practitioner clients.

Input/Condition The annotated video stream is generated and ready for transmission.

Expected Output The annotated video stream is transmitted to each practitioner-client through their established connections.

Actual Output The annotated video stream is transmitted to practitioner clients.

Result Pass

FR-T11 **Initial State** The signaling server is running.

Input/Condition Signaling requests for WebRTC connections are initiated.

Expected Output The signaling server consistently responds to requests and establishes WebRTC connections.

Actual Output The signaling server responds to most requests and establishes WebRTC connections

Result Pass

FR-T12 **Initial State** The client application is running, but the user didn't do any operations yet

Input/Condition The user joining video stream session.

Expected Output A button to identify if a user is an instructor or a practitioner is rendered.

Actual Output The button to identify a user as an instructor or a practitioner is rendered without issues

Result Pass

4 Nonfunctional Requirements Evaluation

NFR-T1 **Initial State** The system is in a typical operational state with all components and services running, including the user interface.

Input/Condition User interactions such as button clicks and menu selections.

Expected Output The user is able to interact with the client application and understand the response from and results yielded by the system.

Actual Output All 5 users are able to successfully interact with the application with understandable responses and results from the system.

Result Pass

NFR-T2 **Initial State** The system is in a typical operational state with all components and services running, including the user interface.

Input/Condition User interactions such as button clicks and menu selections.

Expected Output System response to user interactions.

Actual Output The system responds to user interactions promptly and correctly.

Result Pass

NFR-T3 **Initial State** The system is in a stable operational state with necessary services and components active. No users are currently logged in.

Input/Condition 5 test accounts (or more) for users. Predefined user actions/scripts (relevant to normal system interactions during peak periods).

Expected Output The system remains stable and responsive. All user transactions are processed successfully.

Actual Output The system remains stable and responsive with all user transactions processed successfully.

Result Pass

NFR-T4 **Initial State** The system is operational, with all services and components running. User accounts for test are set up, and no tasks are being performed.

Input/Condition Erroneous user input data. Improper user actions.

Expected Output The system detects and rejects invalid inputs or actions, providing clear and helpful error messages to the user. Transactions or actions are either rolled back safely or do not proceed until valid input is provided.

Actual Output No invalid inputs can be made within the system.

Result Pass

NFR-T5 **Initial State** The system, with the SFU component, is in a stable, operational state. Initially, there is a base number of video streams being processed, which is within the SFU's current capacity.

Input/Condition A load testing tool or custom script capable of simulating multiple, simultaneous video streams.

Expected Output The SFU successfully processes an increasing number of video streams.

Actual Output The SFU processes an increased number of video streams, which was up to 5 users without significant issues.

Result Pass

NFR-T6 **Initial State** This system is in a typical operational state with all components and services running, the user is in a live session.

Input/Condition Network Interruption/Network Resumption

Expected Output The system attempts to resume the previous session.

Actual Output The system did not resume to the previous session.

Result Fail

NFR-T7 **Initial State** This system is in a typical operational state with all components and services running, the user is in a live session.

Input/Condition Network instability

Expected Output A pop up window for network instability warning.

Actual Output There was no pop up window for network instability warning.

Result Fail

NFR-T8 **Initial State** This system is in a typical operational state with all components and services running.

Input/Condition Turn down the primary signaling server.

Expected Output The redundant server takes over until the primary server resumes.

Actual Output Connections were able to be established without the primary signaling server.

Result Pass

NFR-T9 **Initial State** The system is in a typical operational state with all components and services running. The user is in a live session with a media capturing device plugged in.

Input/Condition Disconnect the media capturing device from the user's computing device.

Expected Output A pop up window which warns the user that the client application has lost connection to the media capturing device and prompts the user to reconnect the device to resume the live session.

Actual Output When the media capturing device is disconnected, a pop-up window alerts the user and prompts for reconnection.

Result Pass

NFR-T10 **Initial State** The system is in a typical operational state with all components and services running.

Input/Condition Connect a media capturing device to the user's computing device.

Expected Output A pop up window which warns the user that the video capturing device does not meet required specification if the client application detects that the video input stream has a resolution lower than MIN_RES.

Actual Output The system was not able to check the specification of the capturing device

Result Fail

NFR-T11 **Initial State** The system is in a typical operational state with all components and services running.

Input/Condition the user starts a live session and begins streaming.

Expected Output Accurate instructional annotations are rendered and overlaid on the instructor's video stream.

Actual Output The system renders accurate instructional annotations on the instructor's video stream.

Result Pass

NFR-T12 **Initial State** The system is in a typical operational state with all components and services running.

Input/Condition Connect more than one media capturing device to the user's computing device.

Expected Output A dialog listing all the detected capturing devices is displayed to prompt the user for selecting a device to use.

Actual Output No dialog box was displayed.

Result Fail

NFR-T13 **Initial State** This system is in a typical operational state with all components and services running, with a live session created.

Input/Condition The live video and audio stream from instructor client application.

Expected Output Audio stream and video stream with annotations on practitioner client application.

Actual Output The practitioner client application receives only video streams with annotations.

Result Fail

NFR-T14 **Initial State** The system is in a typical operational state with all components and services running.

Input/Condition The user starts the client application for instructors.

Expected Output A message with detailed instruction to set up a media capturing device and a list of cautions is displayed.

Actual Output No message was displayed.

Result Fail

NFR-T15 **Initial State** The software system is fully developed, stable, and ready for testing. The different test environments for the latest versions of Windows, Linux, and macOS are set up, each with default settings.

Input/Condition The latest stable versions of Windows, Linux, and macOS. Test cases designed to cover all the main functionalities of the system.

Expected Output The system functions correctly on all mentioned operating systems without crashes, unexpected behaviour, or significant performance issues.

Actual Output The system functions correctly on all mentioned operating systems without any significant issues.

Result Pass

NFR-T16 **Initial State** The system is fully developed, with all features operational, and is hosted in a stable environment accessible via the web. Test environments with the latest versions of Chrome, Firefox, Safari, and Edge are established, each configured with default browser settings.

Input/Condition Latest stable versions of Chrome, Firefox, Safari, and Edge. A series of test cases designed to fully evaluate the functionalities and features of the system.

Expected Output The system operates as intended on all tested web browsers without significant functionality issues, crashes, or severe performance degradation. Features and visual elements are consistent across all browsers.

Actual Output The system operates as intended across all tested web browsers with consistent features and visual elements.

Result Pass

NFR-T17 **Initial State** The system is fully developed and operational. The testing environments represent a range of standard personal computer and laptop configurations (covering various manufacturers, system specifications, and age of devices) equipped with cameras and, where applicable, microphones. The devices are running compatible operating systems with the necessary drivers installed.

Input/Condition Range of standard computers or laptops with various specifications, but all within the commonly accepted 'standard' range for current users. Devices have functional cameras and optional microphones. Test script detailing system operation tasks.

Expected Output The system operates without significant delays, errors, or crashes.

Actual Output The system operates without significant delays, errors, or crashes across a range of standard computers and laptops.

Result Pass

NFR-T18 **Initial State** The system is in a stable state, ready for testing. The user interface for account creation or any other information input is accessible, and documentation related to data handling is available.

Input/Condition Guidelines or criteria specifying what constitutes "essential" versus "nonessential" information for the system's purpose. Access to the system's user interfaces (UI) where data submission forms are present.

Expected Output Comparison of requested data against the criteria for essential information.

Actual Output The system requests only essential information from users.

Result Pass

NFR-T19 **Initial State** This system is in a typical operational state with all components and services running.

Input/Condition Attempted unauthorized modifications to the system including access to system files and modifications to system configurations.

Expected Output A determination of whether the system are able to prevent access or modifications from unauthorized users.

Actual Output The system prevents all unauthorized access and modifications during the test.

Result Pass

- Access system settings.
- Modify Critical system configuration files.
- Gain access to media streams in the system.

The test will be performed on both the instructor client application and practitioner client application. The test is considered successful if all attempts by the unauthorized user are prevented by the system. The test will be considered a failure if any successful unauthorized access or modification to the system were made during the testing process.

NFR-T20 **Initial State** The system is in a typical operational state with all components and services running.

Input/Condition The user starts a live session and begins streaming.

Expected Output A prompt for granting access to use the media capturing devices is displayed.

Actual Output A prompt appears for granting access to media capturing devices during a live session.

Result Pass

NFR-T21 **Initial State** The system is in a typical operational state with all components and services running.

Input/Condition The user starts a live session and begins streaming.

Expected Output An indicator that the media capturing device is in use and that the user is being recorded is visible in the client application.

Actual Output An indicator is visible in the client application when the media capturing device is in use.

Result Pass

NFR-T22 **Initial State** The system is in a typical operational state with all components and services running.

Input/Condition The user ends a live session and stops streaming.

Expected Output The indicator that the media capturing device is in use disappears. The media stream from the capturing device is no longer displayed on the screen.

Actual Output The indicator disappears, and the media stream is no longer displayed once the session ends.

Result Pass

NFR-T23 **Initial State** This system is in a typical operational state with all components and services running.

Input/Condition User inputs

Expected Output System response to user inputs

Actual Output The system responds effectively to user inputs.

Result Pass

NFR-T24 **Initial State** The system is in a typical operational state with all components and services running.

Input/Condition A set of ISO/IEC 12207 standards.

Expected Output A determination of whether the system and its associated processes, documentation, and activities comply with the ISO/IEC 12207 standards.

Actual Output The system and its processes comply with ISO/IEC 12207 standards as determined through evaluation.

Result Pass

NFR-T25 **Initial State** This system is in a typical operational state with all components and services running.

Input/Condition Various user interactions.

Expected Output The computers continue to function within acceptable performance parameters throughout the test.

Actual Output The computer's function is not affected throughout various user interactions.

Result Pass

NFR-T26 **Initial State** This system is in a typical operational state with all components and services running.

Input/Condition User inputs

Expected Output System response from user inputs

Actual Output The system responds appropriately and efficiently to user inputs.

Result Pass

4.1 Usability

4.2 Performance

4.3 etc.

5 Comparison to Existing Implementation

Our project shares similarities with two existing types of implementations. The first is a project developed by a group of researchers, focused on annotating Tai Chi videos with detailed features such as skeletal outlines and semantic segmentation. Like their summer Tai Chi annotation initiative, our project also annotates videos. However, ours operates in real-time, unlike the Tai Chi project which processes annotations offline, making ours more adept for live online learning contexts.

Additionally, our project parallels certain aspects of video conferencing tools like Zoom, which offer live annotation capabilities. While Zoom boasts a broader set of features due to its maturity as a platform, our project distinguishes itself in several key areas:

It is designed for one-directional streaming, in contrast to Zoom's multi-directional video conferencing. Unlike Zoom, where annotations are generated client-side, our project renders annotations server-side, minimizing the hardware demands on viewers' devices. Our system allows viewers the flexibility to choose their annotations, diverging from Zoom's model where annotations are unified for all viewers as determined by the video sender. These distinctions underscore our project's unique contributions to video annotation technology, especially in educational and collaborative online environments.

6 Unit Testing

6.1 User Authentication Module

UT-UA1 **Initial State** The system initializes the Auth component within a mock routing environment.

Input/Condition N/A

Expected Output The component should display the Motion Mingle banner and a logo image.

Actual Output The component displayed the Motion Mingle banner and a logo image.

Result Pass

UT-UB2 **Initial State** The system initializes the "Auth" component within a mock routing environment.

Input/Condition The user clicks on the Instructor button.

Expected Output The user should be navigated to the '/instructor' path.

Actual Output The user was navigated to the '/instructor' path.

Result Pass

UT-UC3 **Initial State** The system initializes the "Auth" component within a mock routing environment.

Input/Condition The user clicks on the Practitioner button.

Expected Output The user should be navigated to the '/practitioner' path.

Actual Output The user was navigated to the '/practitioner' path.

Result Pass

UT-UD4 **Initial State** The system initializes the "Auth" component within a mock routing environment.

Input/Condition N/A

Expected Output The slogan should be visible within the component with the correct text.

Actual Output The slogan was displayed within the component with the correct text.

Result Pass

6.2 Instructor View Module

UT-M1 **Initial State** The system is initialized with default state settings. The "Instructor" component is about to be rendered within a mock routing environment.

Input/Condition N/A

Expected Output The "Instructor" component should be rendered with the title "Motion Mingle".

Actual Output The "Instructor" component was rendered with the title "Motion Mingle".

Result Pass

UT-M2 **Initial State** The system has loaded the Instructor component, and the "SelectAnnotation" component is ready to receive user input.

Input/Condition A user selects "Skeleton" annotation from the dropdown menu.

Expected Output The dropdown menu should reflect that "Annotation 1" has been selected.

Actual Output "Skeleton" has been selected from the dropdown menu.

Result Pass

UT-M3 **Initial State** The Instructor component is rendered and operational, presumed to be in a state where broadcasting is occurring (mocked condition).

Input/Condition The user clicks the "Broadcast" button to simulate starting a broadcast and then clicks "Stop" to simulate ending the broadcast.

Expected Output The "MessageModal" mock should be displayed, indicating that the stopping of the video is to be confirmed.

Actual Output The "MessageModal" mock was displayed.

Result Pass

UT-M4 **Initial State** The Instructor component is rendered and operational. The self-video is initially off.

Input/Condition The user clicks "Start self video" to initiate the video stream.

Expected Output The system should transition to a state where the self-video is active.

Actual Output The system transitioned to a state where the self-video is active.

Result Pass

UT-M5 **Initial State** The Instructor component is rendered and operational. The self-video is active.

Input/Condition The user clicks "Close self video".

Expected Output The system should transition to a state where the self-video is inactive.

Actual Output The system transitioned to a state where the self-video is inactive.

Result Pass

6.3 Practitioner View Module

UT-PV1 **Initial State** The system is initialized with default state settings. The "Practitioner" component is about to be rendered within a mock routing environment.

Input/Condition N/A

Expected Output The "Practitioner" component should be rendered with the title "Motion Mingle", a dropdown for selecting annotations initialized to "None", and a "Connect" button.

Actual Output The "Practitioner" component was rendered with the title "Motion Mingle".

Result Pass

UT-PV2 **Initial State** The "Practitioner" component is rendered and displayed with the default selected annotation as "None".

Input/Condition The user changes the annotation selection from "None" to "Skeleton" using the dropdown.

Expected Output The dropdown menu for selecting annotations should reflect the change by displaying "Skeleton" as the current selection.

Actual Output "Skeleton" was displayed as selected in the dropdown menu.

Result Pass

UT-PV3 **Initial State** The "Practitioner" component is rendered, displaying the "Connect" button while the video stream is not connected.

Input/Condition The "Connect" button was clicked to start the video stream.

Expected Output The "Connect" button should change to "Disconnect".

Actual Output The "Connect" button changed to "Disconnect".

Result Pass

UT-PV4 **Initial State** The "Practitioner" component is rendered, displaying the "Disconnect" button while the video stream is connected.

Input/Condition The "Disconnect" button was clicked to stop the video stream.

Expected Output The "Disconnect" button should change to "Connect".

Actual Output The "Disconnect" button changed to "Connect".

Result Pass

6.4 Annotation Configuration Module

UT-AC1 **Initial State** The "SelectAnnotation" component is initialized with default state settings.

Input/Condition The component is rendered without any preselected value.

Expected Output The component should display with the label "Annotation" and a dropdown button showing the default value "None".

Actual Output The component was rendered with the label "Annotation" and a dropdown button showing the default value "None".

Result Pass

UT-BC2 **Initial State** The "SelectAnnotation" component is rendered with default settings.

Input/Condition The user clicks on the dropdown menu to view available options.

Expected Output The dropdown menu should display four options: "None", "Skeleton", "Edges", and "Cartoon".

Actual Output The dropdown menu displayed four options: "None", "Skeleton", "Edges", and "Cartoon".

Result Pass

6.5 RTC Control Module

UT-RC1 **Initial State** Before creating a new "RTCPeerConnection", no connection exists.

Input/Condition The "createPeerConnection" function is called without any specific arguments since it uses predefined settings within its implementation.

Expected Output A new "RTCPeerConnection" should be created with the configuration specified for unified-plan SDP semantics and the Google STUN server.

Actual Output A new "RTCPeerConnection" was created with the configuration specified for unified-plan SDP semantics and the Google STUN server.

Result Pass

UT-RC2 **Initial State** A "RTCPeerConnection" instance exists but has not yet established a connection nor created any offers.

Input/Condition The function "connectAsConsumer" is called with the created peer connection and "annotation" as arguments.

Expected Output The function should asynchronously create an SDP offer, set it as the local description, send it to the server, and set the received SDP answer as the remote description.

Actual Output Same as expected output.

Result Pass

UT-RC3 **Initial State** A "RTCPeerConnection" instance is ready but not yet in a broadcasting state.

Input/Condition The function "connectAsBroadcaster" is called with the peer connection object.

Expected Output The function should asynchronously create an SDP offer for broadcasting, set it as the local description, send it to the server, and set the server's SDP answer as the remote description.

Actual Output Same as expected.

Result Pass

6.6 Other Modules

UT-OT1 **Initial State** The system initializes the "NotFound" component within a mock routing environment.

Input/Condition The component is rendered without any user interaction.

Expected Output The component should display the "Not Found" message.

Actual Output The component displayed the "Not Found" message.

Result Pass

UT-OT2 **Initial State** The system initializes the "NotFound" component within a mock routing environment.

Input/Condition The component is rendered, and the existence of a link is checked.

Expected Output There should be a link that reads "GO HOME" and navigates to the root path '/' upon clicking.

Actual Output Same as expected.

Result Pass

UT-OT3 **Initial State** The "MessageModal" component is rendered with "isModalOpen" set to true.

Input/Condition The "Cancel" button was clicked.

Expected Output The "handleClose" mock function should be called once.

Actual Output The "handleClose" mock function was called once.

Result Pass

UT-OT4 **Initial State** The "MessageModal" component is rendered with "isModalOpen" set to true.

Input/Condition The "Stop Video" button was clicked.

Expected Output The "handelStopVideo" mock function should be called once.

Actual Output The "handelStopVideo" mock function was called once.

Result Pass

UT-OT5 **Initial State** The "MessageModal" component is initialized and rendered with "isModalOpen" set to true.

Input/Condition N/A

Expected Output The modal, including the warning message, should be visible.

Actual Output The modal, including the warning message, was visible.

Result Pass

UT-OT6 **Initial State** The "MessageModal" component is initialized and rendered with "isModalOpen" set to false.

Input/Condition N/A

Expected Output None of the modal's content should be present in the document.

Actual Output None of the modal's content was present in the document.

Result Pass

7 Changes Due to Testing

7.1 Change due to supervisor's feedback

Andrew Mitchell, who is one of the supervisors of this project, has pointed out during the Revision 0 demo that the "check annotated video" button on the instructor page should appear after the instructor has started broadcasting instead of showing it directly, as clicking the check annotated video can't show anything without input video stream. To follow the feedback from Andrew, the UI design will be changed so that the "check annotated video" button only shows up after the instructor starts broadcasting, and extra instructions will be added to the side of the instructor and practitioner view page.

7.2 Change due to reviewing the question in the usability survey

The VnV Plan, states that our group will review the questions in the usability survey as part of non-functional testing. One of the questions in the usability survey is: "Are there any specific content or learning materials you would like to see added to the application?" Some users state it is not convenient that they need to manually disconnect and reconnect to the server when selecting different annotations as a practitioner. The team decided to add an "auto-refresh" functionality to the system

when an instructor or a practitioner changes their selected annotation would make the UI more intuitive and enhance user experiences.

8 Automated Testing

9 Trace to Requirements

10 Trace to Modules

11 Code Coverage Metrics

References

Appendix — Reflection

The information in this section will be used to evaluate the team members on the graduate attribute of Reflection. Please answer the following question:

1. In what ways was the Verification and Validation (VnV) Plan different from the activities that were actually conducted for VnV? If there were differences, what changes required the modification in the plan? Why did these changes occur? Would you be able to anticipate these changes in future projects? If there weren't any differences, how was your team able to clearly predict a feasible amount of effort and the right tasks needed to build the evidence that demonstrates the required quality? (It is expected that most teams will have had to deviate from their original VnV Plan.)