Milestone 2 Submission 1 by Group 1

Proposed Level of Achievement: Gemini

# Panopto Plus

A Chrome extension to improve the user experience of webcasting

**Purpose of this document:**

1. Allow evaluators to evaluate implemented feature and perform acceptance testing
2. Allow evaluators to evaluate planned features
3. Allow evaluators to evaluate UI / UX as well as usability of product
4. Allow evaluators to evaluate testing procedures used during the project

**Recap on the Scope of Project**

The Chrome Extension will serve 3 main purposes:

* The Chrome extension will inject HTML, CSS and JS into the page to improve user-friendliness. There will be a side-bar for users to configure the extension settings.
  + Wider range of video playback speeds, restructuring of page to allow for more space for the video webcast
  + Persistent settings across webcasts e.g. always play all webcasts at 2.0x speed.
* Machine Text Transcription (Machine-generated subtitles for webcasts) will by generated by Panopto. This Chrome extension will leverage on that and process the transcript into subtitles and a user interactable transcript.
  + Users can click sections of the transcript to seek to that video timeframe
* The Chrome extension will also process files of the webcast for voice detection. Sections in the webcast where there is no speech will be automatically skipped.

These features are toggleable (except user-interface modifications to the Panopto webpage).

**Total list of key features, tasks and details**

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| --- | --- | --- | --- | --- |
| **Category** | **User / Main Beneficiary** | **Details** | **Status (Pending / In Progress / Testing / Complete)** | **Deadline** |
| UI | Student | Sidebar with tabs | In Progress (Medium Priority) | Mid June (Overdue) |
| UI | Student | Smaller carousel | Complete | Mid June |
| UI | Student | Removal of Panopto header if loaded on LumiNUS | Complete | Mid June |
| UI | Student | Replace playback Speed buttons with slider | Complete | Mid June |
| Subtitles | Student | Retrieval and caching of transcript from Panopto via REST API | Complete\* | Mid June |
| Subtitles | Student | Conversion of transcript from Panopto to suit app’s purposes | Complete | Mid June |
| Subtitles | Student | Display of subtitles on video(s) | Complete | Mid June |
| Subtitles | Student | Properly synced subtitles on both videos (two video webcasts) | Complete | Mid June |
| Silence Removal | Student | Basic implementation (demuxing, decoding & processing using AudioWorklet) | Complete\* | Mid June |
| Silence Removal | Student | Skipping mechanism based on silent sections detected | Complete | Mid June |
| Misc | Contributor(s) | Error logging module | Pending (Medium Priority) | Mid July |
| UI | Student | Consistent UI & UX for single video and double video webcasts | Pending (High Priority) | Mid July |
| UX | Student | Persistent settings across webcasts under the same module and settings tab to reflect that | Pending (High Priority) | Mid July |
| UI | Student | Transcript sidebar (hideable) even on fullscreen | Pending (Low Priority) | Mid July |
| UI | Student | Other miscellaneous improvements\*\* | Pending | Mid July |
| Transcripts | Student | Transcripts on the sidebar | Pending (High Priority) | Mid July |
| Transcripts | Student | Highlighted line in transcript in sync with video | Pending (High Priority) | Mid July |
| Transcripts | Student | Clicking of line in transcript will seek to section of the video | Pending (High Priority) | Mid July |
| Silence Removal | Student | Extension of basic implementation: caching of results, async, multiple webworklets and audioworklets | Complete\* | Mid July |
| Misc | Contributor(s) | Generation of JSDocs | Complete | Mid July |
| Misc | Student | Optimizations, use of webpack to reduce size of chrome extension and manifest links | In Progress (Low Priority) | Mid July |
| Misc | Student | Fix Panopto’s “buffering” issue | In Progress (High Priority) | Mid July |

\*Carousel refers to the carousel web element below the main webcast on the Panopto page, which allows users to see a “snapshot” of the webcast at that time.

\*\*May include mobile responsiveness, if one is able to deploy chrome extensions on the mobile phone. This may not be possible on the Chrome browser on Android, but it *might* be possible on the browser Yandex. May also include modifications to the video player bar.

**Features – Completed (Reasoning & Implementation)**

Acceptance testing should be performed via the video or directly via the chrome extension that can be found at <https://github.com/crazoter/panplus> (however you’ll need to enable developer mode in order to load an unpacked chrome extension). The following features discussed below simply help flesh out their purpose and implementation detail.

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| --- | --- | --- | --- | --- |
| UI | Student | Smaller carousel | Complete | Mid June |

Why smaller carousel: Simplicity. Panopto’s elements and their positioning were more coupled than anticipated. A smaller carousel instantly translates to a larger webcast screen while still retaining the same functionality that the carousel had intended to offer (allow users to preview & seek to point in video).

Implementation Details: This was already implemented using CSS and was evident in the first video.

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| UI | Student | Removal of Panopto header if loaded on LumiNUS | Complete | Mid June |

Why: This is a small UI improvement that removes an unnecessary second header that can be used for other elements on the page.

Implementation Details: I can’t show this in action because I currently do not have access to any modules on Panopto through LumiNUS. This was implemented prior to NUS dropping access to our previous modules (hence the necessity to begin work quickly).

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| --- | --- | --- | --- | --- |
| UI | Student | Replace playback Speed buttons with slider | Complete | Mid June |

Why: Amongst most UI/UX improvements, the one that catches the attention of students is the one that allows them to increase the playback speed beyond 2x (which is understandable given that would directly translate to shorter weblectures). On top of that, the previous UI with buttons was imprecise; users couldn’t adjust as per their liking.

Implementation Details**:** With this new slider, users can adjust (in real-time) the playback speed by clicking or sliding on the notched slider up to a precision of x0.1 up to a ludicrous playback speed of x7.0. The playback speed is also adjusted as users slide, allowing them to better adjust their playback speed and immediately get feedback without having to release their mouse. If necessary, they can also reduce it down to x0.5 (although I believe that the use cases for *slowing* down a webcast are few and far between).

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| Subtitles | Student | Retrieval and caching of transcript from Panopto via REST API | Complete\* | Mid June |

Why: Our subtitles and transcripts come directly from Panopto. No retrieval, no subtitles. The reason why caching is used is to reduce the load on Panopto’s servers, if this is not an intended use case for their APIs. In my opinion, the load is nominal and shouldn’t cause any issues.

Implementation Details**:**  The work has already been done; the only thing that needs to be finished is an expiry date for the cached transcripts and an expiry system to remove expired transcript data. This is done behind the scenes, so from the user’s perspective they don’t even know this is happening.

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| --- | --- | --- | --- | --- |
| Subtitles | Student | Conversion of transcript from Panopto to suit app’s purposes | Complete | Mid June |

Why: Self-explanatory

Implementation Details: Use of OOP to make things easier for future contributors if transcripts don’t come from Panopto’s API.

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| Subtitles | Student | Display of subtitles on video(s) | Complete | Mid June |

Why: Subtitles means glanceable data, which means that if you know what the Professor is talking about, you can quickly just skip over that section of the webcast. Even with poorly translated transcripts, if you can derive a few pieces of information about what the Professor is saying, or if you find yourself amused by how bad the subtitles is (and as a result injected humour into an otherwise boring weblecture) then the subtitles have helped improve your webcast experience. If all else fails, the subtitles can be disabled in the final product.

Implementation Details: You can check the GitHub repo, code and JSDocs for the nitty gritty details on the implementation details from a developer’s perspective. From the user’s perspective, the subtitles are slightly translucent (but not to the point where they make it hard to read) to reduce the amount of stuff they block on the webcast. In the final product, users will be able to toggle the subtitles.

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| Subtitles | Student | Properly synced subtitles on both videos (two video webcasts) | Complete | Mid June |

Why: Most webcasts have 2 videos. Have you noticed that sometimes one video plays at a higher FPS than the other? That’s right; both videos are playing at a different timestamp, and the difference between their timestamps can vary. This makes syncing subtitles, transcripts and even silent sections a challenge that needed to be resolved to ensure both videos play the subtitles and whatnot at the same time.

Implementation Details: From the user’s perspective there should be no changes in their user experience. The implementation itself is simple; because the offset is only known at runtime, all one needs to do is inject the subtitles from the first video to the second when the subtitles are displayed.

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| --- | --- | --- | --- | --- |
| Silence Removal | Student | Basic implementation (demuxing, decoding & processing using AudioWorklet) | Complete\* | Mid June |
| Silence Removal | Student | Extension of basic implementation: caching of results, async, multiple webworklets and audioworklets | Complete\* | Mid July |

Why: First, before I talk about why we even need to demux, decode and perform voice activity detection, I will need to discuss why we even need Silence Removal as a function. There will be users who may not see the point of this function, because it’s meant to be an “invisible” function; users will enjoy the benefits of the function without really realizing that it’s saving them a lot of time. I myself included am sometimes unsure about the amount of time I’m saving when I watch a webcast using this feature until I check the console logs. This is because there are many moments when the Professor will subconsciously pause to think or breathe and even these moments are shortened with this feature. It is exceptionally helpful if the Professor likes to speak in short bursts with pauses in-between, an issue that cannot be rectified simply by pumping up the playback speed.

Implementation Details: The only reason why this is defined as “basic implementation” and the complete status is starred is because the demuxing and decoding is not done on a webworklet (which would reduce the strain on the main thread of the browser; understand that all javascript runs on only one thread). Even without the use of web worklets, this feature can be considered implemented, considering that the main processing of voice activity detection is already done in a web worklet.

The actual implementation is far more complicated, considering that TS files are not readily supported by Chrome and must be demuxed and decoded into a format that can be used.

This data then undergoes even further processing using audio worklets which is still a somewhat new feature (its use is necessitated by the fact that it replaces a function that will be deprecated in the future); its new-ness and rawness causes complications especially when sometimes the documentation doesn’t describe the implementation.

The logic behind this processing was initially straightforward: under the basis that human speech has a frequency range, one could perform a Fast Fourier Transform to get the magnitude of the frequencies of the human speech. If the magnitude crossed a certain threshold, one could assume that someone was speaking. This didn’t work very well, and I figured that it had to work well, or there was no point in having the feature in the first place.

I thus adopted a second approach based on this research article: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4142156/>. The core idea is to distil a signal down to 5 variables. They then obtained a set of variables as a reference set by assuming a certain section of the audio comprises only of noise and comparing the difference of the sum of each variable of that reference set to any other set of variables derived from other signals. If the difference was large enough, then the signal wasn’t noise (and thus likely to be voice). For the noise reference, I used the last second (or two) of the webcast because that is where the Professor would’ve stopped speaking (and it is much more reliable as a source of noise than the first second, as some webcasts immediately begin with the Professor speaking). However, the paper does not discuss very much about what is the threshold for “noise” and “voice” which made it difficult to implement it. As a result, I instead gathered 30 samples for the noise reference. Assuming a normal distribution of each variable due to the central limit theorem and using a confidence level, I then assigned lower and upper bounds for each variable. If most of these variables fell outside of these bounds, then they would be considered as not noise. This approach worked exceptionally well, even for webcasts with a lot of noise (with the exception of certain scenarios like the Professor playing a video during the webcast). The confidence level could be further tweaked of course, and I am thinking of adding it as a setting for users to play with to improve their experience if possible. However, it works well as is, and the setting would be considered an additional feature.

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| Silence Removal | Student | Skipping mechanism based on silent sections detected | Complete | Mid June |

Why: Save time plus you don’t have to struggle to understand what the Professor is saying if you’re playing at too fast a playback speed. Also very effective for webcasts that have exceptionally long and frequent pauses.

Implementation Details: Once all the heavy lifting has been done, these silent sections are then added as cues to the video. The videos then jump when they reach these cues and need to be synced.

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| Misc | Contributor(s) | Generation of JSDocs | Complete\* | Mid July |

Why: There will come a time when the summer ends, Orbital ends and everyone goes back to studying. In order to make sure a project is well maintained, others also need to understand how the project is implemented and that is where documentation comes in to help others understand and maintain the code. JSDocs is a means to convert all those comments that is in the codebase into a set of pages that make it easy for developers to read the code (much like Java API Documentation).

Implementation Details**:** The package.json is in place to help others build and update the JSDocs if required. The documents are already in the GitHub repository.

**Limitations of Completed Features**

Transcript & Subtitles do not exist for some webcasts

Because the transcript and subtitles are retrieved directly from Panopto, if the webcast doesn’t have machine transcribed transcript attached to it (because the webcast is too old / the feature isn’t enabled on Panopto’s side), then there will not be transcripts or subtitles. This applies to a lot of the old open webcasts. However, in earlier testing sessions on webcasts for the modules I was taking, the webcasts have machine transcribed transcripts. I doubt this will be a big issue.

The alternative is to use something like Google Cloud Speech To Text. However, it is a paid service and it can only transcribe 1 hour of audio per month for free per user. This alternative is infeasible as the goal is to get it into the hands of NUS students as a free service, so I guess we’ll have to make do.

Transcript & Subtitles are inaccurate

As you might have guessed, the transcripts are machine transcribed. This means that although some webcasts will have some decent transcripts, some webcasts will have transcripts that aren’t so good. I thought of a crowd-sourcing feature that students can use to contribute to fixing the machine transcripts, but it was counter-intuitive; the goal of transcripts is to *shorten* the time taken to watch a webcast, not increase it. Also, the alternative (Google Cloud Speech To Text) was unable to provide a better transcription than what Panopto offers.

Not all silent sections may be removed

This is still undergoing refinement, but ultimately, I believe that the result may not be a perfect removal of all silent sections because there is a need to balance the likelihood of false positives (voice recognized as noise) and the false negatives (noise recognized as voice). Although it won’t be perfect, I am still quite satisfied with how it has already removed a substantial amount of noise. By adding the confidence level as a setting, I think it will suffice.

**Features – In Progress**

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| UI | Student | Sidebar with tabs | In Progress (Medium Priority) | Mid June |

Why sidebar (instead of navbar at the top or bottom): A sidebar was chosen for two reasons. First, simplicity. It would be tedious to revamp Panopto's UI for minute improvements of the user interface. At this point, users would also have expectations of how Panopto's UI will be like. Changing it drastically will force users to relearn, which I believe is not not worth the change. Second, the aspect ratio of the webcast. The webcast is limited by the height of the screen; one can observe that by reducing the height of the carousel, one is able to increase the size of the main webcast video stream. Placing other information on the side of the webcast thus allows for a better user interface.

Why tabs: first, users are most likely to only focus on one video webcast. Thus, we allow the user to first select the video webcast of their choice, then tab to the transcript tab. The reason why we include the settings tab (instead of placing the settings options available only on right clicking the chrome extension icon) is to make it easier for users who may not be familiar with how chrome extensions work. There is also enough space on the tab bar to accommodate this settings tab.

Implementation issues encountered: Panopto's implementation of their two video stream system is quite quaint, in the sense that if you want to switch webcasts (when you click the swap button), Panopto literally swaps their positions around. This caused some difficulty in effectively implementing a proper sidebar.

Further Steps: Ultimately the end-users will be the students of NUS. Although I myself am a current user of the system, I figured it would be nice to get more feedback from other students. I am currently conducting a google survey to see which design they like best using screenshots.

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| Misc | Student | Optimizations, use of webpack to reduce size of chrome extension and manifest links | In Progress (Low Priority) | Mid July |

Why: A smaller file for distribution is good and will improve the scalability of the project. However, considering the file size growth (and file size reduction) is currently nominal, this is a low priority task.

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| Misc | Student | Fix Panopto’s “buffering” issue | In Progress (High Priority) | Mid July |

Why: This is not so much a feature as it is a bug fix. From the testing that I’ve been doing using the speed playback increase and silent section removal, Panopto has a bug that causes the webcast to stutter and cause the video player to pause before continuing its playback even though in theory the video should’ve been buffered. This restricts the effective playback speed (even without the chrome extension enabled, this bug can still occur).

**Features – Pending**

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| Misc | Contributor(s) | Error logging module | Pending (Medium Priority) | Mid July |

Why: The rationale behind this module is to use an error logging system (e.g. google analytics) for chrome extensions to submit error logs when something happens, so that developers can identify if something goes wrong without the user having to report it. Although this will be invaluable once the product is distributed and users start using it, its priority is lower than the rest of the core features.

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| UI | Student | Consistent UI & UX for single video and double video webcasts | Pending (High Priority) | Mid July |

Why: Panopto’s implementation for the sidebar (and to a certain extent the carousel as well) is different if there is only 1 video stream.

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| UX | Student | Persistent settings across webcasts under the same module and settings tab to reflect that | Pending (High Priority) | Mid July |

Why: This is necessary to allow users to configure their settings e.g. toggle silence detection, initial playback speed etc

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| --- | --- | --- | --- | --- |
| UI | Student | Transcript sidebar (hideable) even on fullscreen | Pending (Low Priority) | Mid July |

Why: Considering the aspect ratio of the video allows for something to be put at the side (when at fullscreen), I figured that it might be useful to put the transcript at the side. However, in retrospect this might be too much work for too little since the non full-screen version would serve that purpose sufficiently. I will find out more if people think this is a good idea via survey.

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| UI | Student | Other miscellaneous improvements\*\* | Pending | Mid July |

Why: This feature is purposely left vague as there may be other improvements requested by the student population with regards to improvements to the UI.

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| --- | --- | --- | --- | --- |
| Transcripts | Student | Transcripts on the sidebar | Pending (High Priority) | Mid July |
| Transcripts | Student | Highlighted line in transcript in sync with video | Pending (High Priority) | Mid July |
| Transcripts | Student | Clicking of line in transcript will seek to section of the video | Pending (High Priority) | Mid July |

Why: Transcript and clickable lines allow users to jump from one point of the webcast to another, which is very convenient if the transcripts are accurate enough for use.

**Usability** **/ User Interface / User Experience**

The scope of this project is restricted only to pages that display the webcasts hosted on Panopto. Any other pages (e.g. webcast listings, webcast/bookmark/module search etc) is untouched.

Most of the changes (subtitles, silence removal) require no action on the user’s part.

**Types of methods used to evaluate the suitability of solution(s):**