DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING
THE UNIVERSITY OF TEXAS AT ARLINGTON

SYSTEM REQUIREMENTS SPECIFICATION
CSE 4317: SENIOR DESIGN II
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MELODY MASTERS
SOUNDSYNC

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Revision History

Revision	Date	Author(s)	Description
0.1	07.03.2023	AR	document creation
0.2	07.12.2023	AA, BF, PF, EH, AR	complete draft V1
0.3	08.11.2023	AA, BF, PF, EH, AR	complete draft V2
1.0	1.30.2023	AA, BF, PF, EH, AR	Final release

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1 Product Concept

This section describes the purpose, use, and intended user audience for SoundSync. SoundSync is a system that utilizes an audio input to follow along with a musician, keeping track of where they are on a given sheet, and then turning the page for them on a digital version of it. Users of SoundSync will be able to upload physical copies of their sheet music to our mobile application. Using any audio input device, users will be then able to use our application to follow along with their playing on the digital sheet music, indicating where they are at all times, and even turning the page when they are close to finishing the current one.

1.1 Purpose and Use

SoundSync will be able to automatically turn a sheet music page for a musician. This product will be used in situations where a musician would prioritize concentration over page-turning, such as concerts and practice sessions. With planned additional features, this product will also serve as a valuable tool for learning how to play a piece and enhancing self-improvement in musicians.

1.2 Intended Audience

SoundSync is meant to be used by any music enthusiast who plays instruments. Whether you are a concert-playing classical musician, or someone picking up the guitar for the first time, SoundSync provides its users the freedom to focus on their playing.

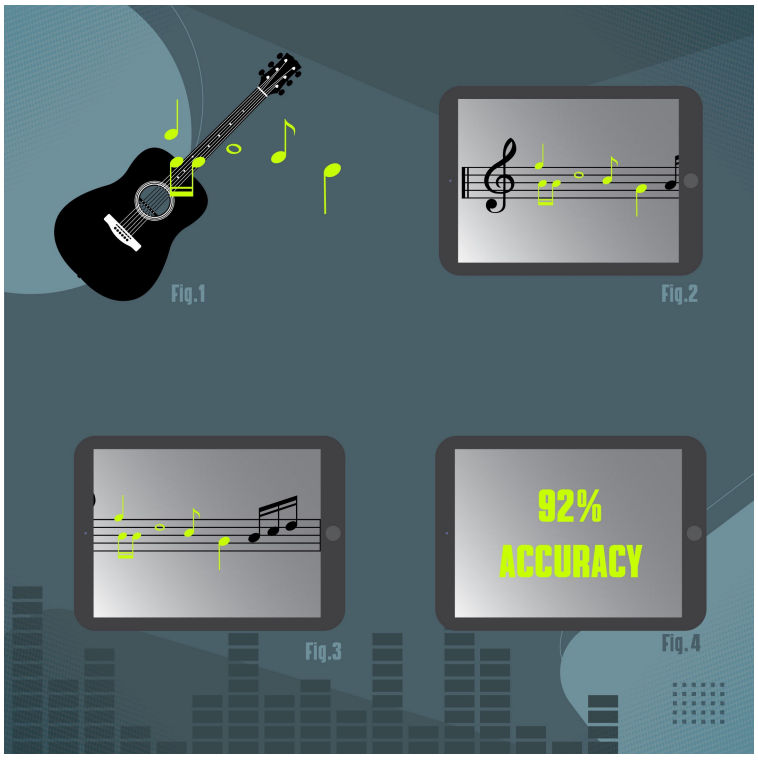

Figure 1: SoundSync conceptual drawing

2 Product Description

This section provides the reader with an overview of the music turning page web-app features and functions. The end user of this product will be able to scan a music sheet into the service and have it displayed on their tablet or phone. The end user will then be able to play music and as they do the service will follow along and turn the pages automatically. Account functionality will be provided so the user can load previously scanned music sheets to save time and effort. Maintainers will use this service to determine if everything is functioning properly. They can do this by testing to see if the web-app reads music sheet correctly and display them without error. They will also make sure the service turns the pages at the appropriate time. They can test note detection by playing a song incorrectly to see if the service is properly picking up mistakes. Administrators will use the web-app to see if the customer is getting the desired product. Checking all feedback on the and improving on features that have bad reviews.

2.1 Features & Functions

The product will allow the user to scan a music sheet with their phone or tablet. This will only be done with mobile devices. Any other devices will not be supported. The product will display the music sheet that was scanned or a previously scanned music sheet if the user has logged in with an account. If the user is not logged in when scanning a music sheet then that sheet wont be saved to the database. The user will play music from their desired instrument and the service will automatically turn the pages of the music sheet as music is being played. At the moment only an electric guitar is supported for the list of instruments. The user can also make an account so all their scanned music sheets can be saved.

2.2 External Inputs & Outputs

Data	Input	Output	Source	Description
Music Sheet Scanning	Music Sheet	Display music sheet	End User	The user will scan a music sheet using the app. That music sheet will be displayed on their mobile device.
Automatic Page Turning	Instrument	Auto page turning	End User/Instrument	The user can play music and the app will automatically turn the page.
Create Account	User Info	Account Creation	End user/Database	The user can create their own account. They provide an email and password as well some other basic info. An account will be created in a database so all music sheets can be saved.
Load Scanned Music Sheet	User Input	Display music sheet	End User/ Database	A user with an account can select from a previously scanned music sheet. This will be retrieved from a database and displayed on their mobile device.

2.3 Product Interfaces

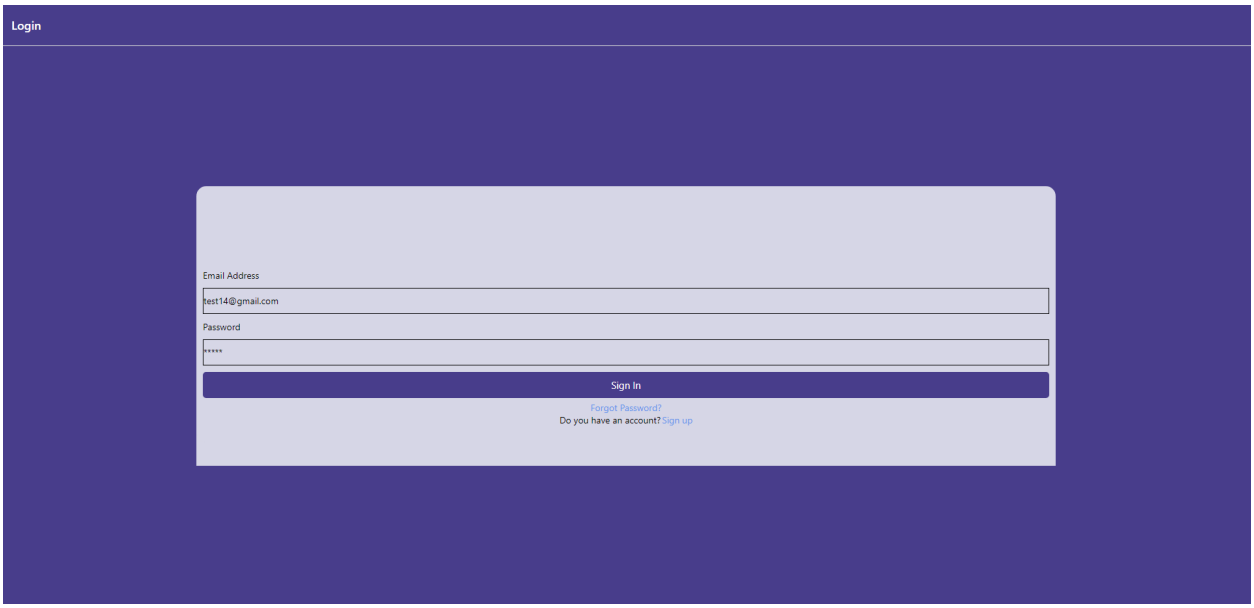

Figure 2: Login and Create Account Screen

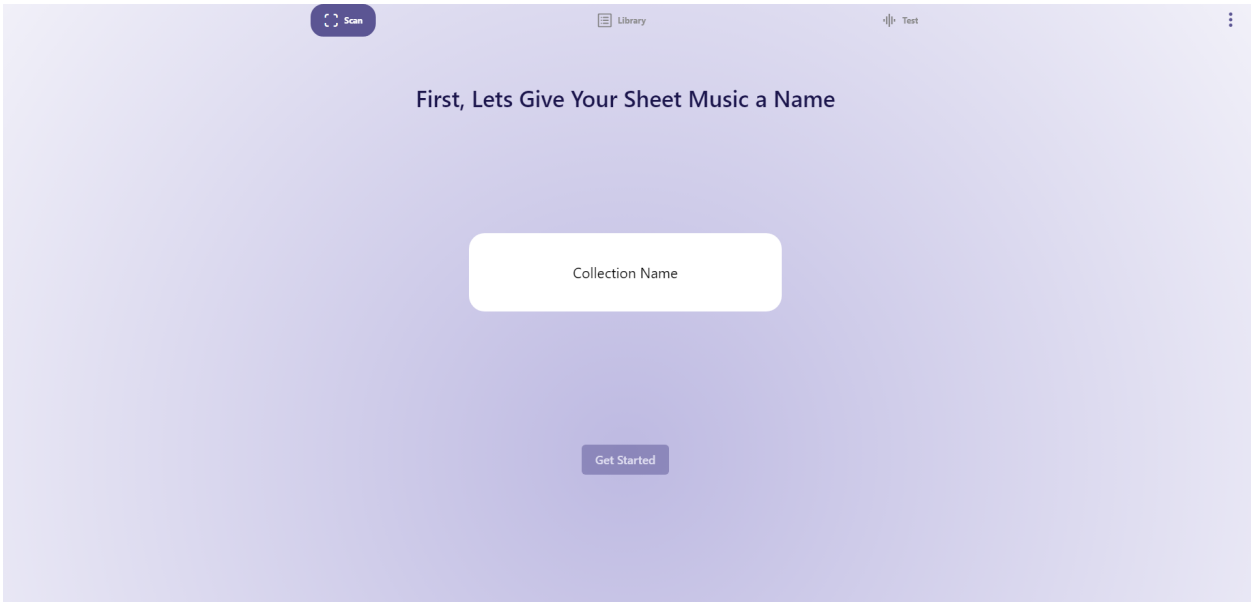

Figure 3: Home page

3 Customer Requirements

These are the planned features of SoundSync. In this section we discuss what the feature is designed to do, why this feature is required in the functionality of the project, and potential constraints that might prohibit the feature from working optimally. These features we believe are necessary to create a user friendly experience with our web-app. The requirements that are labeled future priority do not have to be implemented to meet our vision on how SoundSync is intended to work as a product.

3.1 Sheet music scanning

3.1.1 Description

The web-web-app will be able to scan music sheets on paper using the camera of the mobile device. The web-app will then display these music sheets so the user can play a song and follow along with the music sheet.

3.1.2 Source

The sponsor

3.1.3 Constraints

The lighting in the room can be a possible constraint to this feature. Many times web-web-apps that allow you to scan papers often have problems saving it without having parts of the paper cut out due to lighting. So making sure our web-app can filter out bad lighting when scanning is essential. Also asking permission to use the user camera on their mobile device can be a possible constraint. Some users may not feel comfortable doing that.

3.1.4 Standards

This feature will require a private policy to be created. Since we are using the camera on the user mobile device which can be seen as an invasion of privacy. As such a private policy must be made to ensure the user information is protected. [3]

3.1.5 Priority

Critical

3.2 Live Note Detection

3.2.1 Description

The web-app will be able to recognize different notes being played by the user so it knows when to turn the music sheet page being displayed.

3.2.2 Source

The sponsor

3.2.3 Constraints

Because this web-app will need to listen to the user playing music, any kind of sound interference could create problems. As such the web-app will need to be able to filter out any sound interference and only pick up musical notes. The web-app will also be limited to the user mobile device microphone specification as that what it will be using to record sound. As well as privacy as the web-app will need permission to use the user microphone.

3.2.4 Standards

This feature will require consent from the user. Since we are using the microphone on the user mobile device which can be seen as an invasion of privacy. As such a private policy must be made to ensure the user information is protected./Section 16.02 Texas Penal Code [1]

3.2.5 Priority

Critical

3.3 Accuracy Rating

3.3.1 Description

A feature in which the user will be given an accuracy rating as they are playing notes in a song. This can be done with a percentage number above each musical note that been passed or color coding it. An overall accuracy rating of the song will be given when the user finishes. They can then look back at all the notes they played and figure out which ones they struggled on.

3.3.2 Source

MelodyMasters team

3.3.3 Constraints

This feature will have the same constraints as the live note detection feature as it will also need to use the microphone to listen for sound. But with an added constraint of having an algorithm that can distinguish how accurately a note is being played. We will need to figure out a way to distinguish the difference between a bad note and a good note.

3.3.4 Standards

This feature will require consent from the user. Since we are using the microphone on the user mobile device which can be seen as an invasion of privacy. As such a private policy must be made to ensure the user information is protected./Section 16.02 Texas Penal Code [1]

3.3.5 Priority

Moderate

3.4 Page turning/sliding on page end

3.4.1 Description

This feature will automatically turn the page of the music sheet being displayed so the user can keep playing without taking their hands off their instrument. It will also do this before the user reaches the end of the page so the page transition doesn't cause a gap in time were the user is waiting to see the next note they need to play.

3.4.2 Source

The sponsor

3.4.3 Constraints

The view being shown will be constrained by the size of the mobile device screen. As such we need to make sure our web-app can be resized based on the device being used.

3.4.4 Standards

Minimum margin of 8pt, 44pt for buttons, 12pt for small text, 17pt for body text, 20pt for titles/IOS [4]

3.4.5 Priority

Critical

3.5 Note highlighting that follows the user's playing

3.5.1 Description

This feature will highlight the current note the user is on so they know where they are in a song.

3.5.2 Source

MelodyMasters team

3.5.3 Constraints

This feature will be constrained by how accurately each note is being recorded by the microphone. If the audio interference is too great then the note may not be picked up properly and the user will get an incorrect positioning in the music sheet.

3.5.4 Standards

This feature will require consent from the user. Since we are using the microphone on the user mobile device which can be seen as an invasion of privacy. As such a private policy must be made to ensure the user information is protected./Section 16.02 Texas Penal Code [1]

3.5.5 Priority

High

3.6 Account Functionality

3.6.1 Description

The web-application will allow the user to sign up/sign into an account that will then act as a personal database/inventory of the user's previously scanned sheet music as well as their past performance statistics.

3.6.2 Source

MelodyMasters team

3.6.3 Constraints

The web-application must prioritize the security and privacy of user data. It should incorporate a secure authentication mechanism, such as usernames, passwords, and potentially two-factor authentication, to verify the identity of users during sign-up/sign-in and prevent unauthorized access.

3.6.4 Standards

This requirement will confidential information from the user, such as a secure password. It might also require a user's phone number and email address if 2-factor authentication is implemented.

3.6.5 Priority

High

3.7 Statistics on user playing history

3.7.1 Description

This feature will compare the detected score to the user's playing, keeping track of multiple data points related to the user, such as accuracy, precision, completed pieces, etc. This data will then be compiled and displayed to the user as a UI element to be accessed.

3.7.2 Source

MelodyMasters team

3.7.3 Constraints

This feature will only be able to properly display the user's accuracy if the accuracy detection itself is working without fault. If the web-application cannot keep track of the user's accuracy, it will give false information, and therefore be useless.

3.7.4 Standards

This feature will require consent from the user. Since we are using the microphone on the user's mobile device it can be seen as an invasion of privacy. As such a private policy must be made to ensure the user information is protected./Section 16.02 Texas Penal Code

3.7.5 Priority

Moderate

3.8 Account storage for previously scanned sheet music

3.8.1 Description

This feature will allow the user to save scanned sheet music in a user-friendly location on the web-application that can then be retrieved for reuse. This data will be saved in a database that only the user can access.

3.8.2 Source

MelodyMasters team

3.8.3 Constraints

This feature requires coordination with the account feature in order to ensure that the user saves this data in a secure location that only they can access.

3.8.4 Standards

The feature should integrate with the web-application's user authentication system, enforcing secure access to the saved sheet music. It should follow standard authentication standards and protocols to verify the user's identity and restrict access to their stored data web-appropriately.

3.8.5 Priority

Moderate

3.9 Performance Mode

3.9.1 Description

This feature will allow the user to use their scanned sheet music in a 'performance' mode. The performance mode will be a minimalist view of the sheet music, ensuring that the user will have no distractions. This mode will only consider the order of notes played when considering the automatic page turning. Accuracy metrics will be available post-play for the user.

3.9.2 Source

MelodyMasters team

3.9.3 Constraints

This feature's implementation may be constrained by the need for efficient real-time processing of the user's performance data. The web-application should be able to handle the computational load required for analyzing accuracy metrics and providing timely feedback to the user.

3.9.4 Standards

The web-application should aim to provide meaningful and informative metrics that can help the user assess their performance and identify areas for improvement.

3.9.5 Priority

Future

3.10 Automatic Music Sheet Searching

3.10.1 Description

This feature will be able to detect the scanned sheet music that the user is feeding into the system. It will then compare the initial pages to a larger database of already-digital sheet music and recommend to the user its successful matches. If the user selects a match, it will replace the user's scans and allow the user to retrieve and use this already-created sheet music for their piece.

3.10.2 Source

MelodyMasters team

3.10.3 Constraints

This feature's implementation will be constrained by the available sheet music database that we can use to compare the scanned sheet music. If the database is limited, this feature might not web-appear to the user as a useful one.

3.10.4 Standards

This feature should utilize a comprehensive sheet music database. The matching algorithm employed should follow established best practices in the field of symbol recognition and matching, ensuring accurate and relevant recommendations to the user.

3.10.5 Priority

Future

4 Packaging Requirements

This section proves the reader with an overview of the hardware and software components that will require packaging. This section will also the different sources, constraints, standards and the priority of each component. The SoundSync web-app will not have a package as it will be a digital medium.

4.1 Web - service Connection

4.1.1 Description

SoundSync will be packaged as a web service. The user will then download navigate to the website and connect their instrument and begin playing

4.1.2 Source

MelodyMasters team

4.1.3 Constraints

Constraints will consist of different supported device models and/or supported device firmware.

4.1.4 Standards

Web-apps will generally support a wide variety of models and firmware. In supported regions, the web service will readily be able to navigate to with any web browser

4.1.5 Priority

Critical

5 Performance Requirements

This section will include performance requirements of note detection speed as well as sheet music scanning and generating speed. The length of time it takes to start and stop these operations.

5.1 Note Detection Speed

5.1.1 Description

The web-app will include a functionality that will detect the speed of the music being played by the user. The web-app will continuously follow along with the frequency of the notes being played and guide the user toward the next notes.

5.1.2 Source

MelodyMasters team

5.1.3 Constraints

Constraints will consist of microphone detection failure and possible connection failures. The microphone may fail to detect the correct note if a single or multiple notes are played in succession. Service may hang or delay while processing computations.

5.1.4 Standards

The web-app will detect a note being played on instruments connected to the microphone and properly track and progress the music on the music sheet.

5.1.5 Priority

Medium

5.2 Sheet Music Scanning/Generation Speed

5.2.1 Description

This functionality will allow users to scan music sheets that will be generated as a playable online version for the user to follow along without the need for the physical copy and stored for future sessions.

5.2.2 Source

MelodyMasters team

5.2.3 Constraints

Sheet music may not be readable enough depending on age of paper or type. The sheet music may not detect all the notes on the paper correctly due to scanning feature error or scanning angle. Scanning conditions may not be suitable enough for accurate scanning.

5.2.4 Standards

The sheet music scanning should scan any music sheet that the user scans with little to no error in music note detection. The sheet scanning should be a fast feature with an average scanning time of no more than 5 minutes with an average time of two to three minutes.

5.2.5 Priority

Critical

6 Safety Requirements

This section includes potential safety hazards and the corresponding safety measures to avoid them. Because this project is mostly software based, there are only a few concerns regarding the hardware that will be used with the SoundSync application - namely the audio interface and instrument, and mobile device.

6.1 Wiring Trip Safety

6.1.1 Description

All cords will be put out of the way when testing hardware components. This will be done by securing excess cable near the instrument or tablet.

6.1.2 Source

Melody Masters team

6.1.3 Constraints

This will add setup time when testing to ensure no cords are left on the workspace floor.

6.1.4 Standards

Occupational Safety and Health Administration 1926.416(b)(2) [5]

6.1.5 Moderate

6.2 Water Hazard

6.2.1 Description

When working with hardware components, the team must be mindful of open liquid containers to avoid electrical hazards

6.2.2 Source

Melody Masters team

6.2.3 Constraints

This will add setup time during testing to ensure no liquid containers could reach the hardware components (Audio interface, instrument, or tablet).

6.2.4 Standards

N/A

6.2.5 Priority

High

7 Security Requirements

This section will cover the security surrounding the encryption of account information and a password strength checker to ensure a sufficient password combination has been entered. This will also provide detail on the description, the source, standards, and priority for each of the security requirements.

7.1 Proper Encryption of Account Information

7.1.1 Description

User-sensitive information such as passwords will be appropriately encrypted.

7.1.2 Source

Melody Masters team

7.1.3 Constraints

Our encryption service will be controlled by what our database provider (firebase) provides.

7.1.4 Standards

Firebase uses the 256-bit Advanced Encryption Standard [6]

7.1.5 Priority

High

7.2 Password Strength Checker

7.2.1 Description

In order to avoid users losing their accounts, we will have password strength requirements. This will check for a minimum of 8 characters, a capital letter, and a special character.

7.2.2 Source

Melody Masters team

7.2.3 Constraints

Adding a password strength checker will take some extra time to implement, as well as add time to account registration for users.

7.2.4 Standards

N/A

7.2.5 Priority

moderate

8 Maintenance & Support Requirements

This section covers what will be provided to the user from delivery onward. We will include materials that will show the user how to use the delivered product as well as support to add usability later on.

8.1 Regular Update of Sheet Music Database

8.1.1 Description

After delivery, the team will continue updating the sheet music database to expand the catalogue of songs to practice and track.

8.1.2 Source

Melody Masters team

8.1.3 Constraints

Music selection will be limited by copyrights. It will have to be licensed if the music is not public domain.

8.1.4 Standards

N/A

8.1.5 Priority

Future

8.2 User Tutorial Provided on Application Launch

8.2.1 Description

When launched for the first time, the web-app will allow the user to begin playing. No tutorial is needed. Simply plug and play.

8.2.2 Source

Melody Masters team

8.2.3 Constraints

N/A

8.2.4 Standards

N/A

8.2.5 Priority

low

9 Other Requirements

This section we have listed some requirements that do not fit in other areas in this document. These requirements include a software framework that we will use to develop SoundSync and a hardware component that is used as a potential backup feature.

9.1 React Native for Cross-platform Functionality

9.1.1 Description

React Native as our choice for the software framework that will allow SoundSync to be on IOS and Play Store. This will enable a wider customer base at release.

9.1.2 Source

This was a decision that was recommended by Adrian Ramos and our sponsor, Shawn Gieser.

9.1.3 Constraints

Some constraints of using react native as our framework could include, learning the framework as we develop this app, libraries not working as intended, and hardware components not working as intended.

9.1.4 Standards

N/A

9.1.5 Priority

High

9.2 Bluetooth Pedal

9.2.1 Description

A bluetooth pedal that will allow for wireless connection to device. The pedal can be used to turn turn/slide to the next page of sheet music in case the detection of notes being played is not working as intended.

9.2.2 Source

This was recommended as a potential hardware component by our Sponsor, Shawn Gieser

9.2.3 Constraints

The bluetooth pedal will not work if the app does not have the implementation of a pedal to turn/slide to the next page. SoundSync not recognizing a bluetooth pedal connected to the device.

9.2.4 Standards

Any bluetooth pedal that is used with the app must meet Bluetooth SIG standards for proper compatibility with the device and the app. [2]

9.2.5 Priority

Low

10 Future Items

10.1 Automatic Music Sheet Searching

10.1.1 Description

This feature will be able to detect the scanned sheet music that the user is feeding into the system. It will then compare the initial pages to a larger database of already-digital sheet music and recommend to the user its successful matches. If the user selects a match, it will replace the user's scans and allow the user to retrieve and use this already-created sheet music for their piece.

10.1.2 Source

MelodyMasters team

10.1.3 Constraints

This feature's implementation will be constrained by the available sheet music database that we can use to compare the scanned sheet music. If the database is limited, this feature might not appear to the user as a useful one.

10.1.4 Standards

This feature should utilize a comprehensive sheet music database. The matching algorithm employed should follow established best practices in the field of symbol recognition and matching, ensuring accurate and relevant recommendations to the user.

10.1.5 Priority

Future

10.2 Performance Mode/Practice Mode

10.2.1 Description

This feature will allow the user to use their scanned sheet music in either a 'practice' mode or a 'performance' mode. The practice mode will allow the user to observe real-time accuracy metrics related to their playing. This mode will also consider the musical score's time accuracy, letting the user know if they are rushing or dragging a specific musical piece. The performance mode will be a minimalist view of the sheet music, ensuring that the user will have no distractions. This mode will only consider the order of notes played when considering the automatic page turning. Accuracy metrics will be available post-play for the user.

10.2.2 Source

MelodyMasters team

10.2.3 Constraints

This feature's implementation may be constrained by the need for efficient real-time processing of the user's performance data, particularly in the practice mode. The application should be able to handle the computational load required for analyzing accuracy metrics and providing timely feedback to the user.

10.2.4 Standards

The application should aim to provide meaningful and informative metrics that can help the user assess their performance and identify areas for improvement.

10.2.5 Priority

Future

REFERENCES

[1] Audio recording.

[2] A/v remote control profile.

[3] Privacy and security policies.

[4] Understanding scanning requirements.

[5] General requirements, 1996.

[6] Server-side encryption | google cloud services, Jul 2023.