Requirements Document

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1. Introduction

1.1 Purpose

The purpose of this document is to outline the overall features, constraints, descriptions, and obligations for the Music Assistant project. The intended audience for this SRS is Professor Eliza Dopira, our client. In addition, this document is available for Dr. Chan, our senior design project organizer, and any judges at a showcase or other interested parties.

1.2 Scope

Development will consist of a web and mobile application which will benefit students and teachers. Students will be able to interact with sheet music in the application by playing back the sheet music and singing along with their part. Their performance will generate statistics in a variety of musical areas and provide interactive, dynamic exercises for students to improve their performance. The students will also be able to access the integrated communication tool to query their peers and teacher about their current progress, to get suggestions for help, and to provide peer support to fellow students. Teachers will be able to view the accounts of their students accessing statistics

on both individual and group performance and access the integrated communication tool to provide guidance and additional feedback for students.

1.3 Definitions, acronyms, and abbreviation

1.3.1 Duration - an amount of time or how long or short a note, phrase, section, or composition lasts

1.3.2 Dynamic - the volume of a sound or note

1.3.3 Pitch - the degree of highness or lowness of a tone

1.3.4 Phrasing - the manner in which a musician shapes a sequence of notes in a passage of music, in order to express an emotion or impression

1.3.5 Rhythm - the pattern of regular or irregular pulses caused in music by the occurrence of strong and weak melodic and harmonic beats

1.3.6 Tempo - the pace or speed at which a section of music is played

1.4 References

1.4.1 IEEE 830-1998, IEEE Recommended Practice for Software Requirements Specifications

1.5 Overview

The SRS contains the initial requirements of the Music Assistant project and application. In section two, the overall description of the application is outlined including product overview, user characteristics, constraints, assumptions, and dependencies. In section three, the specific requirements are outlined including the user, hardware, software, and communications interfaces. The functional requirements are organized by the user classes of student and teacher with functional requirements attached to each class. The end of section three outlines performance requirements, design constraints, software system attributes, and other requirements. The document closes with appendixes and an index.

2. Overall Description

2.1 Product perspective

This application is meant to be an aid to students practicing in a choir. This requires interfacing with the teacher and student input including sheet music selection, student registration, and interacting with the integrated communication tool. A flow chart of interactions can be seen in Figure 1.

2.1.1 System interfaces

2.1.1.1 The teacher will be able to create and log in to their own account for the program.

2.1.1.2 The teacher will be able to register a new course and register students in that course.

2.1.1.3 The teacher will be able to add or select sheet music and share it will all students in the class.

2.1.1.4 Students will be able to practice the sheet music using the app by listening to the sheet music being played synthetically and provide input through a microphone of their performance.

2.1.1.5 The student's performance will be analyzed and compared against the expected performance from the sheet music. Exercises will be developed and presented to the student for practice.

2.1.1.6 The teacher will be able to access individual and group statistics from their practice and see the exercises that were developed for those students. The teacher may modify or supplement the exercises.

2.1.1.7 Teachers and students may use the integrated communication tool to interact through the software including sending individual and group messages, sharing performances, and highlighting areas of interest in the sheet music.

2.1.2 User interfaces

2.1.2.1 The app will report all performance that it records allowing the singer and the teacher access to these performances.

2.1.2.2 The app will maintain a copy of the latest exercises generated for each student which will be able to be viewed by both the teacher and student and edited by the teacher.

2.1.3 Hardware interfaces

2.1.3.1 The web app will be available on all major web browsers including Microsoft Edge, Internet Explorer, Chrome, Safari, and Firefox.

2.1.3.2 The mobile app will be available on android with backwards compatibility.

2.1.3.3 The mobile app will be available on iOS.

2.1.4 Software interfaces

2.1.4.1 Aubio v0.4.6 - A library that uses input from a microphone and performs real-time pitch detection. This library will be the cornerstone of receiving input from the student to perform analysis against the sheet music.

2.1.4.2 alphaTab v0.3.0 - A library that provides cross platform music notation and sheet music playback. This library will be the cornerstone of sheet music representation and playback for the student.

2.1.5 Communications interface

There are no current requirements for communications.

2.1.6 Memory Constraints

There are no current requirements for memory.

2.1.7 Operations

2.1.7.1 There will be a student mode of operation which provides a view of the current sheet music, latest statistics based on prior performance, lists of completed and uncompleted exercises, and messages interface.

2.1.7.2 There will be a teacher mode of operation which provides a view of class management, sheet music management, individual and group statistical analysis, lists of exercises generated for students, and messages interface.

2.1.8 Site adaption requirements

There are no current site adaption requirements.

2.2 Product functions

2.2.1 The application for the student will have its own set of functions.

2.2.1.1 The student will be able to view the sheet music digitally.

2.2.1.2 The student will be able to listen to any combination of parts in the sheet music.

2.2.1.3 The student will be able to practice their own part both during and without playback with the sheet music. A general outline of student practice is provided in Figure 2.

2.2.1.4 The student will be able to view exercises generated during prior performance.

2.2.1.5 The student will be able to send individual and group messages to other students and teacher.

2.2.2 The application for the teacher will have its own set of functions.

2.2.2.1 The teacher will be able to view individual statistics of a target student from previous practices.

2.2.2.2 The teacher will be able to view group statistics of all students and small groups of students with a summary overview of each statistic.

2.2.2.3 The teacher will be able to view and manage generated exercises for individual students.

2.2.2.4 The teacher will be able to manage their student's registration and sheet music database.

2.2.2.5 The teacher will be able to send individual and group messages to students.

2.2.2.6 The teacher will be able to assign and access grades for students assigned to exercises and general practice.

2.2.2.7 The teacher will be able to oversee student messages.

2.3 User characteristics

2.3.1 The ideal student should be familiar with basic music concepts of pitch, duration, dynamics, phrasing, rhythm, and tempo and how they relate to music.

2.3.2 The student should be comfortable with a chorus setting understanding the basic breakdown of choral parts.

2.3.3 The ideal teacher should be familiar with basic music concepts of pitch, duration, dynamics, phrasing, rhythm, and tempo and how they relate to music.

2.3.4 The teacher should be comfortable with choral organization and management.

2.3.5 The teacher and students should be comfortable with basic computer skills including file management, file uploading, and website interaction.

2.4 Constraints

There are no current constraint requirements.

2.5 Assumptions and Dependencies

2.5.1 Both the student and teacher can interact with dynamic web pages visually or using visual assistant technology.

2.5.2 The student will be able to hear the playback from the software both during practice of the sheet music and during exercises.

2.5.3 The teacher will be able to hear each student's performance for grading purposes.

2.5.4 The software will support English lyrics and both the teacher and student are assumed to be proficient in reading in English.

3.1 External Interfaces

3.1.1 Log In/Sign Up

Authentication allows the user to access their work and communicate with their teacher. The user will input their credentials (e.g. username and password or Google account) and the third-party authentication system will provide authentication keys as output. No other actions shall take place until the user is authenticated with the system. The username and password fields will accept strings. Any third-party authenticator will provide the third-party authentication system with string keys. The screen will display all log in options as well as a forgot password button. If the user logs in successfully, the application will move the user to their home screen. If the user fails to log in, an error message will display and the user will have the opportunity to try again.

3.1.2 Musical Analysis

Analysis is the core functionality of the software. As the student sings, the software will analyze musical elements in real-time and display where the user is in comparison to where they should be. Input will come from a microphone and output will be displayed graphically on the device's screen. Feedback should display within 15ms of the user singing a note. The device's display will show the music that the student is practicing as well as where they are singing.

3.1.3 Communication

Students and teachers will be able to communicate in real-time through a built in chat tool. Input will come from a user as a message string (student or teacher) and output will be the same message string output on the other user's device (e.g. student sending a message to a teacher). Messages should appear on the other device within two seconds of the message being sent. The device's display will show a chat box with a new message field as well as the chat history. Data will be strings stored in a database. Messages will also be able to reference an interactive copy of stored sheet music.

3.2 Functions

3.2.1 Students

3.2.1.1 Log In / Sign Up

The system shall take the student's credentials and pass them to a third-party authentication system. The third-party authentication system will perform validation and will provide a response. If the response is a success, the student will move to the home screen. If the response is a failure, an error message will appear and the student will be prompted to try again.

3.2.1.2 Musical Analysis

The system shall analyze sound coming from the device's microphone and respond with a musical note to display on the device's screen. If the analysis fails, the student will be prompted to start over. If the failure is minor (e.g. analysis misses only one or two notes), the system will recover automatically and the student will continue to sing.

3.2.1.3 Communication

The system shall take a student's message and pass it on to the correct teacher's device. If there is a failure sending or delivering the message, the student will be notified and prompted to try again.

3.2.1.4 Statistics

The system shall display statistics on a user's performance in the areas of pitch, duration, dynamic, tempo, rhythm, and phrasing. Graphical display of information may come in various forms, including pie charts and bar graphs.

3.2.2 Teachers

3.2.1.1 Log In / Sign Up

The system shall take the teacher's credentials and pass them to a third-party authentication system. The third-party authentication system will perform validation and will provide a response. If the response is a success, the teacher will move to the home screen. If the response is a failure, an error message will appear and the teacher will be prompted to try again.

3.2.2.2 Communication

The system shall take a teacher's message and pass it on to the correct student's device. If there is a failure sending or delivering the message, the teacher will be notified and prompted to try again.

3.2.1.3 Statistics

The system shall display statistics on students' performances in the areas of pitch, duration, dynamic, tempo, rhythm, and phrasing. Graphical display of information may come in various forms, including pie charts and bar graphs. The teacher will be able to view general statistics of all students or view an individual student's statistics.

3.3 Performance Requirements

3.3.1 Capacity

3.3.1.1 Number of Simultaneous Users

The application will support up to forty simultaneous users.

3.3.1.2 Storage of Sheet Music

The application will support the storage of ten pieces of music consisting of up to ten pages each for a maximum storage of 100 pages of music.

3.3.2 Real-Time Feedback

3.3.2.1 Frequency of Feedback

When providing real-time feedback of vocal input, the results will be updated at least 60 times a second.

3.3.2.2 Speed of Feedback

95% of feedback will be displayed within 0.015 seconds of input.

3.4 Logical Database Requirements

3.4.1 Types of Information

3.4.1.1 Audio Streams

Aubio can use audio streams from Pyaudio, and the audio will need to be stored as ffmpeg for the post-analysis.

3.4.1.2 Audio Files

FFmpeg and wav formats will be used to store the audio.

3.4.1.3 Sheet Music

Sheet music will be stored using AlphaTex to interface with AlphaTab.

3.4.1.4 Login Information

The login information for users will be stored using text for emails and some form of encryption for the passwords.

3.4.1.5 Student Records

Student performance records will be stored as audio files accompanied with the analysis of said audio.

3.4.1.6 Exercises

Exercises for students will be stored. Ten static exercises will be stored with an additional ten dynamic exercises per student.

3.4.2 Frequency of Use

3.4.2.1 Audio streams

It is expected that audio streams could be accessed as often as once a minute.

3.4.2.2 Audio Files

These are expected to be accessed once every five minutes

3.4.2.3 Sheet Music

These are planned to be accessed only a handful of times by students as they will download local copies to access as frequently as they desire.

3.4.2.4 Exercises

Exercises will be available to be generated and accessed as often as the user wants.

3.4.3 Data Retention Requirements

All data will be stored and can be deleted when appropriate.

3.5 Design Constraints

3.5.1 Hardware Limitations

3.5.1.1 Microphone

A student's device needs to have a microphone in order to practice their music. This microphone can be built in or external. An external microphone that is closer to the student's mouth will provide more accurate results.

3.5.1.2 Vocal Input

Musical analysis should be consistent across all browsers and devices. This will likely require any speech recognition to be handled on a server rather than on-device.

3.6 Software System Attributes

3.6.1 Reliability

95% of the time above mentioned standards must be maintained.

3.6.2 Availability

The communication server used to send and receive messages will not be unavailable for longer than 48 hours.

3.6.3 Security

3.6.3.1 Cryptographic Techniques

Cryptographic techniques will be utilized to ensure passwords are not readable to anyone and emails can only be accessed by class members and server administrators.

3.6.3.2 Logging

Events such as logins, failed login attempts, and all client-server interactions will be logged

3.6.4 Maintainability

There are no current maintainability requirements.

3.6.5 Portability

3.6.5.1 All software development will be written in languages that are cross compatible with all supported browsers.

3.6.5.2 The measured values from the microphone will be consistent across microphone types.

3.7 Stretch requirements

These are a set of additional requirements that will be nice to have.

3.7.1 Students will be able to view and grade another student's performance and be given feedback based on their grading aptitude.

3.7.2 Sheet Music will be able to uploaded from a pdf file and be imported into this software for playback and use according to copyright laws.

3.7.3 Students will be able to provide input from a variety of instruments besides vocal.

3.7.4 Teachers will be able to create exercises for their students.

3.7.5 Teachers will be able to edit the sheet music digitally which will automatically update for all students.

3.7.6 Major data formats for digital sheet music representation will be able to imported according to copyright laws.

3.7.7 Gamification of practice by adding point system for completing daily practice and exercises.
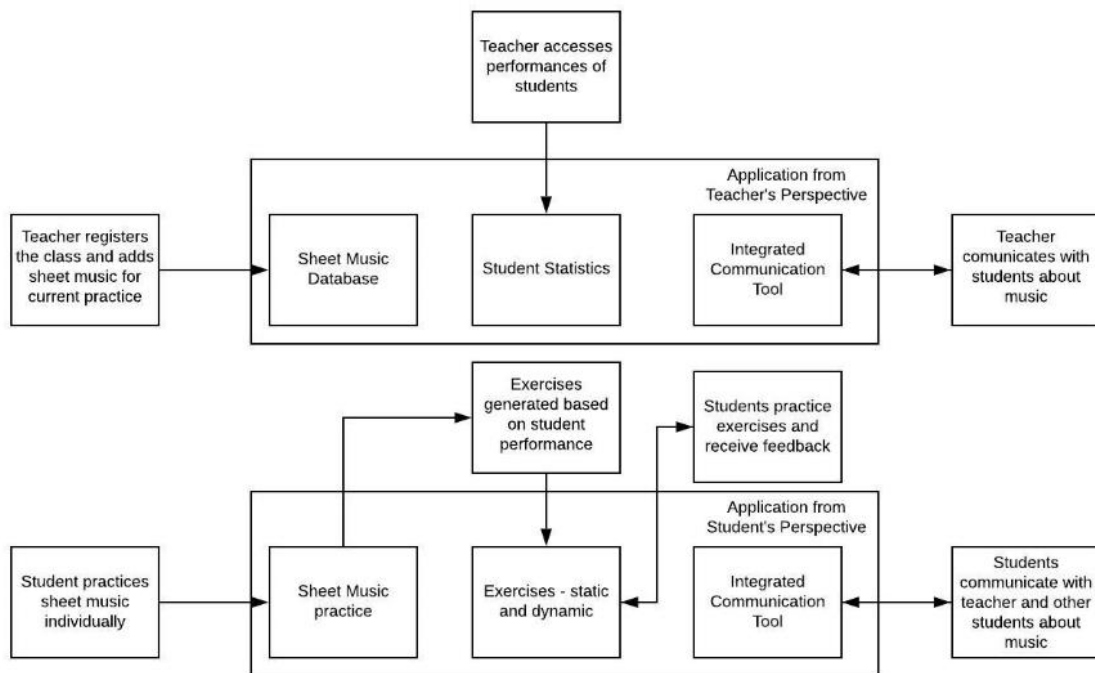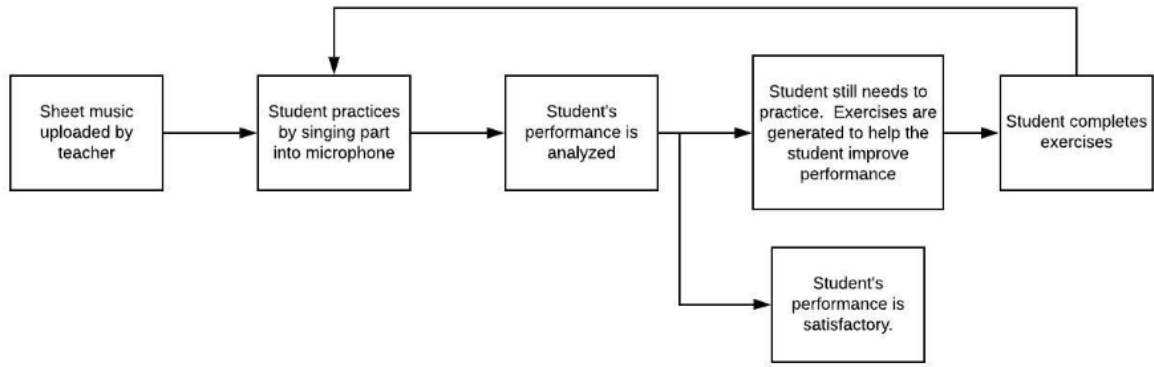
Appendixes

Figure 1

Figure 2