

Plan (Jan 22)

The Music Assistant

Team Members

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Faculty Sponsor

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Client

Name	Affiliation	Email
Professor Elizabeth Dopira	Director of Choral and String Studies	edopira@fit.edu

Meetings with the Client

Date	Topics Discussed	Resolution and Tasks Assigned
N/A - Client was not able to meet before the deadline.	The project plan was sent to the client and the client stated that the plan looked good - no changes necessary.	None.

Goal and Motivation

The goal is to help students learn sheet music and improve their singing ability. This will be accomplished by developing an application to provide choir students with real-time, interactive feedback as they practice by analyzing pitch, duration, dynamic, tempo, rhythm, and phrasing compared to the sheet music provided by a choir instructor. The app will provide static and dynamic exercises developed based on the sheet music. The app will also provide an integrated communication tool between student peers and between students and teachers to facilitate a conducive learning environment.

We focus first on choir students. Choir members are often expected to learn and practice on their own, but many members either don't practice, don't know how to practice, or don't practice correctly. The impact of these circumstances is felt when the choir practices; time is wasted reviewing and teaching students their parts instead of working on integrating the choir together and focusing on the minutia of the piece. Students tend to struggle when practicing independently for reasons such as lack of training, discipline or self-confidence. Current applications exist which can analyze music and provide feedback for students by showing the discrepancy between what the student is performing and the performance that was expected in regards to pitch and duration. The applications that provide this feedback rely on a set series of exercises and abstract away the actual sheet music and multi-part harmony. They also do not provide interactive guidance to students who are struggling.

Approach

Core Features for Singers

1. A web and mobile application which provides playback features and a method to record the student's performance to provide real-time, dynamic feedback.
2. Statistical analysis
 - a. Statistics would be presented in a variety of visual and textual formats and will be integrated into the sheet music directly.
 - b. While the student is singing their part, the app will perform calculations on a variety of musical areas including highlighting discrepancies in perceived and expected pitch, duration, dynamic, tempo, rhythm, and phrasing.
3. Exercises

- a. Based on user feedback, exercises will be provided to help students in the general areas of pitch, duration, dynamic, tempo, rhythm, and phrasing.
 - b. After the app has analyzed a student's performance, exercises will be developed dynamically to target areas of difficulty.
4. An integrated communication tool will allow students to query their peers and teacher about their current progress, to get suggestions for help, and to provide peer support to fellow students.

Core Features for Teachers

1. Statistics about individual student performance
2. General statistics about the choir as a whole
 - a. The teacher will be able to see areas where the most students are struggling and/or where particular part(s) of the choir (e.g. Sopranos) are struggling.
3. The integrated communication tool will provide a connection to remote or struggling students. Through this connection, teachers can provide guidance, reminders, and additional feedback.

Additional Features for Singers

1. Sheet music image parser
2. Support other instruments as input
3. Teacher-curated exercises

Additional Features for Teachers

1. The teacher will be able to upload their own copies of their sheet music per copyright laws into the app which can then be used for rehearsal.
2. Digital sheet music editing
3. Integration with other sheet music databases while adhering to copyright laws.

Novel Features and Functionalities

The main novel feature of this approach lies in the real-time, interactive feedback that assists students as they practice. Current systems provide feedback such as showing you the visual discrepancy between the pitch and duration that you are singing versus what is expected and expect you to fix your singing yourself. Our approach will gather statistics across multiple musical areas including pitch, duration, dynamic, tempo, rhythm, and phrasing. Using these statistics, the app will formulate exercises to guide the student to perfect the areas in the score where they are struggling. For example, if the student is struggling with a certain few bars in the music then the app will formulate an exercise with just the rhythm and will get the student to perfect that rhythm before then focusing on the pitch and then putting them together. These interactive sessions will help students who lack training to improve.

The other novel feature will be the communication tools between the student and the teacher. Our app will provide the teacher with overall statistics over all the practice sessions and will help the teacher to guide group practice by highlighting areas where the group is struggling in the piece. Some choirs have a choir director who is trained to guide practice and already do this in practice. This feature would help choirs whose choir director is inexperienced or in choirs like our acapella group on campus which is student led and lacks a dedicated choir director.

Technical Challenges

- We plan to provide real-time, interactive feedback but our system thus far has experienced performance problems. Due to our unfamiliarity with website development, we will need to research how to improve the performance of our software.
- We need to setup a database and server on the backend for the website which we haven't done before.
- We need to determine an efficient method of storing the data on the backend server so that our analysis is timely and effective.

System Architecture Diagram



System Architecture Diagram.pdf

Evaluation

- Effectiveness: Student performance will be measured when they first use the app and again near the end of semester. There should be an improvement in student performance. Ideally a control group could be had to compare the results of the exercises as opposed to the natural improvement as the students practice throughout the semester.
 - Performance is measured by comparing what the student sang to what the sheet music requests. This is done by analyzing the accuracy of pitch and duration of notes sung.
- Accuracy: Using the sheet music, a file will be generated containing machine-produced performance of the piece and then the software will grade the machine's performance. The analysis should result in a near-perfect score.
- User Survey: A survey will query the students on ease of use and whether or not they believe the program helped them learn. A similar survey will be given to the teacher/client who will be asked whether it was a useful learning aide or not.

Progress Summary

Module/feature	Completion %	To do
Create Web App Template and Host on Firebase	100%	None.
Real-Time Feedback w/ AlphaTab and P5	85%	Fix performance problems. Load AlphaTab only when needed. Fix AlphaTab bugs.
Authentication	80%	Finish coding sign up flow and sign in flow.
Create MySQL Database and Upload to AWS RDS.	50%	Code database design and add database to AWS RDS.
Encapsulate provided sheet music and real-time performance for analysis	75%	Encapsulate student performance to compare against stored sheet music
Integrated communication tool	0%	Set up real-time database, design front end app, design back end app
Display sheet music with configurations	75%	Include custom settings page and options

Milestone 4 (Feb 17) Tasks

- Implement, test, and demo sign in and sign up flow working from the frontend to the backend.
- Implement, test, and demo adding sheet music and related initialization data.
- Implement, test, and demo the flow from performing to receiving exercises.
- Implement, test, and demo all of the customization settings for AlphaTab through the website.

Milestone 5 (Mar 23) Tasks

- Implement, test, and demo setting up a class and overseeing students.
- Implement, test, and demo user results
- Evaluation results

- Create poster for Senior Design Showcase

Milestone 6 (Apr 24) Tasks

- Implement, test, and demo the messaging service.
- Test/demo of the entire system
- Evaluation results
- Create user manual
- Create demo video

Task Matrix

Task	Daniel Griessler	Daniel Levy	Javier Munoz
Authentication	0%	100%	0%
Set up AWS RDS w/ MySQL	0%	100%	0%
AlphaTab Customizations	30%	70%	0%
Flow from performance to exercises	65%	10%	50%
Verify Accuracy of Analysis	0%	0%	100%
Generate Exercise based off Analysis	0%	0%	100%

Description of each planned task for Milestone 4

1. Authentication: Add Firebase Auth to web app. The sign-up flow has been designed, but needs to be coded. Some technical challenges include handling page routing and sending emails for joining a choir. Each "admin" will be given a random code for their choir and must provide the code to students and other admins in order for the students to join. Any admin can accept or reject the requests to join.
2. Set up AWS RDS w/ MySQL: Design the SQL database, code the database, and upload it to AWS RDS. This includes properly setting up an AWS RDS instance. Once the database is up and running, we need to connect it to the web app. Connecting to the web app will require some sort of database authentication and we have yet to figure out how to pass the Firebase credentials to AWS RDS.
3. AlphaTab Customizations: Add custom controls (e.g. show/hide certain elements) to the sheet music. AlphaTab offers an API for these controls, but we need to design and implement the controls ourselves.
4. Flow from performance to exercises: Be able to sing along with the sheet music, send the performance to the server, analyze the performance and get a list of exercises, and send the exercises back to the webpage.
5. Verify accuracy of analysis: Both the back end audio and front end ML5 libraries should produce similar analysis of the same recording. This analysis should reflect a near perfect performance given a generated wav file. If not, we have to determine how to proceed with the analysis, likely keeping the front end analysis as the real-time analysis is the most difficult.
6. Generate Exercise Based Off Analysis: Given a recording of a performance and the sheet music corresponding to the performance, an exercise should be generated that focuses on improving the weakest parts of the student's performance (i.e. a particular measure and either the pitches or duration of the notes sung)

Approval from Faculty Sponsor

"I have discussed with the team and approve this project plan. I will evaluate the progress and assign a grade for each of the three milestones."

Signature: _____ Date: _____