Project Proposal (Draft A)

ECE496 - Design Project (2018 - 2019)

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1.0 Project Description

1.1 Background and Motivation

People start to spend more and more time on entertainment as technology advances and life quality improves. Nowadays music related applications play an important role in people's entertainment activities [1].

Information sharing is now much more convenient with the appearance of the Internet and smartphones. People these days are more likely to sing and share their favorite songs rather than just listening. Furthermore, people will also benefit from professional advice in some specific areas, such as singing, musical instruments and sports. The team would like to develop a product according to the above demands, which combines entertaining, professional assistance and social network enablement.

Traditional music applications such as Spotify are solely designed for searching and playing music, similarly, social media applications have only sharing ability. Besides, people need to seek help from either musical studio or professional software whenever they want to record a soundtrack. After evaluating some of the existing products on the market, the team believes that there lacks a product that combines all functions mentioned above, and this has become the motivation for our project.

1.2 Project Goal

The goal of this project is to establish a system or platform for singing and sharing songs anytime and anywhere. A successful project should allow users to record the songs they sing and improve their singing skills with the feedback generated by the application.

1.3 Project Requirements

Most of our project requirements are from functional perspectives. The following table consists of all requirements and the corresponding descriptions:

ID	Project Requirement	Description
1	The platform can record and store users' voice	**Primary Functional requirement:** the ability of recording user's voice is the foundation of our project

2	Users should be able to search and access songs using our product	**Objective:** the ideal result is that user can access as many songs as possible online, the search function should be intuitive to use.
3	Recorded voice can be translated into signal data for analysis	**Primary Functional requirement:** Feedbacks should be given according to users' singing skills, which requires users' voice to be translated into analyzable data.
4	The product is able to give users feedbacks on songs they sing	**Primary Functional requirement:** The feedbacks are based on the signal data produced, as mentioned in requirement No.3.
5	The product should help users understand and improve their singing skills	**Objective:** Users can understand and improve their singing skills by getting feedbacks from our product. The feedbacks should be as accurate and informative as possible. For example, auto-generated information which contains comments and suggestions is more informative and intuitive than a simple graph of the song's waveform.
6	Users can share recorded songs with others using this product	**Subfunctional requirement:** it depends on how much we can integrate other social network platforms with our product. Primary solution is to allow users to share songs to other social media platforms like Facebook or Twitter. The alternative solution is to allow users share songs within our own platform only.
7	The final project should be easy to use with an aesthetic and user-friendly interface	**Objective:** The product should be as easy to use as possible. Users should have no difficulty with understanding basic operations, a well-designed user interface is also necessary for better user experience.
8	The product should be portable	**Primary Functional requirement:** The product should be portable to allow users to use it anytime and anywhere.
9	Runtime of all feature algorithms should not exceed 10s	**Constraint:** performance requirement. According to Jakob Nielsen's book for usability engineering [2], the runtime should be limited to at most 10s.
10	Reduce the users' expenditures on this project	**Objective:** The total cost that users need to pay for our product should be minimalized to attract more users.

2.0 Technical Design

2.1 Possible Solutions and Design Alternatives

Our team came up with 3 alternative designs for the project, each alternative represents a possible project implementation platform. All alternatives have their advantages and disadvantages, our team carefully evaluated each alternative to make sure that the proposed initial technical design best meets our project goals and complies with the project requirements.

The first proposed design is a smart multimedia control system, the system is to be installed on a desktop computer and will have the ability to connect all users' existing multimedia hardware and allow users to sing and record their songs. Users can have an overall enjoyable experience with big screens and high definition sound qualities with their existing hardware, like a home theatre system, which already includes TV and speakers. Furthermore, such system can support multiple singers at the same time, which means real time sharing among all participants. However, if users do not have access to the above equipment, the product will require a significant amount of initial investment in equipment. The usage environment of the implementation is also restricted to users' living area, hence less portability for users.

Another possible solution suggested by the team is an integrated portable device. The device is solely designed for the purposes of singing, recording and sharing, etc. The product will be optimized from the hardware level to best serve these purposes, for example, an integrated microphone to record the users' voice. The size and cost of the product will also be minimalized for portability and affordability, but additional cost is still required for users to own this product.

The final proposal is a mobile application developed for smartphones, the application will take usage of system APIs to work with existing smartphone hardware like speakers, screens and microphones, which means extra investment will not be required to access the product. The mobile device market is also showing a very large ownership of smartphones [3], this implies better accessibility to the application for the users, also a very supportive community for developers. The audio and video performance may be compromised compared to a home theatre system due to smaller screens and less attractive sound qualities, but the accessibility and portability of this implementation is the best among all proposed designs.

To illustrate the justification more intuitively, some criteria that can best differentiate the proposed designs are selected from the project requirements section. The following table is created to evaluate each design according to these criteria.

Alternative Designs — Selected Project Requirements	Smart multimedia control system	Integrated portable device	Mobile application
Usability	Easy to use since it is on desktop computer platform	Extra time is required for users to learn how to operate a new device	Easy to use since it is on mobile platform
Portability	Doesn't have portability	Has portability	Has portability
Users' Cost	No extra expenditures if users already have all the equipment	Users need to pay extra expenditures to purchase the new device	No extra expenditures if users already have smartphones

As shown in the above table, the mobile application solution performs the best for the selected requirements.

3.0 Work Plan

3.3 Feasibility Assessment (resources, risks)

3.3.1 Skills and Resources

Based on the functionality designs and our proposed development solution, the key skills and knowledges required in this project are listed as follows:

- iOS Development
    - Swift Language
    - Third-party Swift Audio Library "AudioKit"
    - Xcode Development Environment
    - Beta Testing by Testflight
- User Interface (UI) & User Experience (UX) Design
    - Prototyping using Sketch or other softwares
    - Xcode Storyboards
- Machine Learning
- Signal Processing

Throughout the above list, except contents involving iOS development, all other knowledges and skills have been previously acquired by at least one of our team members, which were from either lectures or working experience; however, some key parts of those acquired skills still require deeper understanding. For the iOS development, fortunately, resources for learning are comprehensive. The plan and resources of study is listed below:

- From the web:
    - "Apple Developer Documentation [4]"
        - Learning Swift and all essential knowledges about iOS development
    - "AudioKit" Development Documentation [5]
        - Learning the implementation of the iOS library "AudioKit"
    - "Apple Developer Forums [6]"
        - Asking questions for any technical difficulties about iOS development
    - "Dribbble [7]"
        - Study on and inspired by other professional designers' ideas on iOS UI and UX design
    - "University of Toronto Libraries" Website [8]
        - Search for scholarly resources about signal processing, machine learning and etc.
- From the supervisor & other professors:
    - Discussion
        - Discussing the feasibility of design implementation
        - Seeking further academic support on signal processing, machine learning and etc.
- From libraries:
    - *"An Introduction to Audio content analysis: Applications in Signal Processing and Music Informatics* [9]*"*

3.3.2 Risk Assessment

a) Infeasibility of Algorithm Development on Scoring and Feedback

As a core module of this project, the major algorithm development is targeting to grading and commenting on users' performance of singing skills. As this module will only be triggered after recording user's voice, the failure of its development will not bring any negative effect to other functions. However, since it is a core feature in our application, the infeasibility will lower the enjoyment of user experience and the attraction to potential users.

If scores or comments can't be provided to users, the alternative solution is to implement the graphic library to display the waveform of user's voice and the original song. As a result, the user will be able to visually find the difference between his/her voice and the song, like whether the tone is excessively higher or lower. Instead of directly giving simple scores and comments, this method will be more beneficial for professional user to improve their skills.

Regarding to this issue, no computer model can be implemented. But still, the alternative solution requires the significant change on project requirement 5, as the application won't be able to provide clear comments and suggestions on users' performance. Instead, the modified objective would be visually emphasizing the differences on signal wave of both vocal and musical part. Additionally, the project requirement 4, which is the primary functional requirement of giving users feedback, would be influenced as well.

b) Infeasibility of Functionality on Third-party Sharing

Nowadays, third-party integration has been helping many recreational applications attract potential users [10]. In our project, third-party integration is mainly focusing on the sharing of user's singing voices to other social platforms. On one hand, user's skills and potentialities can be shown to more people; on the other hand, more potential users will be attracted to our application, and our user group will get expanded directly. Serving as an independent module, the infeasibility of developing third-party sharing function will not affect any other functions. Same as the secondary function, the influence caused by the lack of this function is limited.

If direct third-party sharing cannot be implemented in our project, then we have to develop our own platform, as our backup plan. This solution requires us to develop both frontend and backend. For the backend, the basic structure involves server and database. Database will be used to store users' accounts and usage record, including their singing data in need of sharing. Server will be mainly developed based on a web framework, to handle all the requests sent by users, including but not limited to storing user's singing data, requesting playback of designated user's recording data and viewing user's profile. For the frontend, designing and developing the visual page will be the main focus, no matter on mobile app or other environment.

Beyond question, no computer-based models can be simulated regarding to this problem as well. To fully meet the project requirement 6, this sub-functional requirement will be realized by using our own platform, as connecting to social network won't be feasible in this case.

References

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