

CMSC 23400

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2 Motivation

There are two main objectives that we wish to accomplish with our mobile and wearable Android application Playlitr. Our first objective is to democratize control of the music-playing experience at casual hangouts, parties, and bars and cafes. Our second main objective is to collect sensor data from the surroundings, particularly of users' physical movements and heart rate, in order to learn about users' music listening preferences and to recommend music based on these perceived preferences. By focusing on these two objectives, we will explore many of the ideas that we have explored in class, such as "Ubiquitous Computing" and "Everyware", and we will develop software for the latest Android devices, including Android smart watches and new Android mobile smartphones.

The "Background/Prior Work" section of this write-up provides a description as to why we want to democratize music selection in a group setting, and this section describes the research and ideas that our application will incorporate and how our application could potentially show proof for these various concepts. Broadly speaking, Playlitr will allow users to queue up songs from their own mobile devices to a central device, which would presumably be connected to speakers and would be playing music on a central playlist, at the event. In addition, we will provide additional features, such as voting and starring songs, in an effort to give users even more influence over the music. Initially, we thought that these key features could make for a great music application and potentially change the music-playing experience in various group settings. However, having been exposed to many papers concerning mobile computing in this course, we now believe that we can create a much better application. Playlitr is based, in part, on the ideas of Weiser and Greenfield and on one ubiquitous computing vision that we discussed in class, which envisions an environment that constantly adjusts based on peoples' preferences, which are pulled from their smartphones, wearables, etc. When one first conceives an idea for an application that he or she thinks

could solve a problem or fill some need, one might have the tendency to overestimate the extent to which new users would be willing to explicitly interact with the application in order to fill a need. In our case, we believe that we have identified a problem with music-playing in group settings, but we are no longer confident that a large number of users would be willing to frequently queue songs and have to press buttons to vote for songs on the central playlist. These features will still be very much a part of our application, as they will allow users who are willing to interact directly with our application to precisely share their music listening preferences with the group. However, we believe that there needs to be a way for more-passive users to be able to share their preferences with the group with very little effort on their part.

Let us consider the popular music application Pandora with its voting system, which requires users to physically press/click vote buttons in order to help the service better select music for the listener. Pandora's music selection algorithms are extremely sophisticated and, in our opinion, quite good at selecting music for users when they listen by themselves. However, we find it puzzling that the only way for users to relay their preferences to Pandora is for them to press voting buttons. We live in a world where "The Internet of Everything" is the latest phenomenon. There are many smart devices that determine users' preferences passively, such as thermostats, notably Nest thermostats, which regulate temperature in homes by collecting data from the surrounding environment and analyzing patterns in this data to conform to users' preferences and save them money on energy when they are not around. Our application develops Greenfield's belief, "Surfaces, gestures, behaviors as we've seen, all have become fair game for technological intervention" and focuses on using peoples' gestures and behaviors, in response to music, to gauge their music-listening preferences. By using accelerometers to measure peoples' varying levels of activity during songs and by collecting heart rate data, we will complement our more traditional, explicit, voting and queuing systems. Users will not have to press buttons to give their feedback on the music,

but rather will need to just open up Playlitr at an event and allow it to collect data on how they respond to the music.

We believe that it is crucial to support Android wearables in addition to Android smartphones. We will need to rigorously test our application on both types of devices, in order to determine how accurately wearables and smartphones can collect sensor data. With wearables, we believe that we can collect accurate information on groups of users at particular events and potentially give better recommendations for songs to play in particular groups than those of services like Pandora or Rdio. In our opinion, some songs are better for parties, dancing, drinking, etc., and we do not believe that services like Pandora and Rdio, which rely on their push-button voting system, understand this as well as they could if they were to analyze the movements and vitals of their users. If time permits, we would like to use the sensor data that we collect to facilitate user interactions at events. This could involve something as simple as sending push notifications to two users whose activity levels are low and suggesting that they dance together. We are interested in exploring more possibilities for facilitating user interaction after we have the main functionality for our application working. Not only will we use sensors to collect information on a user's reaction to music, but we will also rely on a user's location to make it easy for users to learn about and join "SongRooms", which hold a group's collaborative playlist. In working on this application, we will learn more about the capabilities of current mobile technologies to collect sensor data, and we will create a music application that changes the way music is selected in group settings, making it easy for both active and passive listeners to have a say in what is played.

3 Background

At events where music is played, guests have limited control over song selection. This creates several problems. When a guest has a song request, he or she can plug their phone into the speaker system and annoy the entire party, pester the host or DJ into playing a song, or remain dissatisfied. None of these is an optimal event experience for anyone involved. Moreover, event-goers have no way of getting the playlist of the songs played at the party.

It is in everyone's best interest to ensure that these problems are dealt with. If people are having suboptimal experiences at parties, bars, and other venues, they will be less inclined to spend more time and money there.

Playistr gives the host of an event the ability to create a SongRoom, which will hold a central playlist that people can join as guests. When a host creates a SongRoom, he or she chooses one of his or her Spotify playlists, or an empty playlist, and this playlist becomes central to the party, allowing guests to add songs to it and vote for songs on it. The host will be given certain administrative privileges within the SongRoom, such as the ability to remove users from the SongRoom, the ability to remove songs from the playlist, and the ability to skip songs and play any songs, even if they are not on the playlist, whenever he or she chooses. The music will play on the host's phone, which will presumably be connected to speakers.

Users will be able to queue songs from their Spotify playlists and song libraries. In addition, users will be able to see the song that is currently playing and those on the queue that will be played later. Finally, users will have many other capabilities, including the ability to vote on songs in the queue, so that they can give priority to songs that they want to hear most at these events. All of the features that have been described so far can be done on smartphones. There are even more features that will be available to users who own an Android smart watch. These users will be able to use their smartwatches as extensions of a

smartphone application The smartwatch application that we will build will be a pared-down version of the smartphone app, with the exception of added functionality for collecting sensor information about its wearers, particularly heart rate data and motion data. To be clear, the Playlstr application that runs on Android smartwatches will support voting, will allow users to vote for songs on the main playlist, and will collect their movements and heart rate in order for the application to passively learn about their listening preferences. The application will process the sensor information it receives from users and make song predictions based on music that presumably caused an increase in physical activity, as measured with accelerometers and heart rate sensors. If time permits, we would like to use these data to facilitate user interaction in clever ways. In the motivation section, we said how this could be as simple as sending push notifications to two users whose activity levels are low and suggesting that they dance together. This application will give users with smartwatches the ability to influence the music that plays without having to necessarily vote for songs by pressing buttons.

Most of Playlstr’s competitors are really indirect competitors. Preexisting music services that people currently use to listen to music fall under this category. These services include iTunes, Pandora, Youtube, Soundcloud, and even Spotify. None of these services provides the ability to collaboratively manage a playlist during a party, but many people currently use some combination of these services to handle a party’s music. These services have very large user bases – virtually all music listeners use them today. In fact, the most significant challenge in getting party hosts to use our app will be to get them to change their behavior – using Playlstr will let hosts ensure that their guests have a better time by having a little more control over the music, without any extra mental overhead on the host’s part.

Each of these services also has special licensing agreements with different record labels—a significant barrier to entry for new services. By using Spotify’s API, we can ensure that users have access to all 30 million songs available on the platform. This is well within

their terms of service, and since we incentivize people to join Spotify (by requiring them to login through Spotify O-Auth if they want to play songs or save songs), this is beneficial to their business, too.

Crowdcast, Sonos, and Spotify Connect are more-direct competitors. Crowdcast is an iOS app that attempts to accomplish a very similar task – collaborative playlist management. However, they approach it very differently from what we plan. They attempt to license their own music, which makes users responsible for paying for the rights to songs. The users must already own or purchase the songs on iTunes in order to queue them up in the collective playlist. This works for people with extensive iTunes collections, but many individuals now use streaming services in order to get their music. By using Spotify’s API, we provide access to all of their songs for free. Moreover, Crowdcast is only usable on iOS devices, and requires use of Bluetooth-enabled multi-peer connectivity. By the user specs, this is limited to eight devices, and so is not really applicable to larger groups.

Sonos is a Bluetooth-enabled speaker system that connects directly to phones. A phone connected via Bluetooth to the speakers will stream all audio directly to them. Only one person can connect to a Sonos speaker at any given time, but multiple people can have access to them. In this way, partygoers can switch control of the speakers between themselves. There is no central playlist for the Sonos speakers, though, so people not currently connected to the speakers have no way of influencing what music is played. Also, there could be other issues with having guests take control over music- playing, such as not being able to give one user, such as the host of the event, certain administrative abilities, or running into issues where a user takes over control of playing music and does not have good cell reception or does not have access to a good Wi-Fi network, which could cause interruptions in the music and a reduction in music quality. Moreover, the speakers are expensive and venues that have already invested in a sound system will likely not want to switch over to Sonos. Spotify Connect, on the other hand, supports a very similar use case, but does not require specific

speakers. Rather, it requires only a music-playing device that can run the Spotify/Spotify Connect app. Spotify Connect can be a more affordable alternative to Sonos, but has the same issues, such as limiting control of the music to the individual who is currently paired with the device running the Spotify/Spotify Connect app and the potential problems with switching between users with different cellular providers and with different access to Wi-Fi networks.

Overall, this has been a broad overview of the various features of Playlitr and the competition the application will face. The application will be described in more detail in the following sections with the aid of various diagrams that should give the reader a better idea of the appearance of the application on the frontend and what the backend infrastructure will include.

4 Project Specification

The fundamental purpose of PlayListr is to improve the experience of guests at events playing music. However, there are a variety of avenues by which we can achieve this goal, and we hope to explore as many of them as we can under the time constraints.

4.1 Capabilities

We can divide our planned features in to a hierarchy, such that each higher level depends upon a correct implementation of the previous one:

1. Core functionality.

The core functionality of the app is to allow a host to create a “room,” and to allow guests who join the room to have control over the music that is played.

However, a variety of structure must be in place in order to accomplish this goal. The core functionality is the most ambitious part of this project — a successful implementation requires:

- Correct interoperation with Spotify in order to authenticate users and stream music.
- Construction of a database to hold identifying information about users, with sufficient information to reconstruct the user’s Spotify account details, as well as the details of all existing rooms and the songs enqueued within them.
- Development of a server that exposes a REST API, giving access to the database and allowing simple CRUD operations.
- Ensuring consistency across many mobile users connected to the same room, taking in to account the possibility of high network latency over cellular data networks.

With this in mind, we have focused our current development efforts on building the core functionality before tackling the features that follow — in the “software architecture” section below, we outline an implementation of the core functionality.

2. Location awareness.

Users should be prompted to join a room whenever they come within a pre-set distance of an existing room via push notification.

3. Smartwatch integration.

Users should be able to vote on songs and see the currently playing song from the display of their Android smartwatches. This will likely take place via Bluetooth communication with their smartphones. This step is crucial for the following step since smartwatch sensor data will allow for a much more accurate picture of user activity within a room.

4. Adaptive song selection on the basis of sensor data.

The app should detect when the activity level within a room rises or falls and play faster- or slower-paced music, accordingly. For simplicity, we will simply select songs currently in the queue and pad tempo-matched songs with artificial votes in order to float them to the top of the queue — this avoids problems of trying to match the genre of the music currently being played.

We can take a variety of angles in processing sensor data, but the simplest is likely to be taking the average norm of the acceleration vector of each user per unit time. For example, given that we have accelerometer data for the user’s acceleration \vec{a} such that:

$$\vec{a} = (x, y, z)$$

And, letting \vec{a}_u represent the acceleration vector for the user u belonging to the group

of users U in a room during the previous tick, we define the activity level l of that tick to be:

$$l = \sum_{u \in U} \frac{||\vec{a}||}{|U|}$$

$$= \sum_{u \in U} \frac{\sqrt{x^2 + y^2 + z^2}}{|U|}$$

Yielding a natural and intuitive notion of “activity level” that can be quickly computed.

5. Social features.

Users have a “friend list,” consisting of other users, that allows them to initiate communication (perhaps via a builtin messaging service, or a tie in to an external messaging service, such as Facebook Messenger).

6. Gesture recognition.

Users can add each other to their friend lists by shaking hands. Time permitting, we can explore other gestures, such as a high five to indicate that both users upvoted the current song.

7. User pairing on the basis of activity level.

Given that the server will have access to the activity levels of all users in a room, users can opt-in to a “friendly mode” in which they will be periodically asked if they would like to become friends with another user in the room based on similar activity levels (and perhaps similar music preferences). If both users accept, then a conversation is initiated between the two.

4.2 Software Architecture & Design

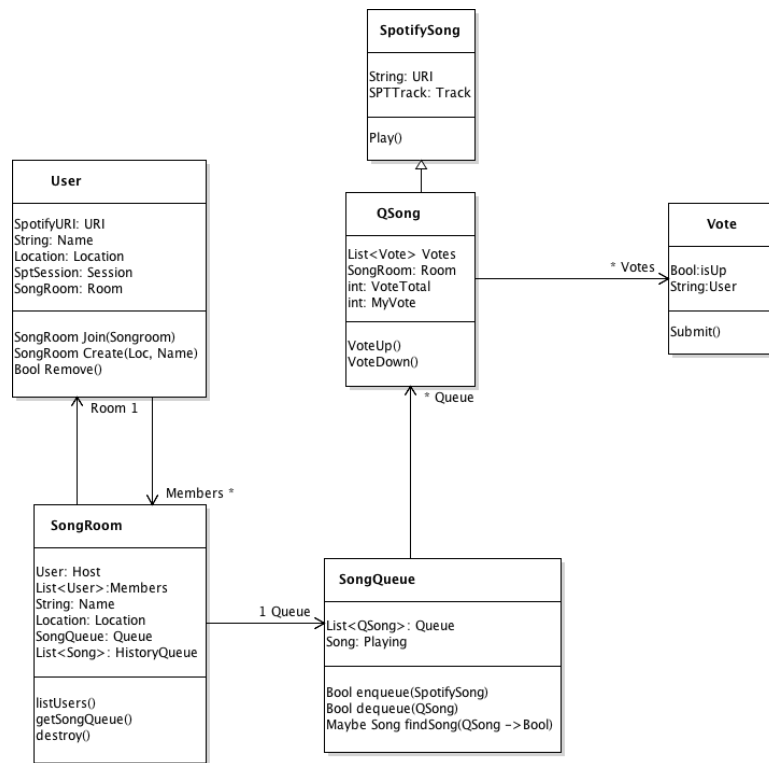


Figure 1: UML Diagram of Client-Side Code



Figure 2: UI Mockup

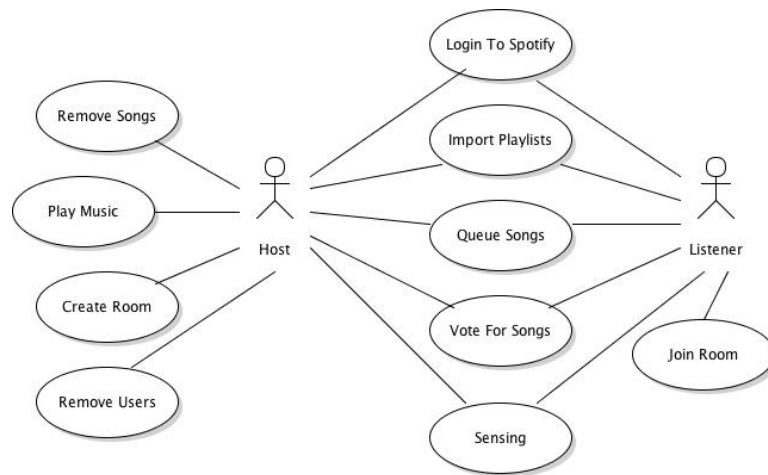


Figure 3: Use Case Diagram

5 Planned Demonstration

At the moment our demonstration is tough to solidify because at the moment we do not know how sensing will play into our final project. This will only become solidified when we learn more about how we can use sensing to infer a users musical preference. However we think the other usecases in the UML Usecase diagram below can be displayed easily through a 3 phone interaction with 1 host and 2 Listeners. The sensing element will likely require some sort of data visualization to show how sensing influenced the most recent song. This is something that we will further decide when we know what the nature of our sensing usage will be.

6 Implementation Schedule & Supporting Tools

6.1 Toolchain

Tools: At the moment we plan on using several frameworks and APIs to make our project happen. The Spotify Framework is how we will be getting access to music streaming. The Flask Framework is a Python web framework, which we will use for our server. We will also use the Flask framework to allow our server to interface with a MongoDB database using the Flask MongoEngine. The server and database will be hosted on Heroku. For using music preference to choose music we plan on using the Echo Nest API.

6.2 Schedule

Our first week we plan on working to get the basic functionality working. Our plan for dividing the work is roughly:

- Mark — Spotify (login to Spotify, play songs, import playlists)
- Patrick — Client Classes (create room, join room, enqueue/dequeue, upvote/downvote)
- Zach — Server (basic database structure, location based room lookup)

Once we have the basic functionality our focus will shift in 2 ways for the next week: get a basic UI working, figure out in what ways we can use sensing through experimenting with the technology.

At the end of the second week (Sunday) we should have a rudimentary version of the app working and an idea of what we want the final app to look like. From here the rest should be implementation that we are able to complete using our one-week iteration structure (Sunday to Sunday.)