AmbientDJ: Enabling Interaction between People and Socially Aware Environments

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ABSTRACT
In social settings, music selection can play an important effect on the psyche of the environment's inhabitants. Choosing the appropriate type of music for a social environment is a complex task involving the constant appraisal of the inhabitants' musical preferences and their changing reactions to the musical selections played. We present a socially aware music selection system that allows people to influence the music played in the environment they are in, using their mobile devices to indicate preferences. We discuss the interaction opportunities between people and their environment as well as the use of the environment itself as an interaction enabler between users.

1. INTRODUCTION
Music and song are some of the most pervasive cultural expression media and as such, form an important part of daily lives of people. Much like other forms of art that do not depend on speech to convey semantics, music and song are able to convey and provoke feelings and emotions regardless of listeners' backgrounds and are thus important elements that help define the dynamics and characteristics of social spaces. Just as a visually pleasant décor attracts people to a social space, music can be an additional element that enhances the experience of visiting a social space, although, in many cases, it is also perhaps the dominant element that attracts people to a space in the first place.

Given music's significance in social settings and environments, appropriate selection of music is a problem that requires as much skill as it requires taste and talent: music must be appropriate to the occasion, time of day, inhabitants of the social environment and type of sentiment the environment's creator or operator wishes to maintain. These criteria have varying importance depending on the situational context, making appropriate music selection a problem that cannot be solved by a static solution or formula.

The skill of selecting music appropriate to the occasion is practiced by Disc Jockeys all around the world. It is said, anecdotally, that a Disc jockey's (DJ) greatest ability is in understanding their crowd: they must constantly attempt to understand the changing dynamics of social environments and adapt the music selection to fit the mood of the crowd. They must also be able to appraise the effect of the music they have just played and adapt the music tempo and style to the "mood" of the crowd, as well as be able to occasionally accommodate requests for specific songs.

In some venues, famous DJs with a devout crowd play according to their own will and people will instead adapt themselves to the music. In other venues, multiple rooms allow people to move about and listen to various types of music played in each room, in an effort to relieve the repetitiveness of a continuous stream of music from a single genre. Recently, "Silent Disco"[1] type events allow people in the same environment to listen to two or more different DJs through multi-channel headphones that can be switched to their DJ of choice. However, in many social settings, such as in bars, events or home parties, employing a professional DJ is prohibitively expensive and music selection becomes the responsibility of either an amateur volunteer, or, in most cases, relies on pre-determined playlists which are left running on their own. The latter (static) solution to the music selection problem makes music inflexible and completely disjointed with the context and circumstances in a social environment.

In this paper, we will discuss a simple system that allows people to influence automatic music selection, using their mobile devices as interaction enablers to indicate their mood and preferences. The system works on the basis of a simple application running on a person's mobile device. The application allows people to indicate their preferred priorities of genres of music and transmit these to a music selection server wirelessly over Bluetooth as often as they like. The server constantly scans for users present in the environment and employs a genre bias towards the genre selection to select appropriate music. The server stores peoples' preferences and associates these to their Bluetooth MAC address, so the application does not need to run constantly on the person's mobile. Apart from detailing our system, we also will discuss the possible interaction opportunities with such a participatory system and its potential to transform the social environment itself into a person-to-person interaction enabler.

2. BACKGROUND LITERATURE

2.1 Music as a social medium
According to Holbrook, music is a medium present in virtually every aspect of human life [1]. This illustrates that music is an important medium to concentrate on and especially because of the effects which music can have on peoples' behaviors [2] and even their emotions [3]. However this can be problematic when it is also shown that often the music, which is exposed to the listener,

[1] See examples at http://www.silentarena.co.uk, or http://www.headphonedisco.com.

causes them to become annoyed with its presence [4]. When considering which music to play, an establishment will often gauge using its clientele and then make selections based upon them. However another option is to provide a jukebox which the customers can then select songs from and then wait for them to come on. A problem with this is that only people who pay the money to select the songs will get their preferences taken into account.

2.2 Pervasive Music Selection systems

MusicFX from McCarthy & Anagnostic [5] aimed to provide the preferred music for people to exercise to in their gym. This system had the gym members' preferences stored and had an algorithm to select which music was played using the preferences of who was present. Gym users had to sign in manually and signed out manually, setting pre-determined interaction points and also preventing users from dynamically updating their preferences.

Flytrap [6] used RFID tags to locate users within a social space. Users' musical preferences had to be gathered prior to the system's operation. The system employed a simple algorithm using heuristic-based rules to determine the next song to play and the researchers investigated interesting opportunities, such as displaying ranked song lists (by popularity), however, one of the most important findings was that exploiting commonality in musical tastes could be used as a basis on which social interaction between people could be increased in intelligent environments.

In 2004, the Jukola project [7] discussed an interactive Jukebox for bars or cafes. People could use PDAs to vote on MP3 music collections created by the venue owners. A public touch screen display could also be used by people in the bar to nominate songs for public vote. The Jukebox was also networked to allow access over the web allowing people to submit MP3s remotely or review a history of the music played on a particular day. While the system tests uncovered interesting aspects of interaction, such as users adopting strategies that would ensure their choices were played, such an implementation would require constant interaction from its users, bringing music to the foreground of attention, rather than allowing it to implicitly enhance user experience.

The "Smart Party" project by Eustice et al [8] presented a location-aware multimedia experience. This was developed with house-parties in mind as a type of social setting. The purpose of the "smart party" was for every person in the common areas (kitchen, living room, dining room etc) to have their musical genre preference recorded and used to create a specific play-list for the room that they are in, pulling music directly from the guests' devices. If there were more than one person in a specific room then the preferences would be combined and the play-list would be a mix of the preferences of the people present. The system used Wi-Fi to locate users present in each of the rooms, with moderate accuracy. A major drawback of the system was that it required pre-configuration as each guest's MAC address had to be known in advance. Furthermore, the constant use of Wi-Fi to locate and stream music would have a detrimental impact on the battery life of guests' devices, effectively limiting the system's operation time.

Mahato et al. in 2008 present a system for the personalization of public environments, using Bluetooth technology [9]. Users define once their preferences, using a web interface, and store them encoded in the Bluetooth friendly name of their mobile phone. This approach has two major disadvantages: first, it requires users to change their Bluetooth-friendly name to an encoded string of characters. This removes a user's opportunity to personalize their phone by giving it a "name" and also completely overrides the reason of existence of a Bluetooth "friendly name", hindering the user's experience when trying to send data to another device. The system was at a very early stage however, one interesting finding of this work was that people were keen to use systems that afford them influence over their environment.

3. SYSTEM OVERVIEW

3.1 Interaction Principles

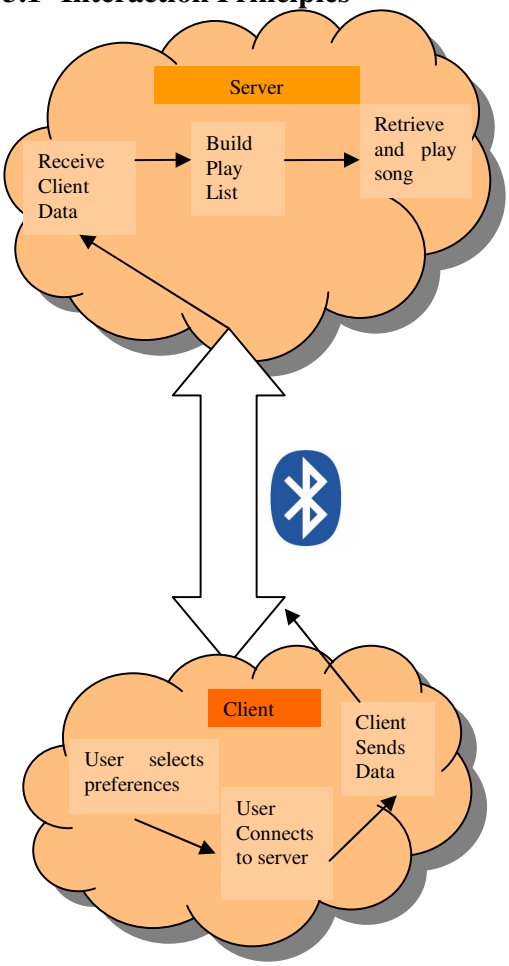

Figure 1: AmbientDJ System Overview

Our system (AmbientDJ) is comprised of two main components: A Music Selection Server, and the Clients, running on peoples' mobile devices. The Client application allows people to select and prioritise their favourite music genres (Rock, Pop, Jazz, Blues, Rap) and send these preferences to the Server, by performing a device discovery through the application and connecting to the Server. The Server logs preferences and associates them to each Client's MAC address. Therefore, the Client can be exited and as

long as the user keeps their Bluetooth device discoverable, the system will account their presence in its decision making process.

In using this system, people are empowered with influence, not direct control over the behaviour of ambient intelligence in their environment. We adopt this form of ***calm interaction***, in line with Weiser's Calm Technology vision [10], to avoid contest over the type of music that will be played by the system and to thus prevent music selection from distracting people from the primary function of a social space, which is to socialize. Furthermore, we allow people to easily and quickly reflect their shift in preferences as time passes in the social space, hopefully resulting in longer engagement with the social space and also greater enjoyment of social events or interaction that takes place within it.

3.2 Music Selection

Initially, without any Clients connected or present in the vicinity of the Server, the music selection is completely randomized across the genres represented by the system. Each song from each genre has the same probability of being selected for playback. With the presence of Clients, the Server utilizes a simple democratic bias to its choice of genre, effectively promoting the playback probabilities of all the songs under that genre. To prevent a situation where a particular genre dominates the playlist selection, the Server ensures that songs from genres other than the most popular one are selected as well. This approach should prevent minority users from feeling excluded from the selection process, while keeping majority users happy with their favourite genre being selected more often.

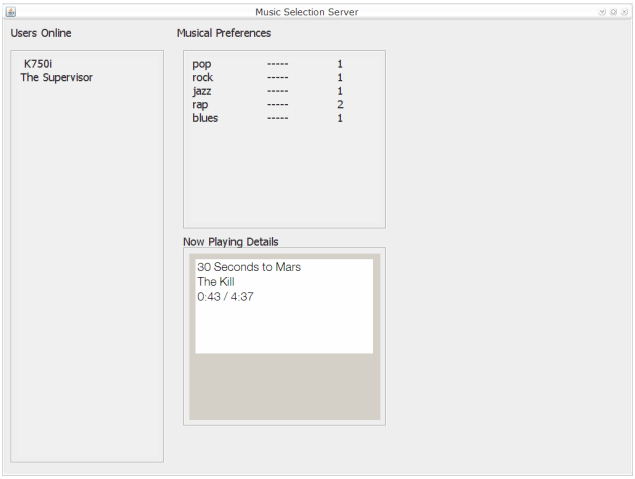

Figure 2: The Music Selection Server Front-End

We felt that based on the findings of past literature (especially Flytrap [6]), it would be important to provide feedback that allows people to understand the behaviour of the system. To accomplish this, a front-end to the Music Selection Server displays the names of those Clients present in the vicinity and an overview of the popularity of each of the genres, as voted by the Clients. Further information such as details of the track currently being played is also displayed on the front end. The front-end can be displayed in a prominent position in the venue, allowing people to understand why the system is making particular choices of music and hopefully increasing their acceptance of the selections.

3.3 Implementation

We implemented the system server using a standard desktop PC, equipped with a USB Bluetooth dongle. The server was written in Java and used J2ME to develop the Client application so it can be ran by multiple device platforms. As can be seen from the prototype screenshot (Figure 2), the server front end does not contain any controls that might be used to influence the choice of music. The selection process is influenced by the presence of users who have uploaded their preferences. In this screenshot, two users are online – their musical tastes are completely different but they both have rated "Rap" amongst their top three preferences. We tested the system for accuracy and functionality using a multitude of device models from various manufacturers (oldest device was a K750i from 2005) and while differences in the UI appearance were present due to the different screen resolutions, the simplicity of the code ensured that our prototype client ran without problem across almost all of the devices we tested with.

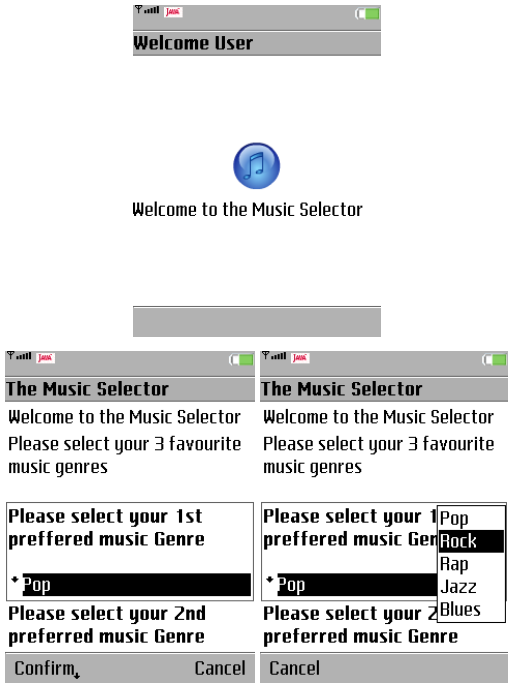

Figure 3: The Mobile Client Interface. Interaction styles are kept simple, without graphical clutter.

4. EVALUATION & FUTURE WORK

We presented our design and prototype implementation for a system that allows people to dynamically influence the behaviour of socially-aware ambient intelligence in a social space. The AmbientDJ prototype presents several advantages over work previously discussed. First, it makes use of technology which does not require special equipment – the clients used are standard mobile phones that users carry with them anyway. Most user devices (phones) nowadays have Bluetooth capabilities and users are quite familiar with the technology. Secondly, the system encourages a form of gentle influence over the ambient intelligence. A user cannot interact directly with the environment and cannot assume control of the selection process or the hardware. This mode of implicit interaction removes the focus of

users' attentions away from controlling the music (as would happen with a jukebox, or with making specific song requests to the DJ), allowing music to remain in the background of a social activity and preventing technology from being disruptive to the primary function of the social space. Thirdly, we do not require the user to pre-configure their preferences before being able to use the system and more importantly, we allow users to change their preferences while still in the social space. This allows users to influence the flow of a particular event, for example choosing to listen to calmer music at the start of the event, moving on to more upbeat music and perhaps dropping back to more relaxed music towards the end.

Our system is still very much a prototype in progress and developed mainly with functional integrity in mind. Naturally we would like to continue development on the user interface to create a more aesthetically pleasing experience for end users. Furthermore, we would like to move away from the rudimentary server interface we employ at the moment and integrate interesting visualizations or possibly adaptive artwork as a means of feedback and communication to the users. We are interesting in exploring different visualization styles or "themes" for the server interface, possibly with displayed artwork and graphics adapting and befitting to the style of music currently played or the type of majority present in the environment (e.g. if the majority are Rock fans, the server artwork could include visual elements associated with a Rock lifestyle, like guitars, motorbikes etc). Emotive feedback through the selection of dominant colour schemes or frequency and intensity of visual element mutation could also be investigated (e.g. the more users interact with the system, the more "happy" it becomes or the system might become "excited" if it notices a regular customer has just entered the premises).

We can envisage our system employed in a variety of situations and perhaps incorporating a range of additions. At the moment we only support genres of music but perhaps giving users the ability to specify their preferences in artists or even songs might be a future addition. We would be concerned that a user should not have to spend a long time configuring their client but perhaps there could be a hybrid approach where users specify a small number of bands for each category and the system employs automatic collaborative filtering to expand the list of likely candidates. A resulting problem would be the classification of artists and songs under genres. Many artists can be subjectively classified under several genres and also many artists produce a few songs that are not typically representative of their repertoire or genre. Resolving such issues is a challenge that would require careful investigation.

Further increments to the system could see the combination of musical preference indication with social interaction, perhaps by allowing users to send messages to each other (e.g. dedications) or by broadcasting messages (e.g. "everybody, let's switch to Rock!") and rating songs currently playing. Moving away from interactions of users with ambient intelligence, such additions would encourage the use of the social space itself as an interaction facilitator between ad-hoc groups of people. The system could also be used as an aid to real DJs, allowing people to indicate their preferences to music and reactions to selections.

Our system is very much a prototype implementation and we are still working on refining the looks of the user interfaces. At the moment, the system is being installed in a social space (student bar) where a prolonged trial will take place. We also plan to test the system under different conditions, such as a house party or as an alternative to a DJ-night at a nightclub.

5. REFERENCES

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