

The Adaptive Song Selector or Locator (ASSOL)

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Abstract. In this paper, we explore design requirements for adaptive and non-intrusive interfaces for ambient information delivery. We describe the Adaptive Song Selector or Locator (ASSOL), an adaptive song selection system that dynamically generates play lists from MP3 collections of users that are present in a public space. It takes advantage of distributed personal digital music collections that are accessible over the network. In contrast to current play lists that are usually compiled before they are played back, it adapts the play list according to the present users in a given area where the music is being played. In addition, the system allows users to personalize certain songs to convey certain information and alert them without interrupting other people in the public space. Certain songs can also be mapped to deliver information for a group of people rather than individuals.

1 Introduction

Digital music, especially MP3 music, has become popular with the availability of powerful computation and high bandwidth connectivity. Therefore, people collect and store their MP3 music in their computers and occasionally download them to portable MP3 players to carry with them while on the move. However, the music collection is personal and usually heard only by a single individual. Using services like the Icecast server [1], one can publish play lists to be listened by other people. However, the play list is static and the listeners cannot change what would be played once they start listening. On the other hand, when music is played in public spaces, it is usually from a radio station, which is compiled by some DJ or a collection of a single individual's MP3 collection. Similarly, users cannot easily provide feedback about what they want to be played.

The ASSOL system is a distributed adaptive system that can play customized background music for different physical spaces. It adapts to the present users in a physical space and compiles a play list based on the preferences of the users present. Since the user's MP3 collection is available online, whenever they move around, their MP3 collection virtually follows them. The system detects a user's presence in a physical space when a user logs on to a specific computer in that area. With this information, it adjusts the play list for that area dynamically in real time to accommodate certain users' presence.

There are two levels of preferences. Their MP3 collection, which is available over the network, forms a general set of preferences indicating the music taste of a user. In addition, they can add more detailed preferences that consist of mappings of songs to certain events. By allowing users to map certain songs to certain events, users in an area can get personal alerts about the events delivered to them through the music being played. This allows subtle ways of alerting an individual or group of users without interrupting other uninvolved users in a public space.

2 Related Work

Our work explores how computation and high bandwidth combined with music as ambient media can be utilized in a public space to generate more personalized background music. This background music can also be a part of ambient media to deliver a user's personal information without interrupting other unrelated parties.

Various research in ambient media has been done by Ishii et al. [2] and Heiner et al. [3]. These pieces of work mostly focus on visual periphery information and how different media can be used to carry information "in the background of awareness." Their work shows how peripheral media can be used to convey information to people. However, their use of sound is limited to certain ambient sound effects. Peder-son and Sokoler [4][5] explored abstract representations of conveying presence information to remote users by mapping audio, video and other sensor information to a more abstract set of information. Smith and Hudson [6] worked specifically on how audio and speech can be manipulated to communicate awareness about different people while preserving privacy. Ambient media can also be used to motivate a group of people by subtly displaying the public's interest level in their work in public space, as investigated by Schmidt et al. [7]. Nemirovsky's [8] work has also shown that musical sounds can be used as a rich, but abstract medium to convey information to a user in his GuideShoes project. Audio Aura [9] was a system that tried to provide serendipitous information via background auditory cues and required the generation of specifically designed audio cues. The system would detect a user's status and play certain audio cues specifically to that user through wireless headphones. The ASSOL system is a less cumbersome and more flexible distributed music system that plays personalized background music for a group of users in a community, by taking advantage of music as an audio medium that is abstract, but that can convey information while creating an ambient audio space.

3 The ASSOL System

The system is based on two main goals:

- Background music as ambient information carrier in a public space.
- Adaptive song selection based on overlapping music preferences of present listeners.

3.1 Background Music as Ambient Information Carrier

The primary idea is that music is played in the background, trying to deliver information without interrupting normal people's activities in public spaces. To achieve that, specific songs are mapped to specific pieces of information. This can be either:

- *Personal information*, like weather forecasts and email alerts, specific for one user, or
- *Public information*, like food alerts (kitchen food cam) and group meetings relevant to a group of people.

A certain song is played to notify one user or a group of people about certain events or piece of information. The mapping of songs to information (Table 1) has to be done beforehand by the user, via a web interface.

Table 1. Example mapping table of a specific user

Song name	Meaning
"It's raining again"	Weather forecasts announce rain for tomorrow
"Living la vida loca"	Meeting in calendar for tomorrow
"Highway to hell"	Email from my advisor

3.2 Adapting to user presence and their preferred music

The second main feature of ASSOL is that it plays the music that matches the preferences of all present users in a given area.

The users are sensed dynamically by looking at login information. Subsequently, their current collection of MP3 music is loaded and merged to form a play list that consists of songs that are overlapping with the users present. The music server dynamically adapts the play list by taking into account of the users that move in and out of a certain public space. While music is being played, ASSOL monitors other information sources or receives notifications from other information sources. When certain event occurs for a present user, the special song corresponding to that event would be played to notify the user. Only that user will know about the specific event that occurred since the user mapped the song to that event.

Example: Figures 1 and 2 show a situation in a given area at two different times: in Figure 1, users A, B, and C are present. The ASSOL chooses songs from their overlapping preferences (red area). Some time later, user A has left the area (logged out of the machine in this area), but user D arrived with a different set of preferences. The possible play list changes to the green area (Figure 2).

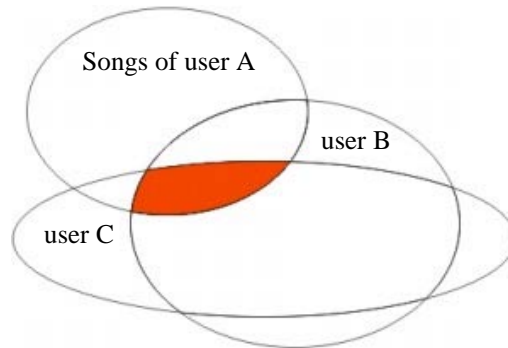


Fig. 1. Red area: most preferred songs when users A, B, and C are present

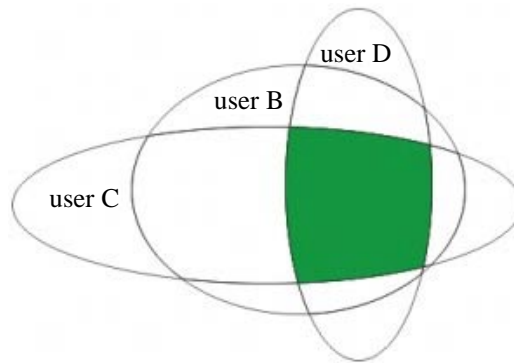


Fig. 2. Green area: most preferred songs when users B, C, and D are present

3.3 Integration of the two goals

The music server primarily plays the songs that match most of the present users preferences. Occasionally, it plays songs that belong to only one user's play list to notify that specific user about a certain event.

Note that if only one user is present in a given area, the music client simply plays this user's songs. It plays all of them except the "reminder" songs, which are played only when the specified events occur.

In the special case that a "reminder" song happens to be a part of the matching songs of present users, the system would ignore it from the common play list and play it only when the corresponding event occurs.

4 Technical Overview

ASSOL is a working prototype, implemented in Java and Perl. It is very scalable because it is completely software based. New audio environments and users can be added with a few mouse clicks. A schematic of the current implementation is shown in Figure 3.

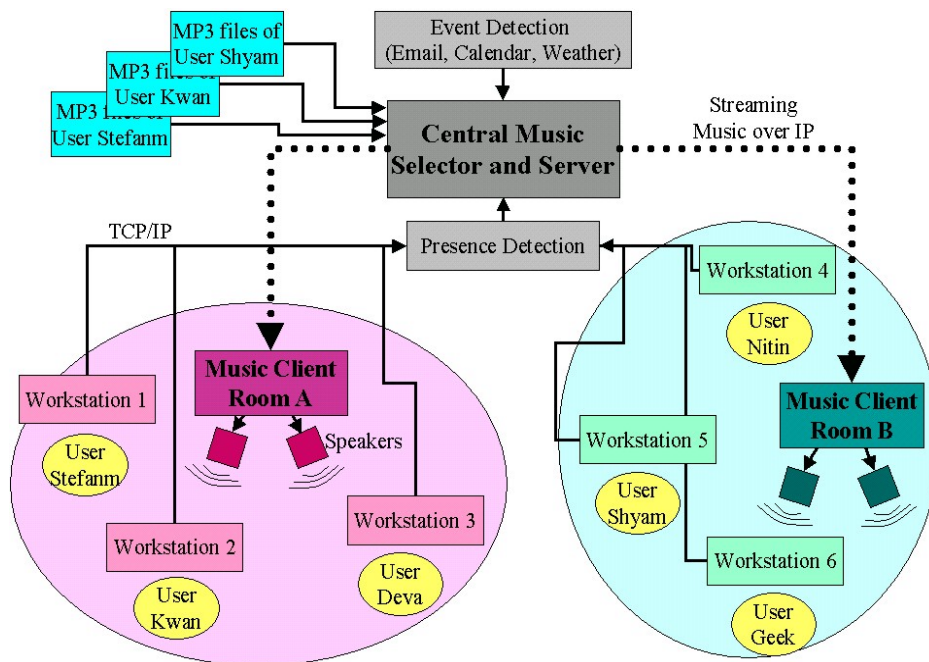


Fig. 3. Schematic of the current ASSOL prototype

4.1 Current Implementation

The current implementation of ASSOL consists of the following parts:

- *Music environments.* Spaces with distinctive music environments where multiple people work, e.g., 2 - 4 person offices or open office areas. Each space has its own sound system. The music is streamed via the network (TCP/IP) to a Java audio client (Figure 4) on a PC that outputs the music to normal computer speakers.
- *Central Music Server.* The central music server is implemented in Java and handles each location with a separate thread. Each thread also maintains a monitor to display the status of an audio environment (Figure 5). The message-handling component receives messages from different information sources to handle events. Songs are decoded into PCM audio data and streamed to client players.

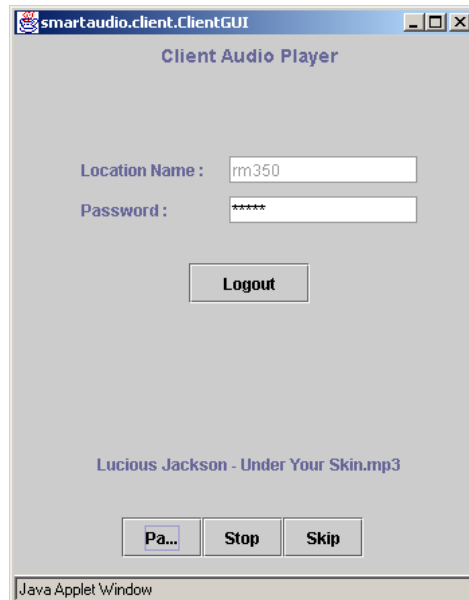


Fig. 4. Client audio player

- *Distributed storage.* Each user has her own MP3 files in a publicly available web directory instead of storing it centrally.
- *User sensing.* Who is present in a certain area? Currently, the user logs in manually via a web interface that invokes a CGI script. In the future, we can retrieve login information from UNIX finger information, from Windows networking utilities, wireless LAN transceiver information (mapping wireless LAN info to certain locations), or any kind of active badges or IR beacons.
- *Explicit user profiling.* The user is asked to provide the following information via a Web site:
 - ❖ Where are your MP3 files? They have to be publicly accessible, either on the network or the web. A Perl script scans all MP3 directories periodically and stores the locations of MP3 files in a file per user.
 - ❖ Mapping between certain songs and certain information sources. The user is presented with the list of her MP3 files and asked which song means which alert. These user preferences are stored in a simple ASCII file that is edited automatically by the CGI script.
- *Location profiling.* Which computer is located where, in which room or audio environment? This mapping was done manually for some areas in the Media Lab since it was not already available.
- *Access to external public information sources, e.g., weather forecasts.* ASSOL scans the preferences of all users periodically with a Perl script. If it detects requests for weather forecasts, it connects to wunderground.com with telnet and parses out the weather forecasts for the next day.

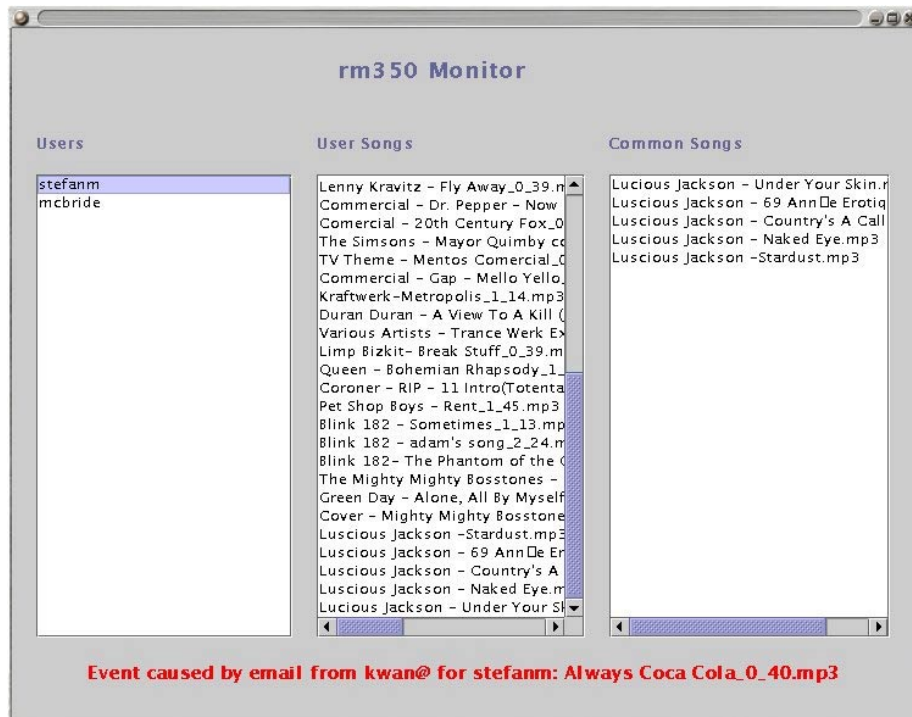


Fig. 5. Example of location monitor window. In the left column are the current users. In the middle column, the songs of the selected user stefanm are listed. In the right most column, the common songs of the present users are listed. In the lower portion of the window, the system displays the external events, e.g., user stefanm got an email from kwan@ which triggered the song "Always Coca Cola"

- *Access to external private information sources, like email and calendar.* The ASSOL scans the UNIX calendar files of all users regularly and compares them with the keywords found in the user preferences. Email filtering is done on the e-mail receiving point through Procmail. Each incoming email message is routed through a script that compares sender and subject line with the data in the user's preferences file. If they match, the central ASSOL server is notified through a socket connection.
- *Song selection.* The central music server keeps a dynamic playlist for each location. It consists of the MP3 songs that all the present users in this area share. The play list is updated whenever users move in and out of an area. Furthermore, it inserts special songs into the playlist if an external event occurs, e.g., a user gets an email message from a specific person, or a calendar event needs an alert. In order to monitor the status of an audio environment, the music server displays the current users at this location and the playlist for this area (Figure 5).

5 User Interactions

Since the ASSOL was designed to be a context aware system, the goal of the interface design was to minimize user interaction with the system. Therefore, only two kinds of user interactions are needed:

- Signing up and setting preferences (once)
- Logging in or out of the system

5.1 Signing Up and Setting Preferences

Signing up as a new user is literally a one-click process. The user opens the ASSOL web page and enters her user name. Upon this action, the system creates the necessary user files and looks up all her MP3 files at the standard location in the network path. (If the user's music files are in a different location, she can specify that at any time and the system will adapt.) If the user wishes, the user preferences can be further refined with personal events (Figure 6).

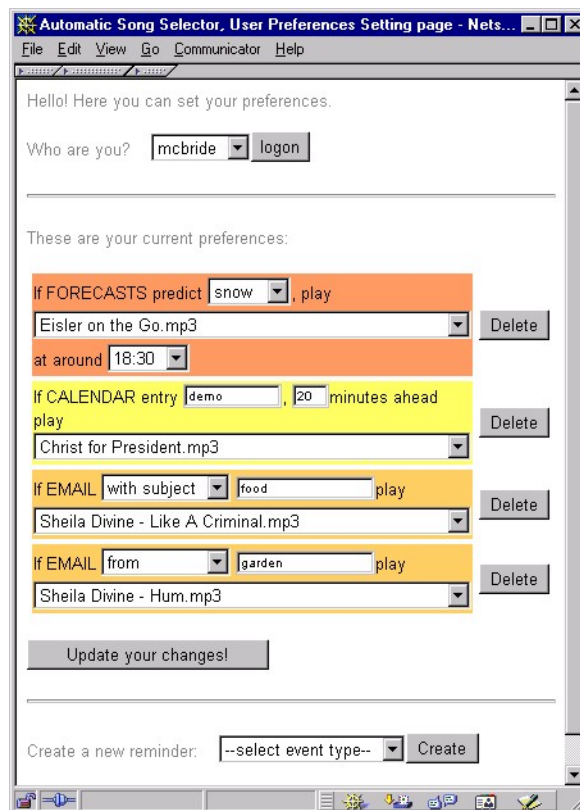


Fig. 6. User interface where one can specify which song should be played upon which event

Currently, a user can specify three kinds of events that would trigger specific songs:

- *Email*. If an email from a certain person arrives, play this song. If an email with this keyword in the subject line arrives, play that song.
- *Calendar*. If there is a calendar entry with this keyword, play that song this many minutes ahead of the event.
- *Weather forecasts*. If there will be snow (or storm, or rain, or clouds) tomorrow, play this song at that time of day.

5.2 Logging In and Out

The user needs to log in in order to let the ASSOL know where she is located. There is a small browser window where the user can tell the system that she is here or that she is leaving this workstation (Figure 7). If she tells the system that she is here, ASSOL will automatically remove her from her former location. Therefore, the user can move around in an office space from computer to computer, and the system can keep track of her physical location. Consequently, it can play the songs from her preferences, as well as the special reminder songs that have a meaning only to this specific user in the right location.



Fig. 7. Login window. The user can tell the ASSOL where she currently is. The window also shows in which room this computer is located, as well as who is currently in which room

6 Conclusions and Future Work

During the evaluation of the prototype, the users came up with suggestions on how the current system could be extended in several directions:

In order to increase music matches, the system could extrapolate the artists and music genres from the song names by looking up the information on the web. Therefore, it would first match the song names, but if enough matching songs were not found, it would also find songs of matching artists and playback these songs. If there are still not enough matching songs, it could try to find songs with common music genres and playback songs of these genres.

If the common songs of present users do not contain enough overlapping songs, the system could retrieve additional songs from the web, based on preferred artists and genres of the present users.

Since the music is intended to be background music, the volume levels can be automatically adjusted by analyzing the power spectrum of the MP3 file. Furthermore, the BPM (beats per minute) can be measured to filter songs that appear to be too distracting (e.g. "violent").

Taking into account that users have different amounts of MP3 files, the system can normalize the play list of a user with large number of MP3 files by using the most current songs or most recently played songs in building the common play list. Additionally, users with very few MP3 files might be given the opportunity to further specify their musical preferences manually by specifying songs, artists, or genres of their interest.

7 Acknowledgements

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