AuRal: A Mobile Interactive System for Geo-Locative Audio Synthesis

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ABSTRACT

Aural - of or relateing to the ear or hearing
Aura - an invisible breath, emanation, or radiation
AR - Augmented Reality

AuRal is an environmental audio system in which individual participants form ad hoc ensembles based on geolocation and affect the overall sound of the music associated with the location that they are in.

The AuRal environment binds physical location and the choices of multiple, simultaneous performers to act as the generative force of music tied to the region. Through a mobile device interface, musical participants, or agents, have a degree of input into the generated music essentially defining the sound of a given region. The audio landscape is superimposed onto the physical one. The resultant musical experience is not tied simply to the passage of time, but through the incorporation of participants over time and spatial proximity, it becomes an aural location as much as a piece of music. As a result, walking through the same location at different times results in unique collaborative listening experiences.

Keywords

AuRal, sonic environment, distributed performance system, mobile music, android, ruby on rails, supercollider

1. INTRODUCTION

Sound is inherently tied to the environment in which it is produced. Through synthesized and recorded media and various playback methods, people can now overlay, translocate, or completely replace the sound environment that they are in with another environment, refashioning their experience of musical style, location, or even time.

Mobile audio devices have enabled the displacement of environmental sounds. With the growing ubiquity of smart phones, the ability to intelligently overlay or replace those sounds with another sonic environment is eminently possible. This gives rise to locationally tied compositions, displaced and/or ad hoc collaboration, and many other sonic environment bending opportunities.

Through the AuRal project the notion of the dis-placement of sound from location is approached by tying a musical synthesis engine to a specified geospatial region. Anyone who enters the region can participate in the music generated there. If used with headphones, the musical material may replace the environmental sound, yet it is still tied specifically to that location. Also, a musical agent is able to influence the sonic experience of other musical agents in the same region thereby refastening locality and proximity with sonic experience.

This approach can be viewed in three ways; as a distributed musical instrument, whereby individual parameters are distributed to performers within a region; as a shared sonic environment where agents are able to enter and influence the sound of the overlayed sonic environment; or as a piece of music into which and out of which a participant can physically move.

Figure 1: The AuRal environment being used by 2 musical agents at the LSU Quad. Map view in inset.

2. RELATED WORK

Much mobile music development has a tended to focus on instruments for mobile devices, relying on traditional performance dynamics while avoiding collaborative environments through communication between mobile devices. A notable exception is the seminal work done by Atau Tanaka in *Mobile Music Making*[7] which is quite similar in ideology to our approach. The distribution of a compositional system to ad hoc agents and a collaborative compositional experience define the similarities, but AuRal purposefully brings the compositional instrument out of the network and ties it back to physical location to re-entangle the music with our environment, essentially creating what may be considered a hybrid-world or digital hybrid compositional space.

Network performance examples have traditionally been locationally agnostic ignoring the physical location of each

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performer. The ideology behind seminal network performance groups such as *the Hub, the League of Automatic Composers*[5], and more recent groups such as the Princeton Laptop Orchestra (PLORK), Stanford Laptop Orchestra (SLORK), and the Mobile Performance Group (MPG) sometimes employ performance and compositional ideas that are similar in nature to AuRal, but does not engage physical location as a musical factor and tends to be designed for professional or at least experienced users. The approach that AuRal takes engages both location as well as amateur performers.

There has also been significant exploration in the development of collaborative compositional enviroments outside of the mobile computing context such as *JamSpace*[2] and *CODES (COoperative Music Prototype DESign)*[4] where multiple people on a network can effectively compose music together. AuRal takes a different approach in allowing a composer to compose for the system but handing over individual and aggregate parameters to influence the music produced. This reduces the learning curve for novice users, yet still allows for a wide variety of musical synthesis for each musical region.

3. DISTRIBUTED MUSICAL INTERFACE

The AuRal environment contains a novel musical interface dictated by location. A SuperCollider synthdef occupies a user-defined region. Within that region, participants become musical performers by being presented with a subset of parameters for the synthdef. Any changes to these parameters not only affect the local synthesizer, but are sent back to the server and aggregated with other users to set global parameters that affect the music generated by anyone in the region. Distribution of a shared musical interface is an integral part of the experience of AuRal, creating an ad hoc ensemble.

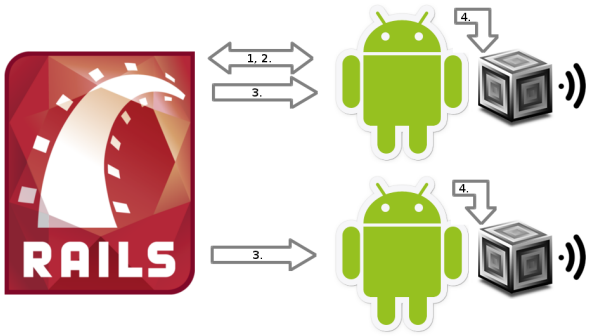

Figure 2: 1. A user enters a location and the device sends an HTTP message to the server, stating it has entered a location. 2. The server adds the user to the database for that location and sends back an HTTP reply confirming success. 3. The server aggregates all user parameters for the updated location and sends OSC messages to everyone in that location. 4. OSC messages are passed on to the devices' SuperCollider servers and update their synths.

4. IMPLEMENTATION

AuRal is a system composed of many users with client apps and a central server. While the client itself is a standalone app, multiple users interacting together can only occur when clients connect to the server.

4.1 Client App

A user's experience with AuRal is mediated through an Android client app. With an embedded Google Maps view and locational services (GPS, WiFi, cellular network) the app keeps track of the phone's location and displays that information for the user. A SuperCollider server running in the app allows it to generate music in real-time.

The app allows users to place areas anywhere on the map and associate SuperCollider audio with these areas. When the user is inside an area, its corresponding audio will play. Certain specially written SuperCollider tracks are affected by a user's personal musical parameters, which are stored on the device. These parameters are sent to the user's SuperCollider instance as OSC messages.

Users connect to a Ruby on Rails server by username and password. Once connected, they may download locations from the server. The server stores a collection of user locations, user-defined areas, user preferences and a list of which areas the users are currently occupying.

For every user location, there is a corresponding SuperCollider synthesizer. If a user is connected to the server, the device will receive updates of aggregated user parameters for all areas the user is in.

4.1.1 Location

The standard screen within AuRal's client app is a normal Google Maps MapView. AuRal keeps up with a user's location with GPS, WiFi or cellular network connections and updates a marker on the map for the user. As such, AuRal tends to work better outside and away from buildings that can interfere with GPS. Along with the user's location, AuRal also displays all downloaded and user-defined areas on its map. These areas may either be circles or polygons. In both cases, they are defined by red borders.

When the user's location changes sufficiently, AuRal determines which areas the user is inside of and sends that information to the server if the client is logged in. While that happens, the client app will play or pause appropriate SuperCollider synthesizers when areas are entered or exited.

New circular areas may be defined by long-pressing anywhere on the map and then selecting a name, synthesizer file, etc. This is where a user may choose to upload the area to the server if connected. To create a polygon area, the user uses the menu button and selects the option. The app enters another state, that allows the user to define points for the polygon's vertices. Hitting menu again allows the user to finalize the shape, after which the same dialog appears as for the circular areas.

Modifying areas is handled by tapping on an area's overlay. A dialog similar to the creation appears, but allows the user to remove the area from the device.

4.1.2 SuperCollider

AuRal utilizes an *Android port*[6] of *SuperCollider*[3] to generate its audio. Each location that the user defines or downloads from the server has a SuperCollider synthesizer associated with it. Some of these synths allow for user preferences to modify their parameters.

4.1.3 Preferences

User preferences are handled through the menu. The user enters a username, password, the server's IP and port here. Along with that, the user may select to play a personal SuperCollider synth that no other user may hear and/or play audio from the areas on the map. Parameters for both user audio and area audio may be modified through sliders here as well.

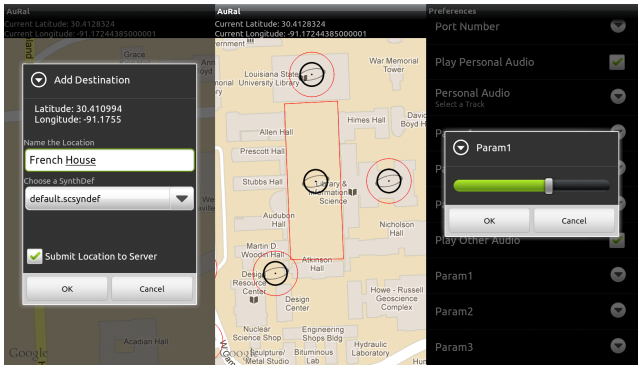

Figure 3: From left to right: The new location screen. Map view showcasing a polygon location in the LSU Quadrangle and several point locations nearby. Adjusting a parameter slider in Preferences.

4.2 Server Side

AuRal uses a Ruby on Rails server to keep up with user positions and parameters, user-defined areas and their synths, areas that users are in, etc. Users connect to the server with a username and password. Once connected, they may download other user-defined areas from the server to appear on their own maps and interact with them.

One of the server's core roles is to aggregate parameter data from users in a given location and then send that information via OSC messages to the users' devices. These updates occur when a user enters or leaves a location, changes parameters within the location or connects or disconnects from the server. OSC on UDP was chosen over TCP because it is easier for the server to handle. A few messages not reaching a client app is not a large problem because everything will be resolved when the next message comes through to update the app. After receiving the message, the client app updates its SuperCollider synthesizer for the specified location.

4.2.1 Aggregation

When the server receives word from a device that has just entered an area, it adds it to the corresponding table for users within that area. The parameters of users within that area are summed up and put through different functions, and the results are sent out to the devices via OSC messages.

5. DISCUSSION AND FUTURE WORK

AuRal successfully allows users to associate music with physical locations of varied shapes and sizes and to collaboratively modify the sounds associated with those locations through physical presence and selected parameters.

The SuperCollider synthesizers that come with AuRal are very simple. A larger number of quality synthesizers would greatly improve the user experience. Electronic music composers have been engaged to fill this void.

Expansion upon AuRal will move the spatial integration from a 2D map into full Augmented Reality, where users will be able to see visual 3D representations of musical interaction areas and colors and forms could adapt in time with the music.

On a broader scale, the techniques to tie musical and sonic information to spatial locations could be expanded to encompass further compositional and geographically performative music systems. Spatially distributed and walkable compositions and game-like musical systems utilizing augmented reality tied to actual locations are just a few ideas that fall into this category.

Finally, for ease of development, the interface to musical parameters has thus far been tied to a few sliders displayed on screen. Tying the performance interaction to gestural data from the touchscreen, IMU sensors, camera, and/or audio input will greatly increase the compositional freedom and musical engagement of the user when collaborating in performance. Introduction of these gestural controls will go a long way towards the acceptance of the system as a mobile instrument.[8]

6. CONCLUSION

The AuRal environment presents a novel way to deal with the topic of location and music collaboration within the context of locationally and environmentally tied media. Ad hoc ensembles can be spatially navigated with musical collaboration as the result. The system handles coordination of location and region information, SuperCollider synthdefs, active user information, and shared parameters among regions.

The *AuRal environment*[1] is open source and can be found at its Github location.

7. ACKNOWLEDGMENTS

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