HURSPAT: SONIFICATION AND SPATIALIZATION OF HURRICANE TRACKING DATA

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ABSTRACT

This extended abstract describes an interface that generates sonification of hurricane tracking and position data and spatialization in virtual space. The audio streams are generated with Max/MSP in real time and output via Ambisonic and Binaural methods. The goal is to create sonification and aesthetic works generated from this type of atmospheric data for artistic and educational purposes.

1. INTRODUCTION

The sonification of hurricane or some type of atmospheric event is not new. The difference lies in the approach and varies for the sonification purpose or other specific goals.
In Andrea Polli's project, the storm sonification had three primary goals; the development of a software system for the creation of sonifications based on storm data with the intention of using them in performances and installations, live and recorded musical performances [1]. Mark Ballora's sonification project, used a parameter-based approach of sonifying the data into "sonic scatter plots" in order to engage the listeners about meteorology [2].
In this project, hurricane tracking data are sonified and spatialized in 3D space using an interactive approach for either binaural configuration for headphones or quadraphonic for speaker output. The interface also allows the user or listener to create his/her own immersive listening experience with the data.

2. HURRICANE TRACKING

In order to understand the impacts of hurricanes on natural and human systems, a long-term perspective and an estimate of the spatial variation in each individual storm is necessary.

2.1 Dataset Description

The Hurricane Data (HURDAT) database maintained by the National Hurricane Center (NHC) provides track and maximum wind speed data for all known hurricanes since 1851 [3]. The NHC and the Central Pacific Hurricane Center (CPHC) both conduct post-storm analyses of tropical cyclones in their respective areas of responsibility over the North Pacific Ocean. They officially determine the assessment of a cyclone's history. The revised database, HURDAT2 [1] is based on the "best tracks" available from the Automated Tropical Cyclone Forecast system database [4]. The complete HURDAT2 database contains cyclone data from 1851 to present, yielding over 55,000 records of data. However, many of the early records (previous century) contain little information and were excluded in this work. The datasets have a sampling period of six hours. Each day contains four measurements, taken at 12:00AM, 6:00 AM, 12:00 PM, and 6:00 PM. Each dataset has 20 data points. The timestamp for each dataset shows values for:

- Record identifier
- storm type
- latitude and longitude
- minimum air pressure
- Maximum winds
- NE, SE, NW and SW each measured at 34, 50 and 60 knots
- Radius of the maximum wind (recorded from year 2021 and beyond)

In this project a total of over 1000 hurricane data records are available for aesthetic exploration and immersive listening engagement.

3. SONIFICATION AND SOUND DESIGN

Besides for listening, sonifying atmospheric data can also be used for aesthetic, artistic purposes. Due to the complex nature of hurricanes or meteorological events, the sonification of these can yield interesting soundscapes or compositions. From a media arts perspective, the interest lies in applying novel sonification mappings to these types of atmospheric data, as well as in the creation of new computational languages for interpreting these types of data.

3.1 HurSpat Interface

HurSpat, an interface (Fig. 1) created in Max/MSP [5] allows users to import hurricane data to sonify and spatialize. Once the hurricane database is imported showing all datasets for each hurricane in the database, the users can select a specific hurricane and which data values (e.g. air pressure, max winds etc) of that hurricane they want to work with.
The interface includes three modules for sonification and sound generation:

a) The *Audio Buffer*, imports the data into the buffer that is used for sonification and sound output. The datasets themselves do not contain enough samples for audio rendering. Therefor an algorithm was developed to interpolate in between data values to add more sample data, generating noise/rain sounding textures.

[1]https://www.nhc.noaa.gov/data/

b) The *Play speed buffer,* allows the user to select the hurricane parameter that will manually control the audio buffer's playback speed or select a specific data to control playback speed. For example, if the maximum wind speeds is selected as the control variable, depending on the data value there will be large sounds and twirlings corresponding to the wind speed values and cyclone effects.

c) The *Spat buffer*, allows for the control of the sound spatialization. Users can select data for example, longitude to control the spatialization. If this is the case, the sound output will move in a longitudinal manner around the listener. They can also manually adjust the audio in 3D space by moving the speaker array in the 2D view of the sound scene Figure 2.

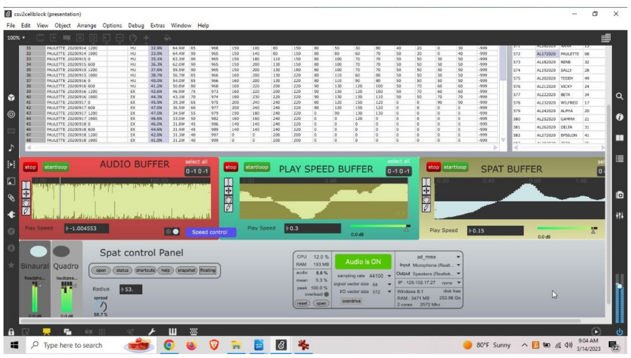

Figure 1: HurSpat interface

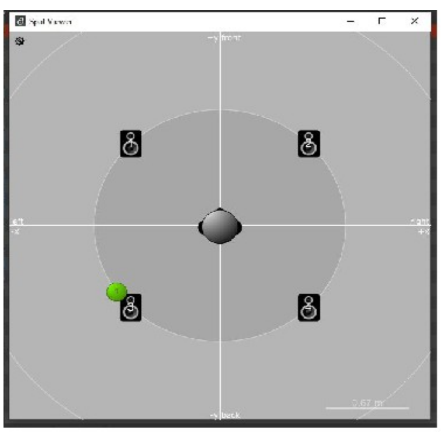

Figure 2: 2D view of the sound scene

3.2 Sonification

Air pressure is an important component in hurricane generation, this parameter is mapped to a pitched sound. The minimum air pressure mapped to a pitch sound, allows the listener to hear how the change in air pressure affects wind speeds and thus sonic textures. As the wind speed increases, so does the volume and pitch of the noise. The sonification in HurSpat are spatialized using Ircam's Spat5 audio processing library. The Spat~ object used in Max/MSP is a real-time audio engine dedicated to sound spatialization, artificial reverberation, and sound diffusion [6]. HRTF databases cannot accommodate all speaker arrays. For example, the interface developed in [7] used HRTFs for binaural output of spatial cues by using data (e.g. azimuth, elevation) from an HRTF database. Here, the HRTFs could not accurately represent specific spatial cues, so the closest HRTFs were used instead. The Spat5 library allows for a more accurate and quick design of binaural development.

In this work, the resulting 3D Ambisonic audio stream virtually rotates at rendering in real time creating a twirling effect around the listener, for binaural listening using headphones or for a quadraphonic speaker layout. The sonic output result is an iterative feedback loop of listening, engaging and manipulating.

4. FUTURE WORK

The work presented in this paper is geared towards towards both the general and scientific community. After initial evaluation of the interface, we were able to accomplish our goal of sonifying and spatializing the hurricane tracking data. Further enhancement of the interface would be to allow users to work with more that one hurricane simultaneously. Another addition to the interface would be to add more speaker configurations as well as adding 3D graphical mappings to data for additional artistic creativity. Future works using the HurSpat interface will be for installations, media arts exhibitions and for artistic interpretations of the data. The overall goal of this work is to offer ways in the intersection of art and science using novel sonification and visualization methods which can aid in the understanding of this atmospheric phenomena.

5. ACKNOWLEDGMENT

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