INTERFACING THE EARTH

Peter Beyls

University College Ghent,
School of Arts,
Jozef Kluyskensstraat 2, B 9000 Gent, Belgium
peter.beyls@hogent.be

ABSTRACT

We provide a short introduction to *WindChime*, a real-time web-driven audiovisual installation. Weather data from many world locations is gathered from a server and accommodated in a dynamic visual representation. The dynamics of the wind at specific world locations exercises influence over a mass of floating particles in a virtual parallel world. Particles in turn influence the production of complex sounds. In effect, a rewarding aesthetic experience results from the appreciation of the intricate interplay of two complex dynamical systems; one of natural origin (the earth), the other of cultural design (the program).

1. INTRODUCTION

Artists developing private first principles might suggest new scales in time and space while challenging the notion of dimensionality, both conceptually speaking and in terms of embodiment. This includes the exploration of sound aiming the expression of spatiotemporal complexity hidden in a tiny organic micro-world [5]. In contrast, project *WindChime* suggests viewing the whole Earth as a dynamic system subject to sonification. In essence, we implement a virtual version of the archetypal wind chime; an arrangement of objects suspended from a frame creating tinkling sounds in a light breeze.

Previous research exploring the Earth as a global source of information includes the translation of the *Kp* indices reflecting the Earth's magnetic field into musical pitches and compressing thousands of data items into a few minutes of musical time [4]. *Sonification / Listening Up* is a more recent MIT project aiming the sonification of the interplay of sun winds with the Earth's atmosphere, a continuous interaction that takes place some 60 miles above ground level [1].

The conviction that rewarding aesthetic experiences may result from the perception of multifaceted behavior in a given complex system underpins the present project.

More precisely, the global systems output here emerges from the confrontation of two complex dynamical systems: (1) the complex stretch of non-linear forces instructing the development of wind across the surface of the Earth, and (2) the largely unpredictable (though coherent) behavior in a sounding network of digital audio processing units. So, the earth is considered a *found system* while the sound producing system is a deliberately constructed system; the net result is collaborative effort involving a natural and a cultural system.

2. IMPLEMENTATION

The project is conceived as a real-time web-driven audiovisual installation. The implementation continuously captures the intensity and direction of the wind at many different locations worldwide by probing live data from a server at the National Center for Atmospheric Research [7]. Implementation consists of two concurrent programs, (1) a Java program running the web sensing functions, the dynamic visualization and the analysis and mapping functions and (2) a program written in SuperCollider [9] handling real-time audio synthesis. The programs communicate through OSC [8].

The Java program holds a number of classes from which functional objects are instantiated: the *World* includes *Particles*, their behavior being influenced by forces emanating from a *Field*, the strength of the Field being developed on a continuous basis from local data gathered from *Stations* providing live weather information. A brief description of the functionality inside every class follows.

The Stations class holds a data structure containing information on 7961 weather stations. A single 80-character entry contains 18 data items, including name of location, a four-character international ID, latitude and longitude, elevation, aviation specific information and country code, for example:
ISLE OF MAN/RONA EGNS 03204 54 04N 004 37W 17 X T 6.

A single *Station* object is instantiated by randomly selecting a candidate station from the list of potential stations. The Station object computes its visualization on a world map image - displayed as a permanent background image – by converting its latitude/longitude data to a Cartesian map (see figure 1). In addition, the object makes a request to the server and, when available, parses the data received for extraction of wind strength and wind direction at that station's location.

A single global *Field* object holds two complementary matrixes (32 by 20 elements) called *data* and *previousData* – they hold information about the strength of the wind captured for the whole world over a span of two consecutive time frames. The representation of the matrix is actually mapped on top of the world map – respective matrix locations are imagined as being connected to specific physical locations in the world map.

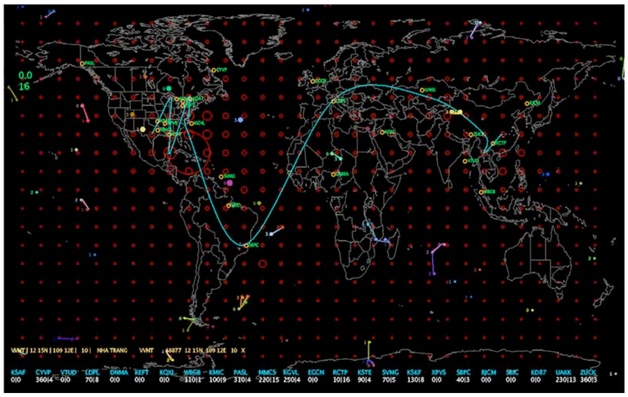

Figure 1: Snapshot of visualization resulting from sampling 24 world locations for real-time weather data.

The data gathered from the current Station in the World updates the Field at a specific location i.e. where the (normalized) image of the matrix and the station's location coincide. In addition, the numeric data in every single matrix element is scaled down in proportion to its distance from the current Station XY location. In the long run, following successive process cycles, the matrix will dynamically capture the strength of the wind with live data from 24 stations simultaneously. The World object actually aims to optimize data input and gradually builds a data structure of locations in the world trying to maximize the effect of the wind in the installation as a whole. In the current implementation, the matrix is visualized as an array of red circles, their radius relative to the strength of the wind at the respective locations.

A *Particle* is envisioned as virtual dust facing – a representation of – actual physical wind. Particles float in 2D space, their velocity and size is modulated by the intensity of the Field being expressed at their respective positions. Particles are also sensitive to their surroundings: neighboring particles within a given critical distance produce temporary clusters visualized by line segments. Particles within clusters interact in two ways, (1) a particle will adapt its angle of movement to the angle of one of its (randomly selected) neighbors and (2) a particle's energy level will boost in proportion to its number of neighbors. An isolated particle (no neighbors) will slightly decrement its energy level in every process cycle, energy levels are considered in the audio mapping algorithm documented in section 3.

A single *World* object accommodates 100 particles. The World creates a list of 24 unique stations that return actual data (not all servers are operational on a permanent basis). The data from all 24 stations is visualized and accommodated in the field matrix. Every station remains active for some time interval (normalized to a scale; from 30 seconds to 5 minutes) in proportion the strength of the wind at its specific location.

Figure 1 shows the world map in the background, the Field matrix (the red circles reflecting the local intensity of the wind) and a few clusters of floating particles. The blue curve is computed by interpolating between data points above a given threshold, the curve thus an emergent phenomenon built by forces spread out around the globe.

3. MAPPING

The mapping strategy developed here is unusual as it aims to develop a sensible association between behaviors in two independent parallel systems that coexist within their private domain. This procedure attempts to avoid the simplistic notion of conventional mapping [2] or direct sonification [3]. Audio synthesis in *WindChime* explores the principle of "influence" as detailed next.

A complex audio network is developed – by trial-and-error method, much like trying patches on an analog synthesizer – by patching a critical collection of synthesis and processing modules. Audio complexity builds up because the modules interact in non-linear ways and, given certain parameter settings, the global synthesis engine engages in chaotic behavior. Although the patch remains static, it reveals a quite significant expressive musical space. In addition, the patch can be pushed into a great many behavioral modes, its operational integrity remains guaranteed and its sonorous identity equally recognizable. The patch is characterized by control economy: it has only two entry points for external signals, so it may be imagined as a 2D surface accepting a single XY location. Inside a patch, X and Y control signals map to many different parameters simultaneously, however using distinct interpreter algorithms. The mapping strategy is consequently minimal on the side of "control" (only 2 parameters), yet the system aims to maximize its effect on audio complexity through the critical design of a networked synthesizer.

Now, the free running audio patch continuously consults the Field instance variable of the World. Any particle may trigger a sound when its present location (i.e. the contents of the Field at the particle's location) exceeds a given adaptive threshold. The threshold increases while facing overstimulation; the absence of input (e.g. "wind energy") will lower the threshold thus increasing the probability of audio responses. The adaptive algorithm actually contributes to global emergent behavior in *WindChime*. In addition, this project features real-time visualization of pinged information from the weather data server, the station's ID's are displayed and the accumulated Field is stretched across the world map. Interaction between particles shows up in dynamic computer animation.

4. CONCLUSION

The present project bridges two complex dynamical systems: the progression of wind patterns around the globe with the development of audio patterns inside a complex digital audio patch. Aesthetic appeal follows from the perception and appreciation of the complementary complexity inside the unfolding visual representation of the world's wind data in relation to the unfolding sonorous complexity enacted by the audio synthesis patch. The *WindChime* project suggests evidence that fractional recognition of relationships between behaviors in both systems provides the basis for a rewarding human-machine experience.

5. REFERENCES

[1] L. Heineman http://www.mit.edu/spotlight/ionosphere/ 2005

[2] J. Chadabe, "The limitations of mapping as a structural descriptive in electronic instruments", NIME '02 Proceedings, Singapore, 2002

[3] A. de Campo, J. Rohruhuber, T. Boverman, and C Frauenberger, "Sonification and Auditory Display in SuperCollider". In: The SuperCollider Book, The MIT Press, Cambridge, MA 2011

[4] C. Dodge, The Earth's Magnetic Field, Nonesuch Records, 2-track LP, H71250, 1970

[5] E. Miranda, A. Admatzky and J. Jones, "Sound Synthesis with Slime Mould of Physarum Polycephalum". Journal of Bionic Engineering, 8: 107-113, 2011

[6] G. Kramer (ed.) Auditory Display, Sonification, Audification, and Auditory Interfaces, Addison-Wesley, Reading, MA 1994

[7] UCAR 2012: http://www.rap.ucar.edu.

[8] M. Wright, "Brief Overview of OSC and its Application Areas", OSC Conference, Berkeley, CA 2004

[9] S. Wilson, D. Cottle and N. Collins, *The SuperCollider Book*, The MIT Press, Cambridge, MA 2011