SONIFICATION OF EMERGENT URBAN EVENTS WITH GRANULAR SYNTHESIS AS AN URBAN DESIGN TOOL

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As the contemporary city emerges as a dynamic field, new temporal dimensions with inter-scale relationships have to be included in urban analysis and design, such as urban mobility. The auditory sense equipped with ecological psychological principles is fit for the task of tracking emergent events. An urban design tool is proposed and partially implemented in the form of a sonification environment with operative principles of granular synthesis.

Fig. 1. Movement channels of people and vehicles, Still from Videoanalitik: Eminönü Series, 2001, Emre Erkal, digital video, Copyright Emre Erkal.

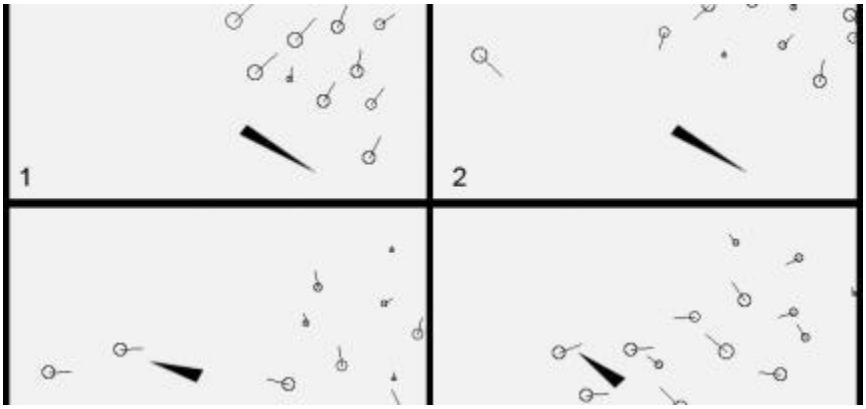

Fig. 2. Screenshots from Agents with PulseTrain, 2006, Emre Erkal, interactive Max/MSP/Jitter program. Copyright Emre Erkal.

Crisis in Contemporary Urbanism

Parallel to the increase in problems due to contemporary urbanization, it is not possible to state that today's cities are better analyzed, designed or known, all yielding to a current crisis of comprehensibility. One set of reasons has to do with the qualitative change in the urban realm, while another set of reasons arise out of the tools we try to understand our cities with.

Urbanization in many parts of the world yield to an increase in size, density and depth of cities. If megacities constitute one facet of the phenomenon, shrinking cities constitute another. In addition to this complexity, we are facing the impact of information and communication technologies (ICT's) in the urban realm. [1] For several years, it has been well-researched and understood that the relationship is more complex and ICT's and the large metropolis effect each other and therefore a more intertwined and hybrid view of space has come up. Recognition of double sided effects bring opportunities as well: these technologies might be utilized for the design of contemporary urban areas, in the form of new urban design tools.

Urban Design in Today's World: The Need for Design with New Concepts

The paradigm for Urban Design originated in 1950's architecture culture, when the capacity of public spaces in cosmopolitan city centers were questioned to be the vessels for the public sphere. Initial conceptions had more to do with devising an architectural vocabulary for symbolic identification of public space with the public sphere. However with the Team X group, urban designers concentrated on the manifest forces of publicness across a variety of urban spaces, not necessarily on 'publicly owned spaces' to begin with. Similar ideas were circulating in the zeitgeist of the post-war western circles of architecture and urbanism. Jane Jacobs analyzed the condemned urban centers in the US, and documented lively mechanisms of self-regeneration in these neglected neighborhoods. Jacobs was the first to utilize mathematical concepts of self-emergence over social networks, in fieldwork.

Since then, Castells' notion of "space of flows" and the "network society" have come to dominate urban thinking, in response to developments that can not be explained with classical notions regarding how cities work. [2] As contemporary urban design theory utilizes the concept of space of flows as the new logic of urbanism, dynamical concepts that take into analysis the flows and mobilities of people, goods, energy, money and information over what is deemed to be infrastructure become instrumental. These views take modern urbanism as complex processes playing out on complex fields over time. Relationships and links occur across many scales and vast distances.

We choose to concentrate on one such dimension: urban mobility. Barley recounts "choreographies of travel" in London, where definitions of center and edge are constantly re-emerging. [3] The physical aspects of mobility could be the indicators of forces and relationships in the social realm. Movements of crowds in urban spaces yield to the view that cities today need to be understood in terms of ever-changing possibilities. Koolhaas' work on the city of Lagos showed that the city has massive flows of people and goods in uncategorized and unregulated ways. Koolhaas' documentation of mechanisms of self-regulation and emergence begin to propose Lagos as a model for the future of urbanism in the industrialized world. [4]

As an example, seemingly unused interstitial spaces in between highway bridges act as arenas for organizing junk for re-use. Collection and dispersal rhythms of metal or tires could turn any seemingly irrelevant space into a temporary logistics center. Emerging megacities, such as Lagos or Istanbul might be illustrative of the dynamical forces of mobility, with infrastructure in formation [Fig. 1].

Tools for Monitoring Urban Change

CONTINUUM BETWEEN MICRO AND MACRO PROCESSES

If this is the future for the cities, what could be the parameters for studying and comprehending these forces of mobility? Therefore, analysis and intervention could begin with the notion of the event. Events in modern architecture theory have come to signify well-defined observable sequences in spatial configurations, yet events in contemporary urbanism are emergent singularities where novelty comes not only with re-occurrence but also with undefined categories. In other words, an event could emerge in an uncategorized way. Thus, as an event arises out of a recognition, it is a phenomenon of perception.

Mobility at larger scales signify a swarming of the individual movements and linkages; and the type of knowledge one aims to arrive at is about the large scale implications. When faced with micro-level changes in patterns of movement of people, the moment of recognition that a novel event has occured becomes critical. Deleuze reads Leibnitz's work as he defines the passage from micro-perceptions to macro-perceptions: for him the role of perception is about the "granulation of the world and spiritualizaton of the world's dust." [5]

EVENTS IN ECOLOGICAL PERCEPTION

For discussing the problem of comprehension of urban intensities, a distinction could be made between model-based and event-based approaches to cities. As inheritors of classical urban planning tools, model-based approaches develop a map, an enhanced representation of the city based on pre-determined categories of inhabitation, use, linkages and event types. They are inherently ontological: the approximation of the representation is crucial to the information that can be extracted from the model/map, regarding the large scale undergoings in the actual city. Model-based approaches show a great variety: ranging from absolutist intelligent maps to computer simulations that are constructed from the vantage point of a single generic observer. However, as this observer is generic as well as the city, the model keeps it distance from the actual city.

Event-based approaches could be defined by taking the actual city and the actual observer as the departure point. As an observer in the city is part of the physical environment and the information he/she receives could be understood in terms of embodied cognition. Embodied cognition implies that information – and thus knowledge – of the actual world has to be communicated to the individual through sensory and perceptual channels that are physically coupled with the real world, as opposed to the view that observers are static receivers of sensory data. The work of J. J. Gibson in ecological perception has been fundamental for the development of this line of understanding. For Gibson, the information for perceiving events are a result of the individual's being in the environment he/she perceives. [6]

However, for developing an urban design tool, comprehension of large scale events are crucial. As an observer is limited with his/her physical existence, the problem of the comprehension of large scale

workings has to be developed with the principles of embodied cognition. Embodied cognition implies that information – and thus knowledge – of the actual world has to be communicated to the individual through sensory and perceptual channels that are physically coupled with the real world. For tackling problems of detection of events in ever-changing flows, pertinent sensory channels must be selected for conveying information. Processes of hearing has been shown to deal with temporally varying intensities better than vision.

Sonification with Granular Synthesis

ABILITIES OF HEARING IN THE EXTRACTION OF TEMPORAL INFORMATION

Sonification is a set of techniques where information is transferred with sonic elements, other than speech. Temporal nature of sound and hearing allow real-time information to be monitored constantly. The most widely known early application of sonification is the Geiger counter, a device which instantly tells the amount of radiation its sensor counts with a series of clicks: density and intensity of sound elements convey information about a landscape of ever-changing real-time data. Studies show that auditory monitoring of emerging events allows faster detection, compared to just visual monitoring or visual and auditory modalities combined. Hearing is simply more equipped for the detection of real-time change. [7]

Early sonification applications utilize musical qualities such as pitch variation in order to indicate the magnitude of change in the observed parameter. However, more recent applications try to utilize human auditory capabilities for information extraction about physical magnitudes within the physical world. Human hearing can extract information regarding the physical events that occur among physical objects in its surroundings: density, malleability and weight of objects are easily reported.

The data that needs to be sonified has to be mapped onto auditory parameters according to its dimensions. For monitoring parameters regarding change in the urban realm, issues of scale is critical. Furthermore a gradual change in parameters such as densities over a region has to be mapped gradually. In the literature there are sonification examples for geographical information which are direct translations from visualization. Zhao et al propose a four-part system: overview, navigation (zooming), filtering and details-on-demand. Performance is difficult to document, and yet the results are in accordance with other basic research that theoretically disparate dimensions such as timbre and amplitude are not totally independent. [8]

These studies show that the design of sonification becomes crucial for its effectiveness. In order for the hearing observer to make sense of the sonic input, the design of the system has to begin with auditory capacities that are to be tapped into, rather than imposed classical music theoretical categories. Trevor Wishart puts forth listening in the frequency domain, and discusses the potential in much neglected noise spectrum. Wishart is interested in the listening of a dangling telephone wire in the wind, where the sonic output is connected with the physical properties of the wire itself: its mass, cross section etc. [9] These physical parameters are directly embodied in the sound generated, and furthermore the human ear is capable of extracting information regarding these. Therefore, a natural morphology of sounds could include: crack, turbulence, wave-break, bubbles and similar physical processes.

Physiological research into auditory scene analysis, backs these holistic views. Bregman provides a framework for understanding hearing in an ecological point of view. [10] In Gibsonian psychology, event replaces sound-object as the unit of analysis. Bregman takes it further and proposes that flow is pertinent: a series of footsteps tells us about haste or laziness whereas a single footstep sound is irrelevant. Following this logic, it is plausible to propose the address the kind of hearing of layered events in sound streams, that extend across micro and macro scales. What is critical for urban fields is the capturing of dynamic morphing qualities in the continuum regarding the movement of individuals amassed. Wishart extends the analysis into group phenomena proposes streams of micro-events producing a sound landscape that is continuous across scales.

PRODUCTION OF MICRO-SOUND FOR TEXTURAL DEPICTION

One particular technique that could be instrumental in the implementation of these principles is the technique of granular synthesis. Granular synthesis is a synthesis technique devised with slightly changing micro scale sound packets produced in unison. As masses of 1 to 100 millisecond long sound quanta come together in clouds, their variations produce macroforms. Simple changes in simple parameters like the duration or the density of the granules yields drastic transitions. The potential of granular synthesis for the monitoring of the full variation in the spectrum is illustrated in the Keller and Truax study. In this study the sonic material of water drops were used as granules, and masses of these sounds were then varied in density and flow speed to fully invoke sensations along a continuous spectrum ranging from sequential water droppings to the flooding of a river. [11]

In terms of sonification, granular synthesis techniques provide an invaluable set of bricks in portraying varying textural data, such as urban fields. For implementing a sonification environment for real-time change, an observer is crucial, so that real-time intervention becomes meaningful. The more textural the granules, the more embodied will be the sensory integration for the observer.

Design Tool Implementation

THE GENERALIZED CASE

An urban design tool is proposed to track emergent events within mobility patterns happening over time. Real-time change is dynamic, yet classical planning and design tools are incapable of capturing. This proposal rests on the assertion that an operator is crucial to assess the emergence within the flows. A disembodied computer model will only be able to detect occurences of pre-determined classes of events. For the detection of novelty, a mechanism tapping ecological perception can to be utilized.

Sonification with granular synthesis has two advantages for the task: utilization of the auditory modality for fast detection of temporal change, and micro-level granular change allowing for textural depiction of a phenomenon played out on a spatial layout. Mapping is straightforward: persons could be seen as singular moving particles, and each person’s movement can be sonified in its own terms. This movement will occur in a given urban spatial configuration. With interactive parts within this configuration, an operator could make decisions and change the parameters of these moveable parts according to the emergent events she recognizes. This consitutes a feedback loop where the operator becomes enmeshed within the system she observes: in real cities these moveable parts in urban spaces do exist, however they are in the hands of security experts, not designers.

Therefore, the overall tool is conceived of in several parts: sonification of moving agents, the feedback design loop and the piping of real-time mobility data from real-time cities to provide for the agents. As the total project is an ongoing venture, the purpose of this essay concludes with the discussion of the sonification and feedback parts.

INITIAL IMPLEMENTATION: PROOF OF CONCEPT

A Max/MSP/Jitter implementation of the analysis counterpart is based on a modified version of the original Boids algorithm by Reynolds. The urban field is represented as a two-dimentional surface on which agents are set in constant motion. In the original Boids algorithm, each agent moves according to simple rules: avoiding collisions with neighbors, trying to align its speed with the speed of the group and aiming for the instantaneous group center. As all agents are on the move, the center and the collective speed is constanly changing; an ever-changing swarm of agents are simulated [Fig. 2].

In order to complete the feedback loop, a few objects are placed in the field. The operator can change the orientation of the objects. These changes bring forth more dimensions to the complexity of the system. A real-time coupling of the operator's sensorium with the chaotic system forms an embodied coupled channel, working its way through the auditory system. The emphasis should be placed on processes of hearing with granular synthesis, rather than the closure of the feedback loop. With textural depiction, chages across many scales – ranging from the micro to the macro – will be audible, and yet responsive to miniscule changes in the operator's actions with objects.

Conclusion

For the first portion of the urban design tool, an embodied feedback loop is established between a dynamical phenomenon and an operator/observer through sonification. Granular synthesis allows a textural depiction of the event landscape, the resulting sound-field is capable of portraying miniscule changes in parameters for the acute ear. There are numerous granular synthesis techniques that need to be tried out to develop an understanding of the kinds of emergence each technique is sensitive to. For example with the implemented 'pulse trains', tight convergence and staggered cross-passage phenomena were strikingly recognizable.

References and Notes:

1. *Stephen Graham, ed., Cybercities Reader (London: Routledge, 2004), 3 – 9.*
2. *Manuel Castells, The Rise of the Network Society (Oxford: Blackwell, 1996), 376.*
3. *Nick Barley, "People," in Breathing Cities: The Architecture of Movement(Basel: Birkhaüser, 2000), 9 – 13.*
4. *Rem Koolhaas, "Harvard Project on the City," in Mutations (Barcelona: ACTAR, 2001), 650 – 720.*
5. *Gilles Deleuze, The Fold: Leibnitz and the Baroque (Minneapolis: Univ. of Minnesota, 1993), 76.*
6. *James J. Gibson, The Ecological Approach to Visual Perception (Hillsdale: Lawrence Erlbaum Associates, 1986), 93.*
7. *Gregory Kramer and Bruce Walker, "Sonification Report: Status of the Field and Research Agenda," (paper presented at International Conference on Auditory Display, Palo Alto, 1997).*
8. *Haixia Zhao, Catherine Plaisant, Ben Shneiderman and Ramani Duraiswami, "Sonification of geo-referenced data for auditory information seeking: design principle and pilot study," (paper presented at International Conference on Auditory Display, Sydney, 2004).*
9. *Trevor Wishart, On Sonic Art (Amsterdam: Harwood Academic, 1996), 180.*
10. *Albert S. Bregman, Auditory Scene Analysis (Cambridge, MA: The MIT Press, 1990), 9.*
11. *Damian Keller and Barry Truax, "Ecologically-based Granular Synthesis," (paper presented at International Computer Music Conference, San Francisco, 1998).*