davos soundscape, a location based interactive composition

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ABSTRACT
Moving out of doors with digital tools and electronic music and creating musically rich experiences is made possible by the increased availability of ever smaller and more powerful mobile computers. Composing music for and in a landscape instead of for a closed architectural space offers new perspectives but also raises questions about interaction and composition of electronic music. The work we present here was commissioned by a festival and ran on a daily basis over a period of three months. A GPS-enabled embedded Linux system is assembled to serve as a location-aware sound platform. Several challenges have to be overcome both technically and artistically to achieve a seamless experience and provide a simple device to be handed to the public. By building this interactive experience, which relies as much on the user's willingness to explore the invisible sonic landscape as on the ability to deploy the technology, a number of new avenues for exploring electronic music and interactivity in location-based media open up. New ways of composing music for and in a landscape and for creating audience interaction are explored.

Keywords
Location-based, electronic music, composition, embedded Linux, GPS, Pure Data, interaction, mapping, soundscape

1. INTRODUCTION
In the spring of 2007, we were commissioned to produce an interactive piece by the organizers of the annual music festival in the Swiss mountain town of Davos. Instead of proposing a more traditional interactive installation in one of the festivals venues we opted for a new approach that would expose the audience more directly to the spectacular nature and landscape present. Davos is best known for being the location of the annual World Economic Forum or the setting of Thomas Mann's Magic Mountain. The town and its surroundings are characterized by richly varying natural and urban environments, ranging from the urban chic of the main shopping street to the alpine rock wilderness of the high peaks reaching up towards 3000 meters above sea level. These contrasts inspired us to devise a location-aware site-specific musical work that would cover a large area and would have to be explored by an audience ready to do some walking. We called the piece very prosaically the *davos soundscape* [1] and decided to make use of an experimental dedicated GPS-enabled computing platform that would be purpose-built for the specific demands of this project.

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2. CONTEXT
Locative media work [2] draws from a rich background of Dadaist, Situationist, and post '68 philosophy and media theory. The focus lies on the creation of situations of social interaction where the intention is to bridge the gap between the virtual, online and Internet based media and the physical world, be it through mapping, tagging and/or representing one domain in the other. In our own approach the situationist Guy Debord's concept of *dérive* [3] is as much present as is the de/territorialization of sounds postulated by Deleuze/Guattari in their seminal work "Mille Plateaux" [4]. The former intends to generate an urban psycho-geography by dissociation of motion through urban space from its function of transport or reaching a destination. The latter focus on the role of sound and music in defining a territory or mental space. Through the creation of a territory that exposes music in a real landscape, we establish a non-deterministic composition that owes its existence and perception as much to the presence of the audience as to our own construction. In a sense, we present a typical open work, as set out by Umberto Eco [5], who defines an open work as one that doesn't intend to convey a definite meaning to be comprehended by the audience. The creation of the work of art is rather an act in which the perceiving individual is directly involved by assigning it a personal meaning. The constituting elements of the work do not represent a static structure but establish a dynamic and fluctuating field of relationships.

In this context, the design of a musical expression takes on a different meaning. The relevant issues here are not, for example, modeling of the action-perception coupling [6] and the enhancement of the specific affordances present in the technological platform deployed. The intended audience behavior and the expressive qualities given by the technology are very clear. The user moves through the landscape; the music heard is dependent on his topographical position and his temporal evolution through the given space. Sonic complexity arises out of the superposition of natural environmental sounds and composed materials triggered by the motion of the user. The real cognitive achievement is the ability to perceive one's movement in space as the acting element of the piece and to merge proprioperception

with listening on at least two levels (natural sound and composed electronic music) and to engender from this a meaningful musical experience. This setting is representative of a number of everyday musical and sonic experiences that form part of our contact with mobile technologies. Ubiquitous or pervasive computing is a growing trend through the closer integration of a increasing number of technologies into our personal communication devices. Tapping into this potential for musical creation and acquiring knowledge and experience in dealing with these issues is one of the main motivations of this project.

The following projects serve as examples of other location-based concepts in the urban field. Both Akitsugu Maebayashi's Sonic Interface [7] and Lalya Gaye's Sonic City [8] use urban sounds and user interaction to create a mobile personal soundscape. Marc Shepard's Tactical Sound Garden [9] is about planting sounds in an urban context and it locates the user through triangulation of known wireless hotspots. The projects Mediascape by HP Labs [10] and the net_dérive by Atau Tanaka for Sony/CSL [11] merge different types of media content and location technologies to create an urban and social interaction.

3. COMPOSITION

The first task in our composition process was to define how the landscape should be subdivided. Eight routes were devised, each representing an essential aspect of the area. The two town centers (Davos is actually split in two); the lake-side promenade; the town's park; the famous two kilometer long hill-side promenade; the walk downriver to the secluded forest cemetery; the high pastures and woods on the slopes above the Schatzalp sanatorium and finally the alpine hiking trails high up towards the Weissfluhjoch. Each of these routes was treated differently, the sonic structure or spatial placement of the music governed by a different principle. The longitudinal topography of the hillside promenade for example engendered sequential musical segments that connect differently according to the point of entry and the direction along which one walks on the promenade.

Figure 1. The lakeside promenade and its corresponding sound zones (image from Google Earth)

The circling of the lake by its promenade led to overlapping zones some of which functioned like musical beacons across the water. The common structure that emerged and became the guiding principle for all areas was the use of circular zones centered on a point of interest in the landscape and extending spheres of influence of varying size. We collected the GPS-coordinates for each spot, assigned them their music, a playback mode, a radial amplitude envelope which controls the cross fade between zones or the increase in volume towards the point of interest and finally the size of the sphere. The eight routes were mapped out with a total of 86 points of interest, each covering a large area and overlapping with one or several of the neighboring zones. Google Earth became an invaluable tool for planning and visualizing the spatial relationships of the sound zones and routes. (Fig 1.)

While approaching the task of producing the actual music for the *davos soundscape* several additional strategies emerged. Since one of the premises was to present a transparent sound overlaying natural and composed elements through open headphones, it was quite natural to think of the effects an augmented acoustic reality achieved by using field recordings or recordings of natural sounds as well as their polar opposites, the purely synthetic sounds. It soon became apparent that the strict separation of the two would be difficult and not very desirable if one wants to to maintain the sonic unity of the piece. The music contains brief sequences of field recordings made on site, sometimes deliberately displaced, for example where the cowbells from the alpine pastures make their appearance on the busy main thoroughfare or when the sound of the wash of the waves on the lakeshore reappears in the middle of the mountain woods. Since most of the time no predetermined chronology is possible in the arrangement of sounds, the music rarely establishes a linear evolution. Most zones have several possible neighborhood relationships; the music can overlap and occur in a number of combinations all depending on the itineraries chosen by the visitors. It was our principal intention to generate an inderminate field of acoustic possibilities that had to be explored and experienced in an individual way.

4. TECHNOLOGY

At present mobile devices equipped with GPS are becoming very common but they were less accessible when we evaluated possible solutions for our GPS-enabled music platform. Based on the options available at the time the choice was made to use a semi-industrial platform running Linux.

4.1 Hardware

The prerequisites for the mobile device were guided by a number of personal choices. We wanted to be able to write custom code without having to develop the entire software from the ground up. We wanted a device that gives access to all low-level routines of the Firmware or OS in order to set up daemons for automatic upkeep of the devices for extended periods of time. Coming from a background in electronic music, we were interested in using data-flow software for composition. The device needed to contain or easily connect to a GPS receiver and make the position-data available on a software-accessible interface. It had to have a solid-state medium on board that would store several hours of uncompressed stereo PCM audio and an analog audio output which could be controlled from software. The device needed to be able to run for about eight hours on one battery charge. Most importantly we wanted to avoid having to build any custom electronic components ourselves.

4.1.1 Choice of Platform

After evaluating all available options, ranging from commercially available GPS equipped PDAs to open source hardware, we finally decided to use the Gumstix platform [12]. It fulfills many

of the prerequisites by offering a selection of expansion-boards in addition to its ARM-based motherboards. The three determining factors were that the Gumstix run a Linux OS, that they offer an expansion-board that hosts both a GPS receiver and audio I/O chip and, as we were excited to learn, that a port of Pure Data called PDa (Pure Data anywhere) [13] is available for the ARM processors used on many of the embedded single board devices. Finally, several expansion modules exist for the Gumstix that offer Compact Flash or MMC interfaces to connect large solid-state storage devices.

4.1.2 Device Assembly

In addition to the embedded computer with its daughter boards, three other components are necessary to make the device complete: the battery, the GPS-antenna and the headphones. Unsure about the actual power consumption we opted for a large single-cell 3300mA/h Lithium Polymer battery. This is the same technology found in mobile phones and laptops. Preliminary tests had shown that the device consumed roughly 250 to 350 milliamps per hour so in theory a full charge should run for a full eight hours. Active GPS antennas are readily available and have a form-factor ideally suited for mounting on top of headphones. The entire device was assembled in a standard electronics shielding metal-case and packed into a soft case for protection and user-friendlier packaging (see Fig. 3).

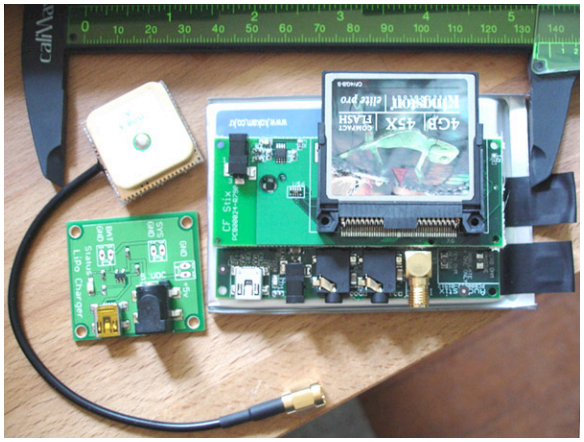

Figure 2. The Gumstix computer with a 4GB Compact Flash Card on top, the battery underneath and both the LiPo charger circuit and the active GPS-antenna on the left.

4.2 Software

4.2.1 Linux OS

The Gumstix computers come with a factory-installed fully functioning Linux OS that contains all necessary device drivers for the possible expansion boards. In our case there was a problem with the OSS audio layer that took a lot of time to correct. In-depth knowledge of Linux and experience in building and compiling was a definite plus. In theory, things should work right out of the box but our experience was a little bit marred by the problems we had getting the audio to work. The buildroot environment used for cross compiling for the ARM architecture and the available command line tools on the Gumstix offer a limited but essential set of features, all geared towards autonomous functioning with a minimal footprint. The working methodology for embedded systems may take some getting used to, since the Gumstix typically provide neither screen nor keyboard. All operations are executed from the host computer on the command line through a secure shell.

4.2.2 PDa

An important step for our project was to port PDa to the Gumstix. Featuring a limited set of functions PDa still contains all essential tools for audio on such a system. Originally ported to run on an iPaq-PDA this downscaled version of Pure Data has been successfully applied to Apple iPods, Linksys routers and a variety of portable devices running Linux [14]. Since the ARM type processor doesn't feature a dedicated Floating Point Unit, and software processing of IEEE-754 32-bit floating point numbers is extremely slow, PDa has been rewritten to run all DSP code in 16-bit fixed point numbers. This makes extending the audio-capabilities difficult and for that reason, for example it is not possible to play compressed audio in the Ogg/Vorbis or the mp3 formats. Apart from this limitation normal patches can be written, system-access is given through the shell external and access to serial ports is possible after porting Pure Data's comport object. The most essential feature of PDa for our application is the ability to extend its functionalities by writing dedicated objects in C.

4.2.3 Custom C Code

Because of the limited set of objects and for the sake of efficiency, PDa is used as a kind of framework within which to run our own code. The first task is to obtain the coordinates from the GPS receiver. Thankfully, the data from the module used by the Gumstix is made accessible on a standard serial port. This stream of data is parsed for the standard NMEA GPS reports to obtain a new set of coordinates every second [15]. At startup a database file is loaded into a simple data structure which contains the map with the coordinates of all the points of interests and their associated sound files and further information about global scaling factors, reference points and envelope tables. With each new GPS coordinate, this internal map is evaluated and the appropriate commands are generated to control a very simple patch which consists of four sound file players and a mixer.

4.3 Long Term Usage

A lot of care was taken when planning and assembling the devices to ensure a completely unattended functioning for the duration of three months. By avoiding any manipulation by either the users or the attending festival personnel, we achieved the goal that the devices survive this extended period. Through a combination of shell scripts and daemons the device was made to boot straight into the PDa patch and in case of a crash automatically relaunch it. In order to reset the GPS receiver the Gumstix was also automatically power cycled and restarted at regular intervals. Whenever not in use the devices needed to be charged since a full charge can take as long as twelve hours.

5. USER EXPERIENCE

We built a series of ten devices for the festival. Against a deposit the public borrowed them from the local tourist office for the duration of a day. The goal was to present a seamless experience that convey as little technological complexity as possible. With the compact packaging and the clear documentation this goal was clearly achieved.

The audience or visitors were handed an already running device in a closed pouch to which a set of semi-open light headphones is attached. The GPS antenna is placed on top of the headphones to ensure optimum satellite reception. There are no user-controllable elements on the device and no setup is required. Right after

moving outdoors with the device there is a brief waiting period since the GPS receiver needs to locate and identify the satellites, download the almanac and obtain a stable position fix. A printed map of the landscape, including point descriptions and information, is handed out together with the GPS device. The eight routes that make up the *davos soundscape* are clearly marked. In the real landscape, to facilitate orientation but more importantly to leave a physical mark, stakes painted a bright orange and bearing the logo of the *davos soundscape* are planted at all 86 points of interest.

Feedback from members of the audience clearly indicates that a memorable sonic experience was presented. Of course not all of the music can be heard in one day and sometimes the participants have difficulties to orient themselves within the multitude of elements present within the acoustic domain. Often the terms "treasure hunt" and "exploring new territories" are mentioned. The intention to enhance Davos' sonic reality by overlaying the natural acoustic environmental with electronic sounds is not always recognized. This might be largely due to the fact that we have all been conditioned to filter out external sounds when wearing headphones. Depending on the weather the individual experiences can also vary. Satellite signals get disturbed by certain atmospheric conditions; some people reported problems during thunderstorms and were clearly apprehensive to walk around under such conditions wearing an antenna on their head!

Figure 3. One of 86 markers in the landscape and a visitor with the GPS-device and Headphones.

6. CONCLUSION AND OUTLOOK

Davos soundscape taught us some valuable lessons. Complexity emerged as the constantly challenging factor. It happened on a technical level during the first phase when a lot of elements had to be assembled and problems sorted out, before even raw sketches of the planned features could be made and evaluated. Once the prototype for the device was functioning, the challenge of imagining, structuring and composing music for a landscape arose. As musicians we are clearly not trained to think in loose aural or temporal relationships and need to learn how to deal with a real topographical space as the stage for our music. The final most valuable lesson learned was never to underestimate the demands that a series of experimental devices make to be able to run for an extended period of time without any attendance. This being said, it still seems an intriguing concept to be able to take a device capable of real-time interaction with intelligent electronic music generation out into nature and to witness a musical expression and spatial sonic experience which would not be possible any other way. Due to the complexity of all elements involved, the composition and topographical principles applied to the music in the *davos soundscape* had to remain quite simple. The platform's computing power and the flexibility of the software offer a much greater creative potential that remains to be explored. Generative, algorithmic music and a closer integration of the user through sensor technology are only some of the ideas that come to mind.

For future iterations of the piece, the software will be ported to one of the new commercially available GPS enabled devices running Linux such as the N810 Internet tablets by Nokia. With these devices the hardware constraints are resolved and since the software has already received its validation, location-based interactive music experiences can now be imagined in many other forms.

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