Unbounded: Aos & The GoingPublik Software

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ABSTRACT
GoingPublik is a work for distributed ensemble and wearable computers. The core idea behind the work is a strategy of mobility employing a wearable computer system running a software based electronic scoring system. The score allows for 'composed improvisation', which permits improvisational elements within a compositional structure. By electronically monitoring the performer's physical positions during performance using universal inputs such as geographical positions obtained via satellites and sensors using the earth's magnetic field, the score makes suggestions to various degrees and times. This paper shows how electronic scoring can be self-regulating and depicts how performers using it are able to interact with one another and to create a unique choreographic dispersion of sound in space [1].

Keywords
Wearable Computers, Score Synthesis, HCIs, Aos, Bluebottle, Linux, Q-bic

1. INTRODUCTION
In GoingPublik sonic coherency is accomplished through a theory of 'distribution'. All of the electronic scoring systems used are matched and share similar sensor inputs, (3d-compass and GPS) which are the common denominator to virtually linked them. So despite the physical distribution, commonly shared elements can be structurally exploited. For example, at moments of close proximity between performers synchronized "tutti like" group movements such as rotation bring about synchronized changes in the score. The compositional quantities and qualities of the work are thereby based on spatial mobility; Intensity of form is held by changes in timbre and rhythmic modulations are brought about in conjunction with the sound distribution [2].

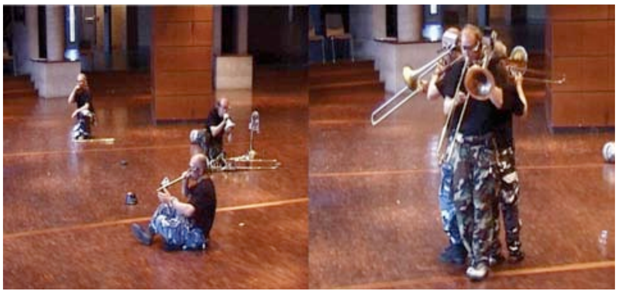

Figure 1. Members of the ensemble in "distributed" and "huddle" formations. Each player is wearing a Q-bic computer, sensor network and display glasses.

2. SOFTWARE & HARDWARE
The system hardware in its current form comprises a StrongARM/XScale based proprietary wearable computer (Q-bic)[2]; a custom made micro programmed 3D compass sensor, a Garmin GPS device, and a Micro Optical SV-6 head-mounted display. The main tasks of the wearable computer is reading the sensor data and computing the score in real time according to predefined rules. The scoring application is programmed in a Pascal-like language called Active Oberon[4]. It runs on Bluebottle (Aos)[5], a lean, open source system kernel enhanced by a highly efficient 2.5D graphics engine that supports sophisticated visual effects on the basis of general-purpose hardware.

3. BEYOND OPEN SOURCE

3.1 Open Sources and Useable Toolboxes
Open source software is like an open toolbox. It is a necessary but often insufficient step towards truly "malleable" software. What is actually needed is mastery and full control of the tools in the box. ETH's integrated programming language Oberon has been available as open source since its invention. Oberon differs from many comparable systems by its simplicity, minimalism and conceptual uniformity in the spirit of Niklaus Wirth's widely acknowledged lean-system tradition. The newest evolution along this line is the Active Oberon language and runtime. As an innovation, Active Oberon introduces a new computing model based on interoperable objects with encapsulated active behavior. This model is ideally suited for programming "the new media", and it easily scales up to distributed systems. This issue addresses the growing interest in the use of computers in the new arts in general and the quite apparent benefits of custom software design in particular. Using the "Going Publik" project software as a proof of concept, we shall argue in favor of both application-aware runtime kernels and small ad-hoc languages as an effective alternative to widely spread graphic builders.

3.2 The Lean versus the Fat System
The reusability of typical open source software is not guaranteed by its openness alone. Even if all the source code that is needed to rebuild an application is provided, it is often very difficult to reuse parts of a project for new purposes. Even reducing the functionality of an open source system can be difficult because of non-modular or inconsequent design. The C based programming languages typically used in open source projects does not encourage a clean modularization and can easily result in header-file incoherencies whose correlation can only be grasped after a long period of review. One could consider the Linux kernel as an example. Although its system is

"open", it is at the same time "closed", because only few people are able to really contribute to its development (in fact, all changes in the Linux kernel are still made by the original author, Linus Torvalds). Of course, kernels are not simple topics and this is not really that different in the case of Aos. However, in a lean and compact system like Aos there are simply fewer unnecessary pitfalls and time consuming debug sessions.

To continue the comparison between Linux (a well know system) and Aos (a less known system) in order to better understand the points made above, one can state that the Linux development can profit largely from a massive amount of manpower and available tools, where as Aos is more limited in this regard. However, most of the tool chain used for Linux development would not be necessary or would have been much easier to develop for a small and completely compile-time type safe programming language such as Active Oberon. Although the available Linux tools and the number of C oriented programmers who are willing to program far outweigh the time lost on insufficiencies of the used programming language, there is still no progress in obtaining malleable and more coherent tools for the future.

To improve code reusability and understandability, ETH follows the lean system initiative. Lean systems have a well-designed, clear and modular structure based on a unifying set of concepts. Lean systems are teachable and therefore understandable. With a deep understanding of a software layer, it becomes possible to adapt it to new needs or to only port or implement the needed parts that are essential in solving a given problem. Having the possibility of leaving out unneeded parts not only improves resource efficiency of a program, but also reduces the number of possible errors and potential exploits.

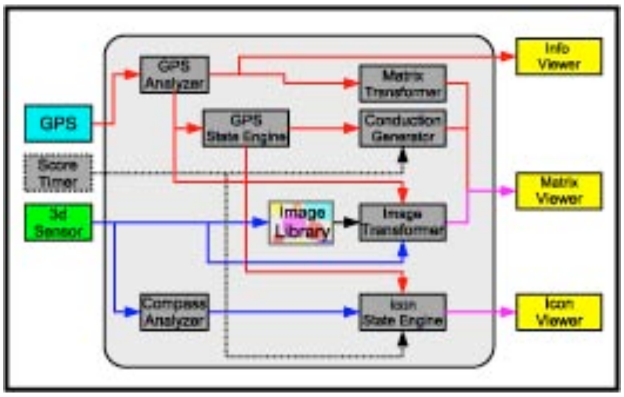

Fig. 2. Depicted is a schematic showing the relationships between the sensor systems and the component packages of the GP software.

4. THE SOFTWARE

4.1 Modularity and Malleability

Contained in the GoingPublik software package are eight modules, which can be more or less included or excluded during runtime. The elements depicted in Fig.2**.** within the rectangle are the software components, the elements depicted to the left are the sensor systems, and the elements depicted to the right are those drawn into the screen areas of the display glasses. The GPS and the 3d Compass sensor are connected per Bluetooth and are mounted as wearable sensors on the performer's clothing. The graphic elements drawn by the Info Viewer, the Matrix Viewer and the Icon Viewer modules are combined in the display glasses into a single score as depicted in Fig.3. To exemplify the system's malleability: When the software module "Icon State Engine" is not needed for the performance version without the behavioral icons, then it would simple be left out of the software package[1]. The icons would not appear in the viewer and the other modules would not be affected in any way and would operate as expected.

5. THE MATRIX WINDOW

5.1 The Modulating Matrix

The basis of the electronic score is a modulating matrix. The resolution of the matrix is determined by the performer's position within the performance space, which is obtained via GPS satellites or generated by a GPS simulator. In either case, the received GPS string is parsed and given further as x, y value pairs that reference the position within a predefined area. By moving within this area, the performer influences the position of the matrix's lines, therefore continuously adjusting the 'resolution' of it to parameterize sonic domains with frequency and time values. The 'Range-Lines' of the matrix move on the horizontal plane in relation to the North-South axis; the 'Time-Lines' move on the vertical plane in relation to the West-East axis. The Time-Lines move in contrary motion and modulate the spaces between the lines into equidistant and non-equidistant states. The 'Conduction-Arm' travels through the matrix from the left to facilitate score reading. The time taken by the Conduction-Arm to scan through the space between two Time-Lines is always a constant value in milliseconds (independent of the distance), but is dependent on walking speed measured in meters per minute. There are four discrete tempi: Rest, Relax, Work and Hurry. The speed of the Conduction-Arm therefore makes a quantitative difference in the amount of time the performers may 'stay' on an area of the score image.

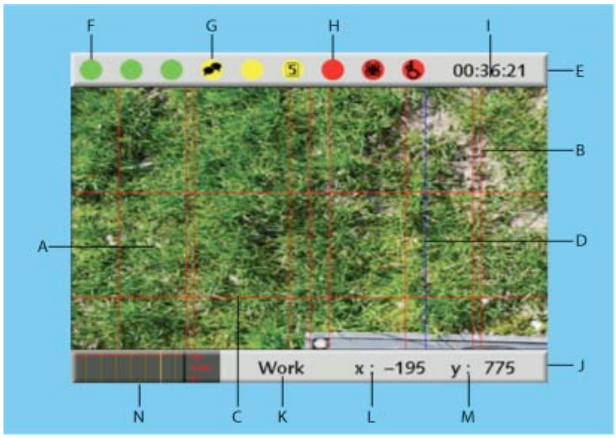

Figure 3. The Matrix Window: (A) Score Image, (B) TimeLines, (C) RangeLines, (D) Conducting Arm, (E) IconBar, (F) GoIcons, (G) ModIcons, (H) StopIcons, (I) Timer, (J) TempoBar, (K) Tempo, (L) GPS x-Coordinate, (M) GPS y-Coordinate, (N) Activity Graph.

The movement of the Range-Lines brings about equidistant

[1] Such a malleable system could also be realized by a program written in C, but its lack of modularization concepts on the language level would require more efforts of the programmer.

spaces, which limit and expand the instrumental range based on changes of position within the space. When all Range-Lines are present, seven range spaces can be seen. The available ranges would then be as follows: Outside, Very Low, Low, Middle, High, Very High and Outside. Ranges are always kept in consecutive order, the performers freely choosing the lowest initial range first and then continue upward from there. The performers decide where the boundaries the instrumental ranges are and what is meant by 'outside' the instrument.

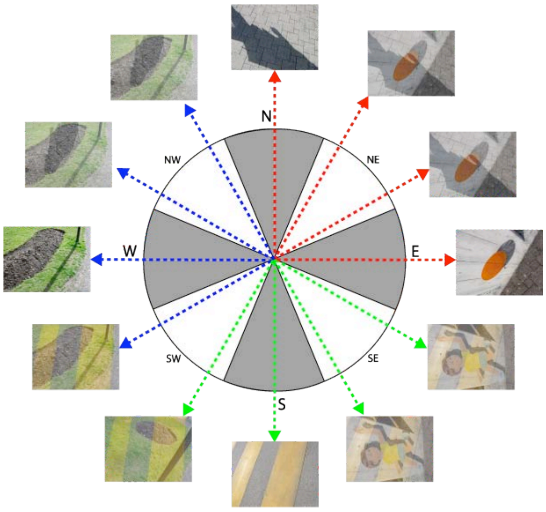

Fig. 4. The 360° of Directional Imaging: Single score images are at the poles and complex images are between these poles.

5.2 Directional Imaging

There are four score images and each is assigned a direction. A discrete resolution of eight possible 'headings' is used and these values determine the score image. Single score images are rendered at the poles of the compass and superimpositions between these. The 3d-compass also measures 'pitch' and 'roll', whose values distort the score image to create 'variations'. The larger the intensity of pitch and roll is, the greater the distortion of the score image is. The size of the displayed score image is dependent on walking activity. This is calculated using speed average over a given period of time. If the performer is 'standing' more than 'walking', the image will enlarge up to 200%; if the performer is 'walking' more than 'standing', the image will shrink back to its original size. Variations in sound material therefore not only arise on account of the Conduction-Arm speed but also due to score image distortion and changes in size.

Figure 5. The Icon Menu Bar. From left to right are three blank Go-Icons, the Mod-Icon for "Medium Playing Density", a blank Mod-Icon, the Mod-Icon for "Phrasing in Groups of Five", a blank Stop-Icon, the Stop-Icon for "Stop and Hide", and lastly the Stop-Icon for "Sit Down".

5.3 The Action Icons

Three groups of three icons contained on the "icon bar" are used to suggest actions to the performer. The green 'Go-Icon' and the red 'Stop-Icon' groups suggest changes in walking speed, the time spent doing so, and a random component. Related performative actions are associated with each of the icons to artistically integrate changes in walking activity, regulate the tempo in general and to integrate the performer's sonically into the environment.

Based on the rate of heading change, walking speed and a random component, the 'Mod-Icons' suggest how the score is to be read by designating parameters of 'style'. Here, eye movement through the matrix is confined by phrasing rules. These rules are PHRASE (the division of the matrix into units of material), PATH (the form of the curve used to read through the matrix) and PLAY (the degree of density in playing while reading through the matrix). By interpreting the score in this manner, contrapuntal differences between the performers are brought about, so that 'sonic windowing' is created through which unoccupied audio space and variation in voice density are guaranteed.

6. THE MAPPING WINDOW

6.1 Performance Modes

There are two software based performance modes: An 'indoor' mode is for closed spaces and an 'outdoor' mode for open spaces. The indoor mode relies on a route simulator and the outdoor mode relies on GPS satellite information to make changes to the matrix and icons. The software automatically switches between route simulator and GPS satellite information dependent on satellite reception so that a performance may take place in and between closed and open spaces. To use the route simulator, each player draws a predetermined route onto the provided map with a handheld mouse. When finished, the performer presses the range button and switches back to the Matrix-Window.

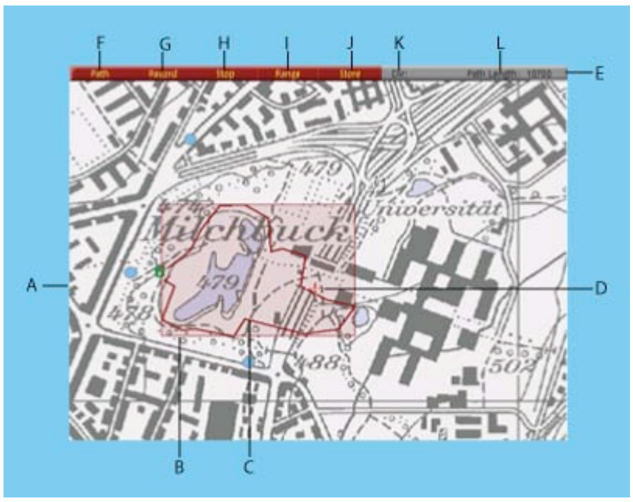

Figure 6. The Mapping Window: (A) Map Area, (B) Range Box, (C) Performer's Route, (D) X-Bow Position Indicator, (E) InfoBar, (F) Path Selector Button, (G) Path Record Button, (H) Stop- Record Button, (I) Calculate Range Button, (J) Store Route Button, (K) Direction Indicator, (L) Length Indicator.

6.2 Synchronization Types

There are two types of synchronization exploited in the work: 'local' and 'global'. Local synchronization is made possible by the 3d compass sensor data and takes place when performers are "huddled" and change heading, pitch and tilt readings together, thus changing the score image at the same time and to the same degree. For an 'inside' performance the performers dismantle their instruments and spread the parts across the peformance space. This action emphasizes the effect of distribution visually and creates a predetermined task that results in a predictable choreography of movements. The system sensors respond accordingly, and the electronic score changes in conjunction to all movements made as the performers re-assemble their instruments. Global synchronization is made possible via GPS and takes place via Conduction-Arm synchronization and when there is some form of coordination of routes between two or more performers. For an outside' performance three routes, one for each of the performers, are roughly designated. The greater the distance between the performers, the more varied their scores will appear; the lesser the distance between them, the more similar their scores will appear. So, when the separation between performers diminishes as they come to meet, their scores slowly grow in similarity until each score matrix is similar [6]. As listener, a gradual morphing from individual to collective sound masses can easily be heard.

7. FURTURE WORK

7.1 GPS Time Mark Function

In the next version of the GoingPublik software, the GPS Time Mark will be used to synch an on-board clock housed on the Q-bic computer. The GPS Time Mark arrives at the exact same moment for all of the performers of the distributed ensemble and this event makes it possible to synchronize the movement of the Conduction- Arms of all of the players. To employ it aesthetically as a compositional mechanism, the concept of "global synchronization" is used again as a uniting force. Each of the four tempi used in the scoring system are in ratio to one another: Tempo "Relax" is therefore 2 * Tempo "Rest", Tempo "Work" is 3 * Tempo "Rest" and Tempo "Hurry" is 4 * Tempo "Rest". The speed of the Conduction Line for the slowest tempo, "Rest" is used as the basis for determining the speeds of the other three tempi used in the score.

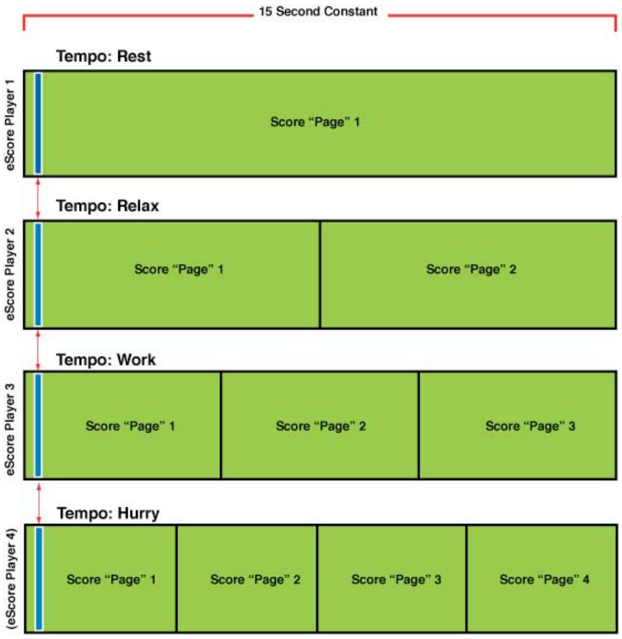

Figure 7. The figure illustrates how the Conducting Line (here indicated in blue) can be synchronized in relation to tempo for each of four players.

What by "page" is meant is the width of the score image. So a tempo is always in terms of how long it takes the Conduction-Line to get through one "page" of the score, One page is the therefore the time it takes for the Conduction-Line to transverse the entire score image. In this way all of the Conduction-Arms of all players stay synchronized and will always meet (after some number of pages) at the "beginning" of a score "page" just as certain polyrhythmic groupings meet at the initial beat they began at. This feature was tested outside of the GoingPublik in the work China Gates for gongs and GPS-Wrist Controller [7].

7.2 Collaborative Score

The GoingPublik system allows for the unique opportunity for composers and performers to research the possibilities of collaborative scores. Through changing the .xml file that is used to preset the software, it is possible to designate which score images are to be loaded into the matrix. Having each of the players or each member of a group of composers prepare a single score image for the system, would bring about a system score which would consist of four distinct scores, which would then "integrate" into a single whole via the system and who it works to parameterize and vary the score images during a performance. This possibility of collaboration demonstrates how the GoingPublik software is not a single work, but system, which can be used to interpret a body of, works written for it and also how it might be used to research collaboration in general amongst performers and composers.

8. CONCLUSION

The movements made by the ensemble players can be understood as choreographic patterns having an internal system of counter-point: 'bundled movements', or synchronized movements made together are analogue to polyphony in similar motion and 'free movement' or non synchronized movement carried out in non-relationship to one another are analogue to contrary motion. Therefore, a parallel can be drawn between the distribution amount of the performers and the degree of 'dissonance' in terms of rhythmic and range discord existing between them.

A slight comparison between Linux and Aos system software was drawn. The comparison did not point to the better system, but was intended to serve the purpose of proposing a focus on new paradigms of computer science, in order to develop languages that lead to more malleable and understandable tools. As an innovation, the Active Oberon language was introduced as such a new computing model, which is based on interoperable objects with encapsulated active behavior. By using the GoingPublik project as a proof of concept, it was argued that this computing model is ideally suited for programming need in the arts, in that it was made quite apparent that custom software design in the new arts has become quite common as has the needed adaptability of the that software for further developments of the same an new art works.

9. ACKNOWLEDGEMENT

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