Stillness design attributes in non-formal rehabilitation

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Abstract
Non-invasive sensor technology is used as an interface to a computer system to collect physical movement data that controls elements of a virtual environment. The environment is used for rehabilitation training i.e. physiological learning, for people with profound disabilities, and often no verbal competence. Movement of the human body is sourced as feed-forward kinetic data and empowered to control multimedia feedback content, e.g. audio, visual, or robotic feedback. It is delivered to be as a direct and immediate feedback so as to optimise user-awareness and association. The feedback is selectable as either figurative or abstract in form and can be art or game based. Inherent to the programming design of the data collection is the creation of stillness zones which generate nul data. The stillness zones have been found significant for participant augmented communication. The uses of these stillness zones for this targeted community have been subject to limited exposure. This paper describes how these zones are used in rehabilitation training. Findings are presented from the established SoundScapes body of research that has existed for two decades.

Keywords
Stillness zones; Non-formal Rehabilitation training; Creative Expression; Performance Art; Digital Games

Introduction

Throughout the last decade of the 20th Century a body of research titled SoundScapes evolved so as to offer people with disability new opportunities for creative and joyful expression through movement. Originating in 1987 the research was established as a result of experiences gained from living with a relative having profound disability that were synthesised to experiences gained in working with creative expression through the arts in a professional capacity. The concept is based upon creating a supplementary entity for therapists working within the field of physiological rehabilitation training. Motivated engagement in sessions is achieved through *fun* experiences targeted through the control of interactive personalised multimedia content. In a programme of training the design of the interactive environment is such that behind the user perceived level of fun through the empowered control the same kinetic data that is empowering is simultaneously monitored and archived for session-to-session analysis of the intervention. In this way participant progression/regression as well as facilitator intervention decisions are reflected upon for system and intervention strategy refinements for following sessions and programs. Evaluation is through qualitative methodology where we systematically analyse via a synthesised model combining action research with hermeneutic recursive reflection. Triangulation techniques are used including video recordings, interviews, and case study strategies correlated to a quantifying of the kinetic data generated from the participant's movement.
This paper presents not just one specific case study but rather it compounds the two decades of research in reflective focus upon the stillness attribute in design of the interactive non-formalised rehabilitation and learning inherent to the SoundScapes environment. Following a presentation of the concept and the human-centred technological issues an overview of the pros and cons of non-intrusive interface technologies and the paradigms of application are outlined. These highlight the significance of facilitator knowledge, understanding and awareness of use of the stillness zones for the intervention sessions. The paper illustrates how art, design and education are involved in the non-formal rehabilitation concept and practise, and how computer use is enabling a new generation of therapists to achieve accessibility to related digital tools. Through this access certain traditional

aesthetic values are questioned. Conclusions attest to the use of stillness zones as communication mediators in interactive virtual environments and their potential in rehabilitation for non-formal training. The paper is presented with a view to inspire a next generation of digital artists toward exploration of the SoundScapes concept as well as to further disseminate to the rehabilitation community.

Technology and technique

Non-intrusive digital interface technologies that do not require any worn devices on the body to source movement information are central to the SoundScapes concept.. These devices are selected from a 'library' of input interfaces based upon various sensor technologies that operate beyond human visible range. Such 'invisible interfaces' have been found optimal to promote uninhabited and intuitive natural kinetic expression from activity zones that were coined as Virtual Interactive Space (VIS) (Brooks, 1999). The sourced *feedforward* kinetic data is mapped to a computer workstation. The digital signal protocol is MIDI (Musical Instrument Digital Interface), which is a standard open protocol designed for communication between musical devices. In SoundScapes the digital signal is mapped to control various multimedia content *feedback* that make up the personalised interactive environment. The environment is a room sized space. The personalisation of the feedback content is designed according to an individual profile that originated from knowledge of the individual and evolves throughout a programme of monitored training. A computer database tracks progression of the participant using the profile as a baseline. Feedback content can be music making, digital painting or game playing, all responding to the same kinetic information.

The technique of utilising stillness zones is exemplified in figures 1 and 2. Figure 1 illustrates a single participant head and upper torso with two 3D sensor activity zones set up either side of the head.

The participant in the intervention training becomes aware of the proprioception connected to activating the feedback content, e.g. sounds. The stillness zone is the area between the sensors which is usually established in the neutral position, in other words, the position where the head comes to rest when the participant is in neutral posture and not involved in ‘doing’ anything. The intent in use of the active zones combined with the stillness zones by people with profound disability augments participant communication with facilitator. Apart from this set up there is the opportunity for programming the stillness zone inside of the active zone so that activity transmits a ‘null’ signal.

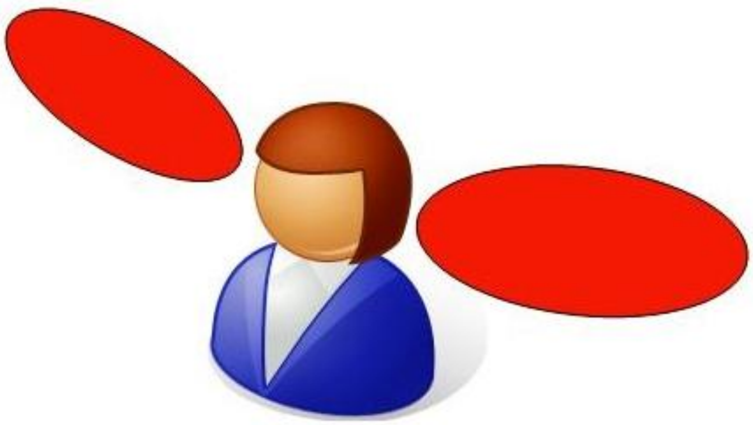

Figure 1. Participant with two active zones either side of the head. The stillness zone is established at the normal rest position.

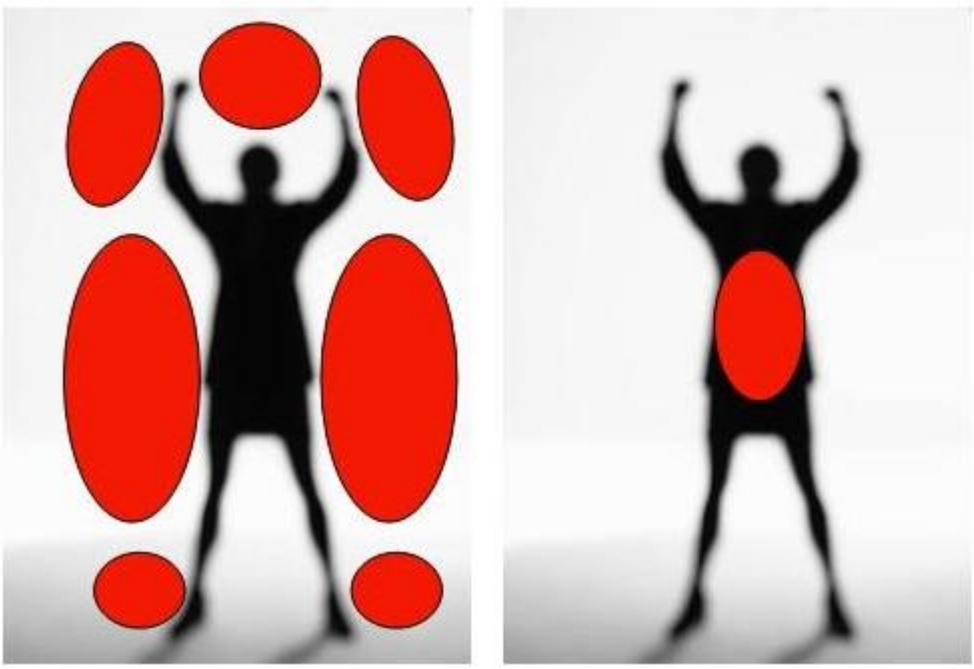

Figure 2(a) and (b) illustrates two scenarios for an extended 3D infrared sensor system. On the left, in Figure 2(a), 7 sensors are set up to surround the body with active zones. The stillness zone is predetermined as a central neutral position from where selected activity, e.g. hand, arm, hip or foot movement will result in triggering (or manipulation) of the selected feedback content. Figure 2(b) illustrates a single sensor that is used in the extended set up (>1meter <14 meters) but the body size is positioned to block the infrared light. In this second scenario the stillness zone is where the body is situated to block the infrared light beam, and as the beam is invisible this can only be determined by a sonic or visual feedback. To activate the mapped media, e.g. sound, in the second scenario the participant moves laterally so as to permit the infrared light to pass the body and in this way the participant can listen to his or her body movement in space as a result of the generated kinetic data being sensed.

Figure 2: (a – left image) active sensor zones can be positioned around the body with the stillness zone being in the neutral position and kinetic data generation is from entry into active zones, as opposed to (b – right image) where a single sensor is blocked by the body so as to establish a stillness zone and where kinetic data generation is from movement away from the active sensor zone.

In comparison to state of the art figure 2 (a) looks similar to common computer vision techniques in camera based interaction where active matrix zones, blob tracking, or pixel differentiation scenarios are established that generate data according to inhabitation of zones, recognition of an object, or change of pixel colour. The use of an infrared sensor instead of a standard camera means that it can operate in complete darkness and that the sensor used is able to collect 3D data from close proximity. Figure 2 (b) illustrates the scenario set up where transfer from stillness to active generation of kinetic data can be as a ‘felt’ dynamic interaction through body change of position that is intuitive and suitable for rehabilitation training. In rehabilitation training with acquired brain injured patients exercises were conducted where the patient closed their eyes when in the neutral still position. Notably, closing of the eyes while standing was a traumatic experience for this group as fear of falling was evident. Body movement trained was initially along an approximately perpendicular plane (to sensor/body alignment) away from this still position and back again. As they moved they were able to ‘listen’ to their body motion in space (the mapped sonic feedback) as a linear sonic scale so as to train direct proprioception association and body dynamic awareness. In other words from no sound (the stillness zone) then rising linear scale tones depending on movement away from the stillness zone, and then falling linear scale tones as the body was returned to start position in the stillness zone. Individual limb movement gave similar training opportunities (also in non-perpendicular motion exercises) and the basic technique of moving to permit the passing of infrared light from emitter to reflector to receiver was easily learnt and intuitively associated and understood. Positive response from participants supported observations of a self-motivated pushing of limitations as confidence grew so that each increment of sonic scalar feedback was an indicated matched achievement of quantified progress in their movement training. The flexibility of the system to be able to change sound patches (also parameters such as octave, resolution, trigger/control etc.,) also gave opportunities for change (alleviating boredom/repetition) and development of system-mediated social-cultural interaction between the facilitator and participant.

Aesthetic Resonance – Where the expression is the art and the art is the expression.
In SoundScapes the 'art' aspect of the work is often misconceived as the interactive content feedback created from participant movement; however, this is incorrect as the true art lies in the perceived effect on the participant, thus the therapeutic aspects attributed to the system. This experienced phenomenon is optimised through the tailoring of the design of the environment and the interaction to it so as to be immersive and engaging such that a state of flow and related autotelic experience (Csikszentmihalyi, 1991) is achieved. This has been termed as Aesthetic Resonance and has multiple interpretations, for example, Swingler (1998a, np) quotes Ellis' (1996, 1997) original coining of the term as referring to "special moments experienced by individuals described as having profound and multiple learning difficulties, in which they achieve total control and expression in sound after a period of intense exploration, discovery and creation." Whereas Camurri et al. (2003) states that it is defined as giving "patients a visual and acoustic feedback depending on a qualitative analysis of their (full-body) movement, in order to evoke ludic aspects (and consequently introduce emotional-motivational elements) …" (p. 269). Ellis further refers to how it is the facial expressions of children with a disability that are indicators of aesthetic resonance (Ellis, 1996, 1997, 2004; Ellis and Van Leeuwen, 2000; Swingler, 1998a, 1998b). In our earlier work we have augmented Ellis' definition by suggesting it refers to "a situation when the response to intent is so immediate and aesthetically pleasing as to make one forget the physical movement (and often effort) involved in the conveying of the intention" (Brooks et al., 2002; Brooks & Hasselblad, 2004). With this document we redefine the meaning as special moments that are experienced as control with intent within a responsive environment where a direct association between body movement and audiovisual feedback content (including games) acts as a stimulus that evokes joyful discovery, intense exploration, and expressive creativity that results in, and from, optimized and motivated ludic engagement. This phenomenon is such that the response to the intent is so immediate and aesthetically pleasing as to make one forget the physical movement (and often effort) involved in the conveying of the intention. The approach is such that it encourages the participant to disassociate toward incremental higher engagement and the inherent motivation of the play. This disassociation could for example be from pain that may otherwise be present as a result of the physical movement involved in the conveying of intention in interacting with the system. The aesthetic resonance paradigm can offer a potential in training where physical functionality limitations may be exceeded through motivated play.
The state of Aesthetic Resonance happens when there is a balance between a person's skills and the challenge at hand. This can be compared to the state of flow (Csikszentmihalyi, 1991) which associates to autotelic activity (Csikszentmihalyi, 1991). Play is similar to the autotelic experience as it is characterised as being carried out for its own sake by inner goals generating the state of flow (Petersson, 2006). This is similar to the way the 'doings' or actions function as prerequisites to playful engagement and how the technical system intends to awake and develop enjoyment and curiosity among the participants resulting in an optimised motivation to train, play and learn. Being engaged is in this case closely related to "having fun" (Göncü, 1999; Rogoff, 2001).We build upon

this view by referring to Gadamer (1997) where we agree to his statement on the transformational power of real aesthetic experience. However, we decline from expounding further, as, whilst in agreement with the above suggested inferences, we believe that once an experience phenomenon such as aesthetic resonance, or the performing of an art, is attempted to be described in detail it immediately becomes something else, and thus we refer back to the acquaintance principle that states the need for that being referenced to be experienced so as to be evaluated (Budd, 2003).

Designing for kinetic data mapping

SoundScapes is not therapy and we are not therapists. The research has evolved to be a vehicle for multi, interdisciplinary exploration. A concept, apparatus and method has evolved from the work that substantiates non-formal rehabilitation as an intervention towards improved opportunities in quality of life for certain people. The designers and creators of these works are artists. Processing decisions in respect of the kinetic data mapping, both pre/post sessions (designer assigned – therapist advised) as well as in session (facilitator intervention), has continued to be via a computer graphical programming language called Max produced by Cycling74. This has been extended over recent years via improved software. Feedforward data is now more efficiently mapped to an array of multimedia feedback so as to enable the facilitator to address participant preferences and profile. The 3D infrared sensor device and Soundbeam[1] ultrasonic sensor that were used mostly in SoundScapes sessions in the 1990s were easily programmable/changeable, either directly at the sensor head when in intense one-to-one sessions, or in the computer software. In this way the functional ability of the participant, for example sensitivity, range or resolution of the active source zone according to dexterity or other physiological dynamic targeted by the therapist was addressed.

Whilst this paper presents the delimited case it is opportune to state that the SoundScapes concept is applicable beyond solely rehabilitation for persons with disability and can address all ages, and abilities. Recent additions to the libraries of sensors are also expanding with various new prototypes alongside commercially available devices such as the ‘flexible’ Nintendo Wii remote which we predict offers many future opportunities in the field.

VIS has been referred to as an inhabited information space (Brooks, 2004) and it is through active use, (and non-use) of this dynamic volumetric data space that a level of non-verbal communication between a person with profound and multiple disability and a SoundScapes facilitator is achieved so as to arrive at a non-linguistic meaning from the intended action by the participant with disability. The interpretation meaning is achieved through the intention of a participant in use of these stillness zones during facilitator intervention in a rehabilitation session. Examples are given that highlight where this symbolic gesture has been as an indication of user-selected cessation or choice change. It is thus important to incorporate stillness zones into the design of interactive spaces when used in rehabilitation as this community are often lacking in opportunities for artistic or playful expression through being limited by their dysfunction, thus they are restricted from full exploring and experiencing to their fullest potentials. Creatively applied technology can augment such limitations.

Non-formal rehabilitation and the facilitator role

Controlled operation of the system and dynamic use of the stillness zones, which are spaces that do not generate data from inhabitation, indicate user progression in sessions. However, of great importance to a successful non-formal rehabilitation session is the facilitator intervention. This intervention is successful when interpreted meaning from the intent of the participant is achieved. Central to gaining the interpreted meaning is an intimate knowledge of the participant such that space is given for non-linguistic communication. Exemplifying this form of communication is the interaction between the parties through the stillness zones acting as a mediation of intent. It is often in this phase of intervention that misunderstandings are realised through facilitator 'need or desire'

[1] http://www.soundbeam.co.uk

to reach a goal. In other words, time needs to be given where the facilitator steps back and permits the participant a breathing space in the session interaction so as to indicate through the mediating stillness zone his or her desire. This could be an indicated preference for the next phase, for example if bored with a choice of content to move forward to another; it could be a defined pause to reflect upon what had been happening; or it could be an indication of exhaustion and a desire to stop the session. Often these moments can be wrongly interpreted by the facilitator and in most cases the participant would enforce their desire through response to the experienced facilitator verbal questioning so as to reach agreement and mutual understanding. However, the stillness zone offers an increased independence for the participant in that they can indicate choice rather than have a secondary role and thereby contribute to a fun and playful experience.

Pros and Cons of a non-invasive invisible interface

Each sensor interface from the SoundScapes input device library has pros and cons that have to be evaluated so as to make a conscious choice based to optimise for the participant and the therapist goals. This choice is based upon knowledge of the available device (i.e. hardware), the opportunities available via computer software, and the participant (i.e. a personal profile developed with those closest to him or her and including the therapist). In SoundScapes three forms of invisible sensor technology are used where the data retrieval is achieved from, linear, planar or volumetric space. Each sensor can be applied in multiples and the technologies are mixable without any undesirable system cross-talk artefacts. However, the planar sensors require a minimal lumen level of light (not necessarily visible light, e.g. infra red) and when working with image feedback content it can have a tendency to pixel corruption and subsequently miss-triggering. Although improvements have been evident in the field of linear sensors they are still often overly-sensitive to hard surfaces (resulting in false signalling) and operate with an annoying perceivable audible click that represents each cycle of the 'send-receive' frequency of the sensor head. A negative attribute of the infrared volumetric sensor is that it has a limited data retrieval hierarchy which is either incremental from 'skin to core' or from 'core-to-skin' (the invisible volumetric space can be imagined as a virtual onion skin where each layer is a level of data) however, this can be programmed otherwise and saved as user presets in the software so that each participant has specific patches to work with. This latter sensor is the one commonly used more so than the others in SoundScapes as it can source data from natural three dimensional gestures and is operational from close range (figure 1) or up to around 14 meters as illustrated in figure 2.
Being invisible there is limited reference for guided operation thus the interactive space becomes 'tangible' through the mapping of the data to selected content, i.e. the feedback stimuli. In this way the an autonomous intuitive link between user and system is such that a direct and immediate feedback, e.g. auditory or visual, is achieved and recognized which gives the interface its 'tangible' attributes for the user.

Conclusions

Digital advances that are used to create environments that evoke proactive experiences are empowering a question of traditional understanding of aesthetic values. SoundScapes is a vehicle for questioning related aesthetic resonance that is embodied in the experienced content as a between-ness that provokes imagination beyond solely what is witnessed. This is in line with McCloud’s (1994) statement of how certain new media, as invisible art, evolves special moments that are connected through a mental construct – a “continuous, unified reality” (p. 67).

The potentials in augmenting opportunities for the community of people with disabilities by implementing SoundScapes non-intrusive sensor technologies, digital video games and creative expression through music making and painting via whole body, head or limb movement has been shown as evident through application in field studies. Method of delivery has been observed as optimal when a mirroring strategy is evident, i.e. rather than a small desktop monitor to view a visual stimuli created and controlled through the body, the participant is positioned in front of a one-to-one scale back projected screen. In this way the strategy of intervention used in physiotherapy for proprioception training, i.e. a body size silver mirror, is replicated for participant association. The referred to 'stillness zones' are also learnt through such mirrored strategies.

Care-givers were initially reluctant to credit the gain for their charge through the concept of non-formalised rehabilitation, possibly believing their services under threat from a digital agent or just thinking SoundScapes a latest novelty or fad. The witnessed evidence of engaged participation and a desire to express and play, often with gestures beyond what was usually perceived however was irrefutable. Aesthetic Resonance has been found to be a phenomenon that requires first-hand experience according to the acquaintance principle (Budd, 2003).

The multidisciplinary and interdisciplinary responses to SoundScapes have been positive. The afforded opportunities in rehabilitation have been stated by the community. SoundScapes has evolved into a consultation entity that advises institutes and families on intervention strategies and products. Supplementing the dissemination of SoundScapes is the realisation of an international conference titled ArtAbilitation, and further, a workshop under the same name of ArtAbilitation travels under commission to various corners of the world to work with local artists, students, and other interested parties, where targeted is knowledge exchange towards expanding the established network of globally situated user groups. However, the authors recognise that they are just ‘scratching the surface’ of a larger body of research which has inherent questions such as the use by institute staff that are mostly untrained in any IT related activities, or indeed by the end user who can train at home. With the next generations of end users being incrementally at ease with technology we can safely forecast significant changes both in institutional strategies as well as self-health care from home. Conscious of these future directions SoundScapes has evolved into a platform for knowledge exchange, product research and development, and international networking. Currently funding and international collaborations are being proposed and we are open for interested parties to contact us.

SoundScapes is considered in line with McCloud’s (2000) views on the evolving ‘conceptual distinctions’ of digital media and how:

> The resultant ***media landscape*** will be populated with ***art forms*** not rooted in a particular ***machine, venue, or physical substance***, but in the implementation of their respective ***ideas.*** Each one, a simple irreducible concept - - one that ***distinguishes*** it from all others. (p. 205).

SoundScapes is posited as such an art form.

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Biographical Notes

Associate Professor Tony Brooks has a background in performance art, and was born into a family with disability. He has advocated the use of digital technologies in intervention for people with a disability and founded Handi-MIDI in 1987 which later became SoundScapes non profit organisation. He is on the management team of the Medialogy education (http://www.medialogy.eu) and is director of the SensoramaLab at Aalborg University (http://sensoramalab.aaue.dk) where he leads a team of post-doc assistant professors. He was awarded the European Eureka prize for SoundScapes in 1999 and the Danish research prize in his field 2006. There are approximately 50 publications associated to the concept including achieved international degrees citing the work where readers who wish for examples of the research can explore. As founder of SoundScapes he has realised the annual ArtAbilitation international conference and undertakes international workshops where he is invited to work with local artists and research students. SoundScapes has been featured at major international events, for example, the cultural Olympic/Paralympic events 1996 and 2000; the European Culture Capital of Europe 1996 and 2000; the Danish NeWave, New York 1999; the UNI/NGO World Summit 1995; and has been a featured exhibitor at leading Museums for Modern Art. His PhD is based upon SoundScapes and is under the Arts, Design and Media at the University of Sunderland in England. SoundScapes has been responsible for numerous published patents and national and international research funding. His main sponsors are IBM, Martin, and Lego.

Dr. Eva Petersson is an assistant professor; coordinating/managing the Medialogy Bachelor and Master Education Program (see http://www.aaue.dk/medialogy/uk/index.php); and vice chancellor at Aalborg University Esbjerg in Denmark. She is member of the research group SensoramaLab (see http://sensoramalab.aaue.dk). She has a background in Education Science and her PhD is focused on ludic engagement (playfulness as a foundation for engagement) within virtual environments and the potentials in associated non-formal learning (see http://dspace.mah.se:8080/dspace/handle/2043/2963).. Petersson has been coordinating research projects in inclusive and participatory design, storytelling, and creativity and learning processes through the use of new technology in education and rehabilitation contexts. She has been leading projects on physical and virtual toys, the design of toys for children with disabilities, and the use of computer games (interactive environments) in educational and rehabilitation contexts involving flexible methods of delivery for local, national and international users. Petersson is member of the International Toy Research Association (ITRA) and the Toys for Tomorrow Forum. Furthermore, she is a board member of the Pan-European Game Information (PEGI) and expert member of the Interactive Software Federation of Europe (ISFE). She was one of the founders of International Toy Research Conference recently organised by the International Toy Research Association (ITRA).