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Wearable Forest—HCBI clothing

Embrace our bodies with the sense of unity with Nature by trolling a tune with remote soundscape

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Abstract

Wearable Forest, HCBI clothing, embraces our bodies with the sense of unity with Nature through bio-acoustical interaction with wildlife in remote forests. It enables us to experience the diversity of real ecosystems through wearable technology, regardless of the physical and genetical distance between the user and forests. Wearable Forest can opens our eyes and slow ourselves down in our daily life in order to feel the sense of unity with Nature. The paper describes the concept of Human Computer Biosphere Interaction and soundscape quantification method, Bio-Activity Index to visualize its time variation as its clothing fashion.

1 Introduction

Singing birds, buzzing insects, sounds of leaves gently swaying, and the trickling sound of water in a beautiful forest are all integral to help us feel one with Nature. The non-verbal, non-linguistic, interaction gives us the sense of harmony with the whole Nature environment, bringing us a feeling of lightness and freedom.[1] By distancing ourselves from the technologies of modern life, slowing down our pace of everyday life, and holding a reverent attitude toward Nature, we can start searching for a way to our well-being.[2] The micro-minitualization of computer hardware technologies shows unprecedented multi-disciplinary applications.[3] The advent of wearable computing enable us to express our emotional feeling as a clothing fashion in order to develop the human-human communication.[4] Moreover, non-linguistic information technology guides us to extend our communication capability beyond the physical and genetical distance among different species[5]

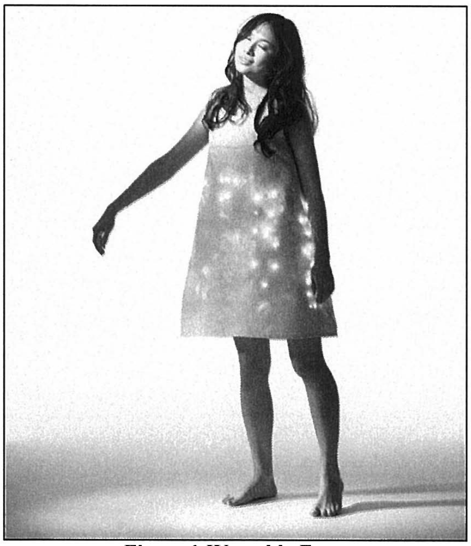


Figure 1 Wearable Forest

Wearable Forest, HCBI clothing in Figure 1 interacts with a forest in real time through network, allowing the user to acoustically experience the forest soundscape as if he/she were actually standing in the forest, thus a merging of man and Nature is possible. That is, the bio-acoustical sound and its time series variation in a remote forest are both expressed as the visible and associative clothing design in real time. The array of LEDs woven inside the fabric winks like fireflies and displays the presence of wildlife in the forest. The paper describes the concept of the Human Computer Biosphere Interaction, and the concept behind Wearable Forest and Bio-Activity Index to quantify the bioacoustical activity of wildlife in the forest soundscape to visualize its time variation as its clothing fashion.

2 HCBI Concept Overview

Wearable Forest is based on the concept of HCBI (Human Computer Biosphere Interaction) in Figure 2, an extended concept from HCI (Human Computer Interaction) and HCPI (Human Computer Pet Interaction). HCI is a discipline concerned with the design, evaluation and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them.[6] Computer supported cooperative work (CSCW) uses such computer systems to exchange explicit message to support task specific activities. For instance, we exchange our ideas, thoughts, theories, messages by de/en-coding into/from transferable words, through computer media, cell phone, email, and chatting systems. However, in our daily lives, we unconsciously exchange and share a great deal of cue information, non-verbal expression, implicitly such as the presence and mood of others to maintain our social relationships. That is, the cue information helps us to find appropriate context during the verbalization process so that the encoded message is easily received and understood by the listener. 'Tsunagari Communication' aims to foster a feeling of connection between people living apart by exchanging and sharing the cue information via network and HCI technologies.[7]

The advent of the implicit information communication opens up a new interaction on non-linguistic and non-verbal expression among different species, beyond the physical distance. Lee[8] presented HCPI in Figure 2, a novel type of physical interaction and symbiosis between human and pet., with a computer and the Internet as a new form of media. The author[9] has built an interactive communication system, remote controllable food feeder with positioning sensing through the Internet between human and house cats for the creation of the mutual relationship. The author [5] also has built

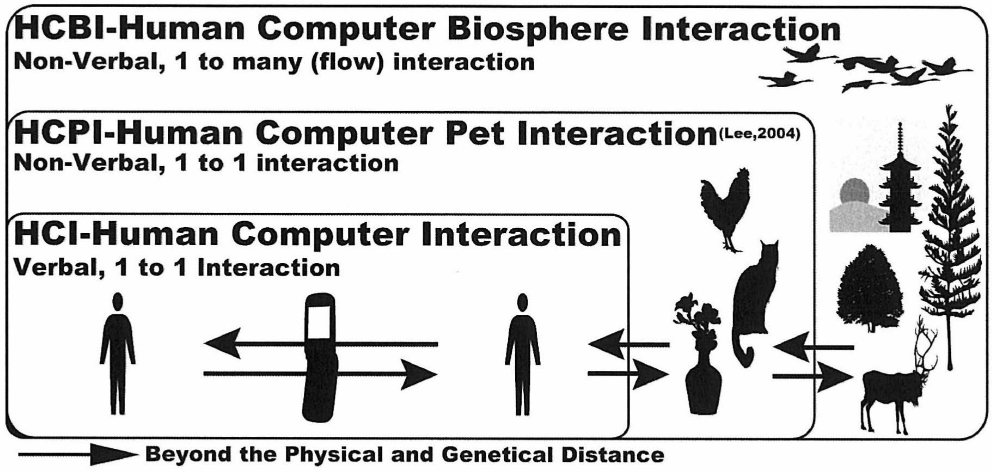


Figure 2 The Concept of Human Computer Biosphere Interaction

human-wildlife bio-acoustic interaction system for ethical and efficient wildlife remote monitoring. Botanicalls[10] was developed to provide a new way for plants and people to interact in order to develop better, longer-lasting relationships beyond the physical and genetical distance.Thus, the use of computer systems becomes the inter-medium to express their telepresence among different species in biosphere in the way their non-linguistic expression is perceived and understood by individual, which violates all the rules of the linguistic science.

However, no matter how advanced the technologies are, these are human-centric interaction. We expected some perceivable feedback from the subjects as a respose to our command before we end the interaction. In contrary senses, in our daily lives, there are many non-human centric interaction. Singing birds, buzzing insects, sounds of leaves gently swaying, and the trickling sound of water in a beautiful forest in biosphere implicitly imprints the beauty of Nature in our memory. When we are at the crossroads of our lives, recalling the beauty of Nature brings a possibility to help us re-search his/her well-being. This interaction uncounciouslly continues for the entire lifetime. The crucial factor here is not the substance thus exuded or secreted, that is, words or language, but "something" hovering around there, thought we cannot exactly identify .[2]

We propose HCBI-Human Computer Biosphere Interaction, extending the subject of the interaction from countable object, pet, plants, to their sounding environment, which is uncountable, complex, non-linguistic soundscape in Biosphere. By realizing HCBI, soundmarks in a beautiful forest are all integral to help us feel one with Nature. Thus, with HCBI, we listen and feel the telepresence of the global ecological system integrating all living beings and their relationships, including their interaction with the elements of the biosphere. With HCBI, we begin to interact with subjects of not only beyond the physical and genetically distance, but of non-linguistic invisible flow toward the feeling of the broader concept, the sense of unity with Nature.

3 BAI, Bio-Activity Index

Wearable Forest visualizes and illuminates the bioacoustical activity contained in the soundscape in remote forest as clolthing fashion in real time, through the use of the Internet. The system consists of an audio I/O system in a remote forest and audio-visually interactive clothing on the local side in Figure 3-1. The remote system[5], consisting of weather-durable microphones and speakers in Figure 3-1, is placed in the uninhabited subtropical forest of southern Ryukyu Islands, Japan. Songs of little birds, trickling sounds of streams, and insects moving about in the forest represent the diversity of organisms on the island. The audio I/O system

Figure 3-1 Local Wardrobe and Remote Microphone

captures and transfers the live soundscape 24 hours a day, between the remote forest and local system over the Internet. The clothing in the local side in Figure 3-1 contains two paper-thin speakers embroidered on both front shoulders, matrix array of 256 pieces of white colored Leeds (Light Emitting Diode) sewn with the conductive thread and sleeve-shaped textile sensors woven with thin wires inside the fabric. The array illuminates the telepresence of wildlife by controlling the lighting sequence based on the bioacoustical activity in the remote forest in Figure 3-2 as visualized clothing fashion in real time.

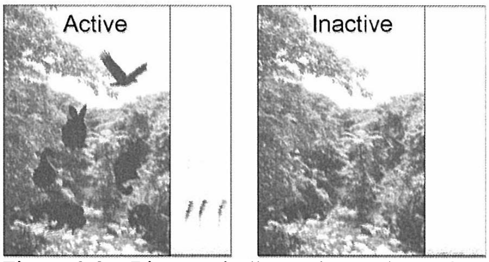


Figure 3-2 Bioacoustically Active and Inactive Environement with the spectrum data

We propose BAI, Bio-Activity Index to convert the bioacoustical activity in the remote soundscape into numbers. Firstly, we investigated to use image recognition approach by which the similar spectrum images are selected. However, this approach, such as SVM[11] with the use of Haar-like features requires a set of training data by which the system distinguishes appropriate images from others. In the case of BAI, it is impossible to select the training data that tells bioacousticalily active or inactive. Soundscape is a set of various sounds which are spontaneously generated from environment and continually changed in day-by-day variation. It is like a choral singing of geography or physical aspects of areas and acoustic properties of the area, which is diurnally changing; it was very difficult to define "constant training data".

Therefore, instead of SVM, we apply Active Contour Models[12] to quantify the activity from the calculated area of shape of the visualized bio-acoustic patterns on the live soundcape data from the remote forest. The active contour model algorithm, first introduced by Kass et al[12], deforms a contour to lock onto features of interest within an image. The model is a controlled continuity spline under the influence of image forces and external constraint forces. The internal spline forces serve to impose a piecewise smooth-ness constraint. The image forces push the snake toward salient image features like lines, edges, and subjective contours. The external constraint forces are responsible for putting the snake near the desired local minimum. Representing the position of a snake parametrically, $v(s) = v(x(s), y(s))$, we can write its energy functional as

$$E^*_{snake} = \int_0^1 E_{snake}(v(s))ds$$
$$= \int_0^1 E_{\text{int}}(v(s)) + E_{image}(v(s)) + E_{con}(v(s))ds$$

Where Eint represents the internal energy of the spline due to bending, Eimage gives rise to the image forces, and Econ gives rise to the external and give examples of Econ for interactive interpretation. Given an approximation of the boundary of an object in an image, an active contour model can be used to find the actual boundary.

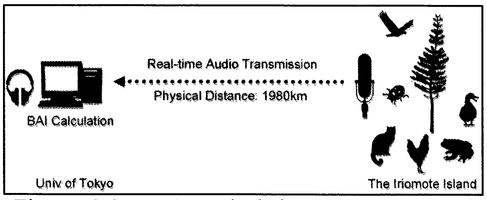
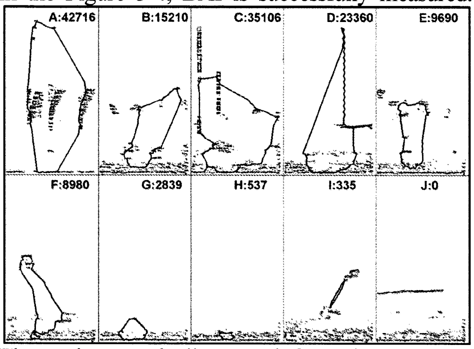


Figure 3-3 BAI calculation system over the Internet

To evaluate this method, we set up a system to receive the real time audio transmission from the remote forest[5], calculate and evaluate BAI with the use of Active Contour Models. The remote system in Figure 3-3 in the island captures and transmits the live sound in CD quality format in the sub-tropical forest over theInternet. The local system, OpenCV on Linux Platform in the University of Tokyo, receives and calculates the BAI on the live sounds every second from the live sound. As shown in the Figure 3-4, BAI is successfully measured.



The Bio-acousticall information usually occupies several bands of a 20-10000 Hertz frequency spectrum. Other environmental sounds usually occupy below 1000Hearz. 10 results of spectrum images are shown in Figure 3-4. The darker the lines are the greater the amplitude in the particular range. The red contour on the each result is the detected pattern by the use of ACM. BAI is the calculated area of the pattern. The large area size indicates that biological activity in the forest is active. In the case of a quiet forest, less bio-acoustic activities, and small areas indicate that the biological activity is inactive. The result A, D and F, with HIGH BAI, the shape of the bio-acoustical activity is well detected by ACM and its area is calculated in pixels. The results, B, C, E and I in Figure 3-4, shows that partials of the pattern were not detected. Software improvement is necessary. The results G and H, with low BAI are typical inactive state in bioacoustics environment. The contours are placed at the bottom part of the spectrum where the other environmental sound is displayed. The result J is methodological problem for this application with ACM. With the pattern of horizontally long and vertically thin, a call from wildlife with narrow band spectrum was not calculated in properly. Thus, BAI aims to measure the area of such band produced by wildlife in the forest. It has been shown how the concept of HCBI and how lively bio-acoustical information can be quatified using basic Active Condour Models. However, it is necessary to impove the software and propose algorithm to complete the development of Wearable Forest.

4 Conclusion

HCBI and BAI has proven the interactive concept and expressional specification of Wearable Forest. We have begun to use them as a basis for multi-disciplinal interface designbetween human and Nature. HCBI defines a new conceptual approach to establish the inter-midium between human and Nature environment with the use of computer-based media in order to create the sense of unity. BAI uses Active Contour Models to extract bio-acoustic information from remote soundscape in real time in order to measure how lively the acoustical environment is. We believe that this fundamental works by Wearable Forest development guide us to open up a new possible relationship among human, soundscape and computers.

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6 References

1) T Williams, et al.: Transcendent experience in forest environments, Journal of Environmental Psychology, 21, pp.249-260,(2001)

2) Daisetz T. Suzuki: Zen and Japanese Culture, (Bollingen Foundation, Bollingen, 1970) pp.335-336.

3) Michitaka Hirose: Space Oriented Computing, (Iwanami Shoten, Tokyo, 2002) pp. 151-154.

4) Lisa Stead, et al.: The Emotional Wardrobe, Personal and Ubiquitous Computing, 8(3-4), pp.282-290(2004)

5) H. Kobayashi, et al.: Development of A Networked Remote Sensing Embedded System for Bio-acoustical Evaluation. Proc. of 4th Joint Meeting of the A.S.A and A.S.J, pp.3324(2006)

6) Definition of Human Computer Interaction: ACM SIGCHI, http://sigchi.org/cdg/cdg2.html#2_1

7) Y. Itoh, et al.: 'TSUNAGARI' communication: fostering a feeling of connection between family members, CHI Extended Abstracts 2002, pp.810-811(2002)

8) P. Lee, et al.: A mobile pet wearable computer and mixed reality system for human– poultry interaction through the internet. Personal and Ubiquitous Computing, 10(5), pp.301-317 (2006)

9) Ryoko Ueoka: Mutual Interaction System between human-pet though telecommunication technology. Relationship between human and companion animal 3rd, (2006)

10) K. Hartman, et al.: Botanicalls: The plants have your number, http://www.botanicalls.com/, (2006)

11) Christopher J.C. Burges, "A Tutorial on Support Vector Machines for Pattern Recognition", Data Mining and Knowledge Discovery, vol.2, no.2, pp.121--167(1998)

12) Michael Kass, et al: Snakes: Active contour models. International Journal of Computer Vision, pp. 321-331(1988)