Human Computer Biosphere Interaction: Towards Sustainable Society

Hiroki Kobayashi
Ph.D. Student Fellow
Cyber Interface Laboratory
Department of Advanced Interdisciplinary Studies
Graduate School of Engineering
The University of Tokyo

Abstract
This paper presents my vision of Human Computer Interaction (HCBI): Towards Sustainable Society. HCBI extends the subject of the HCI from countable people, object, pet, plants, to their sounding environment, which is uncountable, complex, non-linguistic acoustic ecology, Zen elements in Biosphere. By realizing HCBI, soundmarks in a beautiful forest are all integral to help us feel one with Nature, beyond the physical and genetically distance. The goal of HCBI is to achieve a feeling of belonging to nature without causing environmental destruction. This paper will present the vision of HCBI by introducing the concept overview, related works, the method and developed interfaces.

NOTE: This submission was advised and to move from CHI2009 Student Design Competition because this is not the appropriate topic for the competition.

Keywords
HCBI (Human Computer Biosphere Interaction), Nature Interface, Sustainability, Sustainable Interaction Design

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.
Introduction: Contradictory Link

To maintain human civilization, man requires a breakthrough in his relationship with nature, which has been destroyed in the process of urbanization. However, the nature conservation movement, which promotes conservation areas for preservation purposes, has ironically increased the demand for tourism in these areas and thus accelerated the speed of environmental destruction [1]. Nevertheless, a sense of belonging to nature is indispensable for emotional balance. Japanese Zen Buddhism, for example, encourages deep meditation in order to achieve a sense of being at one with nature [2]. Likewise, the sounds of birdsong, buzzing insects, gently swaying leaves and the trickling of water in a forest can imprint the beauty of nature in our memory (figure1). At significant life events, by distancing ourselves from the technologies of modern life, recalling the beauty of nature can help us slow down the pace of daily life. A reverent attitude towards nature can provide a starting point for finding a way to mental and physical well-being [3]. Therefore, it is necessary to establish a concept, a method, and an interface, "Sustainable Interaction with Ecosystem", by which we can achieve a feeling of belonging to nature without causing environmental destruction in where human and nature can coexist. This paper will present our vision of Human Computer Biosphere Interaction by introducing the concept overview, related works, developed Interface and discussion. This paper is not intended to propose a solution to any one single problem. Rather, it will propose a new view of HCBI based design and interfaces to support our future society by a multidisciplinary approach.

Concept Overview and Background

The author proposes a concept of HCBI (Human Computer Biosphere Interaction) (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" [4]. 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 through “Family Planter System (figure 3)” via network and HCI technologies [5].

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 [6] presented Human Computer Pet Interaction (HCPI), a novel type of physical interaction and symbiosis between human and pet., with a computer and the Internet as a new form of media. Ueoka [7] 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. In previous studies, the author developed a networked bio-acoustic streaming and recording system by which environmental sounds in a sub-tropical forest on Iriomote Island, Japan (figure 4), were continuously streamed in real time by a networked microphone for 365 days [8]. This technology in a networked bio-acoustic streaming and recording system, is also used for “AQUASCAPE: the stethoscope for the Earth’s waters” projects through the internet users are able to listen the live sound of water environment of a pond in Tokyo, Japanese garden ornament in Kyoto, and a a street in Mubai city, India in real-time [9].

Figure 3: Several Family Planter terminals are connected each other through network. The system detects person’s motion and share with the other terminals in real time. Optical fiber at the top of the terminal will gleam to indicate the remote human presence and rotate to indicate the remote human motion. These exchanges are designed to blend into the everyday life of the users.

Figure 4: Live sound from a sub tropical forest, Iriomote Island, Japan. A pair of networked microphones (wrapped by black colored a sheet of thick waterproof sponge and a plastic hard mesh.) is tied on a trunk of a tree. The live sound from the forest has been streamed to users in real time for 24 hours in 365 days since year 1997. Photo (right) by SoundBum.

The author [10] also has built human-wildlife bio-acoustic interaction system in figure 5 for wildlife remote monitoring/controlling to prevent the human-caused traffic accidents: Controlling the behavior of an endangered species, the iriomote cat (Felis...
iriomotensis), whose current position is unknown and unpredictable in the uninhabited natural environment through the unique interaction process with a law of ecology (Predator-Prey Relationships), "playing a prerecorded call of prey animal, inducing a feedback reaction to the virtual call from a target wildlife animal and make it away from the roads". This non-verbal interaction increased the efficiency of wildlife monitoring. In comparison to the various styles of traditional passive monitoring, this acoustically active monitoring is a unique and efficient method because it actively interacts with the target and acoustically extends the observable period to ensure the observation success by controlling the movement of the target wildlife. This achievement indicates that HCI technologies provide remote interaction between computer and magnificent biosphere. It provides a practical and effective solution of environment destruction and wildlife monitoring.

Furthermore, Botanicalls in figure 6 right [11] 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 genetically distance. Botanicalls allows plants to place phone calls for human help. When a plant on the Botanicalls network needs water, it can call a person and ask for exactly what it needs. When people phone the plants, the plants orient callers to their botanical characteristics. 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 response
to our command before we end the interaction. In contrary senses, in our daily lives, there are many non-human centric interactions. 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 unconsciously 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]. This thought is Zen Buddhism, Japanese love of Nature. Zen is one the products of the Chinese mind after its contact with Indian thought, which was introduced into China in the first century A.D. through the medium of Buddhist teaching. Suzuki noted the Japanese love of Nature as follows

“It consists in paying Nature the fullest respect it deserves. By this it is meant that we may treat Nature not as an object to conquer and turn wantonly to our human service, but as a friend, as a fellow being, who is destined like ourselves for Buddhahood. Zen wants us to meet Nature as a friendly, well-meaning agent whose inner being is thoroughly like our own.”[2]

The author 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, Zen elements 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.

**HCBI Interface – Wearable Forest**

![Figure 6: Human Computer Biosphere Interaction, Wearable Forest System. Human (wearable computing system, left) Computer (audio I/O system, middle) Biosphere (wildlife, right) Interaction (non-verbal communication beyond the physical and genetically distance) Photo (left) by Masaharu Hatta](image)

The author developed HCBI interface, Wearable Forest [12], as shown in figure 6, consists of an audio I/O system in a remote forest (middle) and a local audio-visually interactive clothing system (left). The remote and local systems perform remote interaction based on the ecology perspective.

Natural communities contain a spectrum of life forms that interact with each other [13]. Many scientists agree with the opinion that the essence of ecology is the study of interactions among species in the communities [14]. In particular, animal communities in
tropical forests have extremely complex interactions involving vast numbers of species [15] [16]. The structure of natural sound in a rainforest forcefully demonstrates the special relationships among the many insects, birds, mammals and amphibians therein. If one creature stops vocalizing, another immediately joins the chorus [17]. Therefore, the animals interact bioacoustically with other animals according to the biological diversity of the natural habitat. We used bioacoustical information to develop the Human Computer Biosphere Interaction.

The remote system, consisting of weather-durable microphones and speakers is placed in an uninhabited subtropical forest on Iriomote Island, Japan. The songs of small birds, the trickling of a stream, and the sounds of insects moving about in the forest represent the diversity of organisms on the island. The audio I/O system continuously captures and transfers the live soundscape to the local system over the Internet.

The local clothing system consists of two paper-thin speakers embroidered on the front of both shoulders, a matrix array of 256 white-colored light-emitting diodes (LEDs) sewn with conductive thread, and sleeve-shaped textile sensors woven within the fabric as thin wires. An embedded CPU system receives the live soundscape data from the remote forest wirelessly, immediately quantizes the bio-acoustical activity of wildlife from the data and visualizes the result as a luminescent pattern through the LED array.

In order to interact with wildlife (right), users can touch the textile sensors, which transfer user-selectable and pre-recorded sounds of wildlife from the local wardrobe to the speakers in the forest on the remote island. This bioacoustic loop, which transfers live sounds bi-directionally between remote and local sides, gives the user the opportunity to interact with wildlife. For instance, in a relatively quiet period after a brief rain shower in the subtropical forest, the user, from their urban location, can play back the croaking of frogs through the remote speaker; in response, actual frogs might start croaking.

At first, the user sends an initial call, a pre-recorded call of animals to the remote host thorough the local host and Internet. The remote host receives the call, plays back the call from the speaker in the forest and performs the loop back operation. If the wildlife exists in the forest, it listen the call. The loop back call at remote host occurs because the play backed sound from the speaker is captured and transferred to the user by the remote host. When the users receives the loop backed call from the forest, they auditory recognize that the initial call did actually travel through the forest environment and start waiting the response if the wildlife actually responses.

This chorus-like experience, interspecific communication in mixed reality, between the user and the frogs gave the users high degree of a sense of belonging (5.31 of 7 point scales, n=20, based on questionnaire survey [3]). Thus, HCBI interface, Wearable Forest, successfully achieved a feeling of belonging to nature without causing environmental destruction.

**Discussion**

*Inserting electronic technology into natural areas is 'eco-friendly'?

-
Yes, moderately. It is no right or wrong answer, but the answer lies in moderation. Moderation is the key to sustainable society, done too often, it defeats the purpose. For example, the author has been operating the networked bio-acoustic streaming and recording in Japan (figure 4), were continuously streamed in real time by a networked microphone for 365 days continuously since 1997 [8] the Island in Japan for more than 12 years continuously since 1997. To maintain the remote system, the author walks in the tropical forest, replaces the system with a new set once a year. Users are able to listen to the live sound over the internet without physically going there.

On the other hand, more than 3000 of eco-tourists visit the same island everyday. They come from city area, look for the magnificent ecosystem, walk in to the jungle, and tramp the plants down by 6000 shoes everyday. Furthermore, the tourists have caused many traffic accidents and kill an endangered species which promotes its conservation areas for preservation purposes, has ironically increased the demand for tourism in these areas and thus accelerated the speed of environmental destruction.

Even though the author is also the one of tourists, a potential murderer of the endangered species in the future, environment destruction caused by the two shoes in one day is much smaller than that cause by 6000 shoes everyday for 365 days. Therefore, inserting electronic technology into natural areas is moderately eco-friendly.

-How the human draws connections between the experience of the wearable and the remote ecosystem, especially since the interaction is so indirect?

The interaction is purposely indirect to build the meditation form in Japanese Zen Buddhism, for example, encourages deep meditation in order to achieve a sense of being at one with nature. The human draws the connection through the indirect interaction between the experience of the wearable and the remote system. Suzuki [2] describes the characteristic of Zen Buddhism as follows.

“Zen purpose to respect Nature, to love Nature, to live its own life; Zen recognizes that our Nature is one with objective Nature no in the mathematical sense, but in that Nature lives in us and we in Nature.” [2]

The local wearable system in designed to be in the nature. The remote system is our surrounded Nature environment.

“He who sits here is one of its objects like every other. He is in no way different from birds singing, the insects buzzing, the leaves swaying, the water murmuring.”[2]

HCBI interface is able to provide this experience through its unique interaction with the remote wildlife. For instance, in a relatively quiet period after a brief rain shower in the subtropical forest, the user, from their urban location, can play back the croaking of frogs through the remote speaker; in response, actual frogs might start croaking This chorus-like experience, interspecific communication in mixed reality, between the user and the frogs gave the users high degree of a
A sense of belonging (5.31 of 7 point scales, n=20, based on questionnaire survey [3]).

What can we do to help sustain animal/plant life, and the overall ecology system around us?

HCBI interface can be a new way of an inter-medium between us and biosphere. For example, tremendous advances in information technology have enabled nature education through the application of sophisticated multimedia today. High-resolution pictures of plants, bioacoustical recordings of animals and descriptions of the diversity of magnificent ecosystems are now easily available through interactive learning systems. However, no matter how advanced the systems and technologies, these remain human–computer interactions, and can never be a substitute for a true human–environment experience. Therefore, sometimes we escape from urban areas to seek out a true experience of nature.

If the current information technology can make us a feeling of becoming closer to nature, why number of eco-tourists who hit and kill endangered species in world heritage-listed area is drastically increasing every year? Again, ironically, the nature conservation movement, which promotes conservation areas for preservation purposes, has ironically increased the demand for tourism in these areas and thus accelerated the speed of environmental destruction.

The goal of HCBI is to achieve a feeling of belonging to nature without causing environmental destruction and going there. The evaluation of the augmented nature experience depends on the personal perspective on everyone. HCBI cannot be the best solution to the environment problem and will be a better solution.

By introducing bio-acoustical sounds in that environment, we might create an imbalance in the environment that we are not aware of.

Historically, our society has been continuously creating many imbalances in the environment to survive. For instance, “introduced species” is a species introduced in a certain geographical area from the outside of the area by human activity for the purposes of benefiting agriculture, aquaculture or other economic activities. Those introductions have also been performed in supporting recreation activities or otherwise increasing human enjoyment. The introduction causes serious environment destruction in worldwide. An estimated 80% of endangered species could suffer losses by those species.

The bio-acoustical impact of HCBI on the nature environment is not negligible. However, what if information technology becomes able to create the presence of the introduced species? If the bio-acoustically created “the virtually introduced species” starts working for the purposes of benefiting agriculture, aquaculture or other economic activities, It possible to controlled the degree of imbalance in the environment.

Again, environment problem exists because human being exists on this planet. If we want to solve all the environment problems, we have to extinct. Therefore, human being has to look for a way, a better way, toward sustainable society.
Future Work

Micro-miniature computer hardware technologies have unprecedented multi-disciplinary applications [18]. Information technology helps us extend our interactive capability beyond physical and inter-species barriers. In the future work, the author plans to perform "ecological and landscaping evaluation” on the field and quantify the impact of HCBI on the environment.

Conclusion

This paper presents my vision of Human Computer Interaction (HCBI): Towards Sustainable Society. Modern society requires a breakthrough in his relationship with nature, which has been destroyed in the process of urbanization. HCBI extends the subject of the HCI from countable people, object, pet, plants, to their sounding environment, which is uncountable, complex, non-linguistic acoustic ecology in Biosphere. 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, without causing environmental destruction. I strongly believe that HCBI becomes the relationship breakthrough with nature.

Acknowledgements

I would like to thank Mr. Nishimura, Mr. Kawasaki, Mrs. Nishimura, Mr. Murata, Ms. Fujita, Dr. Watanabe, Mr. Matsumoto, Mrs. Matsumoto, Dr. Izawa, Dr. Nakanishi, Dr. Rokugawa, Dr. Matsushima, Dr. Kuramitsu, Mr. Yamané, Dr. Takemura, Dr. Hirose, Dr. Ueoka, Dr. Toyama and Dr. Abe for their support in preparing this research. I also appreciate the kindness of many friends who contributed to our research Mr. Takagi, Mr. Suzuki, Mr. Kamiya, Mr. Hamatsu and Mr. Arakawa in particular. This research is supported by SoundExplorer participants, SoundBum participants, NTT-WEST, Inc. okinawa branch, IMS.JP Co., Ltd, the University of Tokyo, the 21st Century COE program of University of the Ryukyus, Japan Forestry Agency, Amazon Future Association, NTT-DoCoMo, Inc., Tamagawa Seiki Co., Ltd., Mikasa Engineering., Ltd, Keio Yochisha Elementary School, Earth Literacy Program, Fukui Research Center for Industry and Technology and Japan Society of the Promotion of Science.

References


