Cultural Computing with Context-Aware Application: ZENetic Computer

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Abstract. We offer Cultural Computing as a method for cultural translation that uses scientific methods to represent the essential aspects of culture. Including images that heretofore have not been the focus of computing, such as images of Eastern thought and Buddhism, and the Sansui paintings, poetry and kimono that evoke these images, we projected the style of communication developed by Zen schools over hundreds of years into a world for the user to explore – an exotic Eastern Sansui world. Through encounters with Zen Koans and haiku poetry, the user is constantly and sharply forced to confirm the whereabouts of his or her self-consciousness. However, there is no "right answer" to be found anywhere.

1 Introduction: Cultural Computing

Since involving various kinds of media technology in our everyday lives, we have built a sphere of communication that reaches to all parts of the globe. However, on the other hand, we are starting to feel the danger that, as the communication network expands, the level of personal communication has become shallow.

In this situation, a new communication medium that will convey personal depth of feeling across long distances has become urgently necessary. Within this context, we decided with this project to pursue the possibility of a communication medium that incorporates a new kind of interactivity, with editorial engineering [1] and art and technology [2] as a foundation, and including research on the operation in which interactions of multiple cultures come to fruition, and research on the "intelligence" that appears in between the user and the system.

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Human communication is originally something cultivated in an environment comprising localities, national customs and language. Therefore, the fruits of these cultures have strong roots in their unique histories.

However, the media that developed in order to convey these peculiarities across cultures were communication media such as writing, music and film. Now, as the computer society covers the earth, the task that computers must take on is the clear and accurate intercommunication between local and global cultures. Toward that end, it is first necessary for those involved with computer technology to bring to life local characteristics.

Thus, the authors focused on the cultural roots of their native country, Japan. This includes Buddhist culture, the *kanji* culture, *haiku* and other Japanese poetry and song, and traditional Japanese dress (*kimono*). They decided especially to dig into the unique communication space and imagery methods developed in Zen Buddhism and landscape ink painting (*sansui* painting).

Within the traditional relationship between culture and computers, emphasis has been placed on the preservation of decaying traditional cultures for the sake of future generations, restoration of artifacts, and computer graphics simulations recreating lost relics. However, the authors struck on the possibility of computing the previously unquantifiable essence of culture inherent within people, such as personal subjectivity, feeling, emotion and cultural personality. [3]

With this research project, the authors offer the concept and direction of "cultural computing" as above, and describe, in simple terms and through the realization of an actual interactive system, a computing method reflecting the differences of emotion, consciousness and memory that will be indispensable for the future communication abilities of computers.

As Cultural Computing is a very broad field, in order to produce a specific example, one must pick out a single local culture and use that as a base for building a real system. In this case, we chose Zen, a special area of Buddhism, and developed and evaluated ZENetic Computer as a system in which people can experience Zen culture firsthand.

2 ZENetic Computer Artistic Concept

We developed ZENetic Computer as a specific example of Cultural Computing. We focused on the roots of Japanese culture, including Buddhist culture, kanji culture, waka and haiku poetry. [8] We decided to especially focus on the unique communication space Zen and sansui ink painting create.

Below is explained the scenario a user experiences within ZENetic Computer. First, the user builds a three-dimensional sansui ink painting on the display using an intuitive and user-friendly interface, constructing her own virtual space.

These images express the natural world that characterizes the East and Japan and their philosophical concepts, providing the user with a dramatic experience very different from the images seen in modern-day life. [9] In this way, in the introduction, the system brings about a kind of awakening within the user, and encourages their unconscious imagination.

Next, as the system classifies the user's state of consciousness based on the composition of their sansui landscape design, it generates a story appropriate for the user, drawing her through the display into this alternate world.

Within the story are included mechanisms to shake the user's consciousness developed from haiku poetry and Zen riddles (koan). The story built from these elements is not a complete linear story like those found in movies or novels, but rather a nonlinear collection of short story-fragments. A user who experiences these inconclusive story-fragments feels a kind of uncertainty, and holds an expectation and desire to build a complete story by connecting these fragments. Because of this desire, the user, in being asked questions without a "correct" answer, may hesitate somewhat but cannot help but try to answer these questions.

Through several such triggers lurking within the center of culture, the user connects these stories and builds her own unique narrative. Next, as the user uses a virtual brush, a rake for the rock garden, and images within the screen in response to questions posed by the system via images and voice, she begins to realize that the system is demanding that she meet it face-to-face. This means the door to her "unified consciousness" has begun to open further. As our desire to connect the story fragments mixes with the system's user interface, the distance between our every-day self and our true hidden self begins to shrink.

Ma interaction plays an important role in the process of fusing together these two selves. Ma is a very Japanese concept; it is one that places a high value on ephemeral events – the here-and-now – within every experience.

The user, having thus traveled through several stages and several scenes, now coming to the end of the trip, interacts with a bull, which is used in Zen as a metaphor for expressing one's true self. Through this dialogue, the user can experience the process in which the everyday self and the subconscious self fuse together to bring about a unified self-consciousness.

Fig. 1. ZENetic Computer at SIGGRAPH 2004 Emerging Technologies

As the surrounding environment plays a very important role in this experience, we have made an effort to conjure an Eastern atmosphere for the ZENetic Computer installation. (Fig. 1)

3 Story Generated from Symbols

3.1 Creation of a Typical *Sansui* Painting

We divided sansui painting into twelve hieroglyphic characters (rock, mountain, moon, traveler, bridge, bird, tree, flower, wise man, cloud and water) and made them into icons. The user drags any 2D icon and constructs his or her own 3D *sansui* painting. Fig. 2 is an example user-constructed *sansui* painting.

Fig. 2. Making a 3D Sansui Ink Painting

3.2 *Sanen* Design

As one can see in the Sesshu painting in Fig. 3, there is a unique method of perspective for *sansui* paintings called *sanen*. Within the painting are three perspectives: koen, lying far away with a view from below; heien, with a straight-on view; and shinen, close-up and viewed from above. Depending on the position of the user's icons, graphics corresponding to the sanen area are displayed, increasing the realism of the user-created sansui painting.

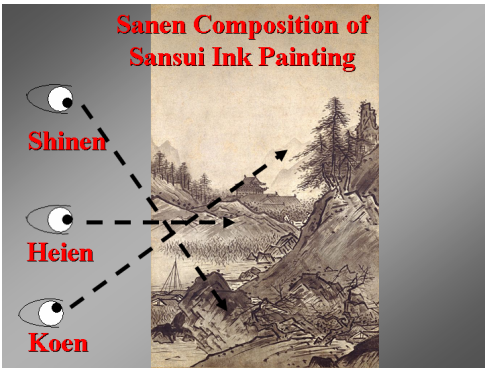

Fig. 3. Composition of *sanen* perspective in Sesshu's work

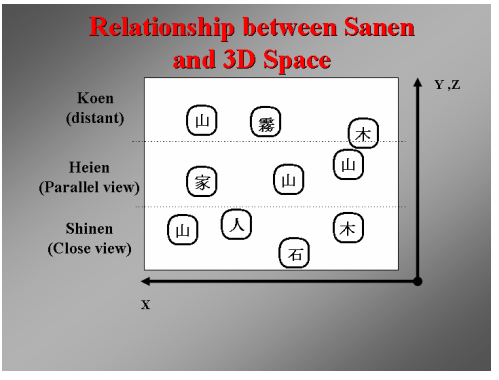

Fig. 4. Composition and distance within 3D space

Fig. 5. Interaction with the rock garden interface

Table 1. Relationships between *Sansui* symbols and Haiku

Haiku Output	Icon Priority		
The day passes slowly; A pheasant comes down onto the bridge.	Bird	Bridge	House
The rush thatched roof looks cool, even from the bridge one can make out the aroma of tea.	Bridge	Mountain	Cloud
Advancing through pebbles, there flows a rivulet running from a spring.	Water	Cloud	Rock
An old quiet pond/A frog jumps into the pond/Splash! Silence again	Moon	House	Water
The autumn moon; I wandered round the pond all night long.	Moon	Traveler	House

3.3 Interactive Story Generation

When the user finishes creating the *sansui* painting, she can walk through the three-dimensional *sansui* space she created by operating the "rock garden interface" containing a touch panel. (Fig. 5) As the user approaches any *sansui* painting icon within the space, a *haiku* poem or Zen dialogue is output based on the combination of *sansui* painting icons contained in the framed display, as shown in Table 1.

4 Interaction Model Using a Buddhist Human Recognition Model

We include the Buddhist communication method between Zen master and pupil, a fashion for the purpose of understanding people, which has been followed for over 2,000 years. This kind of interaction based on the deep understanding of people is a field not yet researched within Western science.

4.1 *Sansui* World Expression Based on World Model "*Godai*" (sky, water, fire, wind, earth)

In Buddhism, the directions and the five elements (godai) constructing the world are closely related. Upon walking through the sansui painting world, changes in weather based on godai appear depending on the direction of movement. For example, weather changes such that if one goes north, it snows; south, a thunderstorm appears; east, it gets foggy; and west, it rains.

4.2 Classification of User Personality Based on Personality Recognition Model "*Goun*: *shiki, jyu, sou, gyou, shiki*"

Goun are the elements that make up the core of the Buddist thought in which five basic physical and mental elements make up the world; in this interactive system, we apply these elements in the classification of personality. The five personality categories are as follows:

色 (Shiki) How nature and materials actually exist
受 (Jyu) Intuitive impression
想 (Sou) Perceived image
行 (Gyou) Process of mind that activates behavior
識 (Shiki) Deep mental process reaching beyond the above processes

We prepare a two-dimensional *goun* space made up of 10 areas with these values along the vertical axis and their strength (positive or negative) along the horizontal axis. When the user generates a *sansui* landscape according to her preferences, the system classifies the user's individuality through the combination of *goun* categories assigned to the icons that make up the landscape. (Table 2) Through this process, the user's individuality is expressed as a *goun* value, and the initial value is determined as described above.

Table 2. Relationships between symbols, *Sanen* perspective and *Goun*

Icon	Koen	Heien	Shinen
Rock	Jyu	Sou	Siki
Mountain	Jyu	Gyou	Siki
Moon	Siki	Jyu	Shiki

4.3 Zen Dialogue Interactions

When the user approaches certain objects within the *sansui* painting, a Zen event occurs. Every event is constructed such that one can have an interactive pseudo-real experience with a Zen *koan*. The User, Target and Zen Master agents exist within each interaction, and the content of the interaction changes based on their interrelationships.

For example, the *koan* “Dharma Anjin” (Fig. 6) is a dialogue where once, in response to a pupil’s complaint that his inner spirit is in turmoil even after training, Dharma replied “Alright, then show me your troubled spirit.” We have translated this into an interaction in which one draws one’s inner spirit. The *koan* “The Lotus

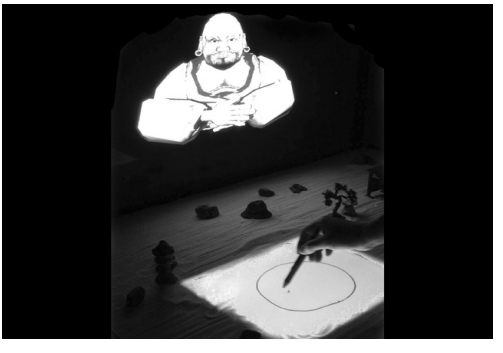

Fig. 6. Zen dialogue "Dharma Anjin," where the user draws herself using the touch screen

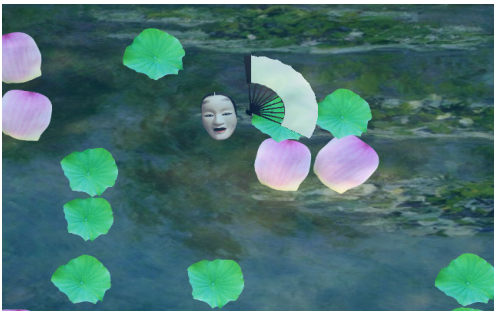

Fig. 7. Zen dialogue "The Lotus Smiles," where the user's *goun* state increases with successful matching of Noh Theater masks

Fig. 8. Zen dialogue "The sound of one hand clapping"

Smiles" (*nengemisho*), shown in Fig. 7, holds the meaning of telepathy. In order to express this, we made an interaction like a matching game, hiding Noh Theater masks beneath lotus leaves, such that the leaves change to flower petals when the user finds matching masks. Fig. 8 is the *koan* "the Sound of One Hand Clapping," wherein the system judges the calmness of the user's spirit by measuring the regularity of the user's hand-clapping.

5 Interaction Control via Chaos

One can think of the interaction for the Zen dialogues as being controlled by a combination of both cooperative and oppositional interactions between three different states: (1) the current state of the user (User), (2) the goal the user should reach (Target), and (3) the Zen master that guides the user (Zen Master). To simulate this process, a model is used such that the reaction of the system during user interactions depends on the interaction of the three elements of User, Target and Zen Master, which are all expressed as points within *goun* space. As a method to implement this model, one can think of a way to show the positional relationships between the three elements and the system's reactions as a table. However, because with this method the system's reactions become fixed, one cannot realize a framework allowing the enjoyment of various kinds of interactions spanning several uses. In order to allow many users to experience various interactions each time they interact with the system, it is helpful to introduce an appropriate element of "fluctuation."

The system uses a method for the dual synchronization of chaos to realize this fluctuation. [10] The method for dual synchronization of chaos is a model handling the synchronization of two or more chaos states. In this case, the system adopts a model containing three chaos states, corresponding respectively to the User, Target and Zen Master. Each chaos state corresponds to a point in *goun* space. Under the method for dual synchronization of chaos, if one applies an initial value and an appropriate input value, the three chaos states relate to one another, moving through *goun* space, and generate an output corresponding to their interactions. For the chaos input, the system uses data from the user's interactions. With the basis of Zen, activity, as the axis, the *goun* value rises (in the plus direction) the more active a user's interaction, and falls (in the minus direction) the less active he is. The data output from the chaos model is used after transformation into the system's reaction data for the user. For example, in

the *koan* "Dharma Anjin," the position of the Target chaos changes depending on the curvature and density of the drawing the user sketches. The higher the density and curvature are, the better *goun* state achieved. In other words, the Zen "*enso*" (circle) is the best. Also, in "The Lotus Smiles," the *goun* state rises with a higher accuracy in matching images of Noh theater masks.

6 The Flow of the Story Experience Within Sansui Space

The story process a user walks through is as follows: (Fig. 9)

1. Generate a *sansui* painting
2. *Haiku* are generated related to the icons on the *sansui* painting
3. When the user approaches objects in the *sansui* painting, associated Zen dialogues appear
4. Depending on the interaction results from the four Zen dialogues, a form matching the user's personality is determined from the following four forms of Japanese culture:

   kisoi: comparative design — *mitate*: choice and metaphor

   awase: design in pairs — *soroe*: design based on sets

   The interaction for kimono pattern choice is executed according to the above forms.
5. In conclusion, the "Ten Ox Story" corresponding to the user's interactions is displayed.

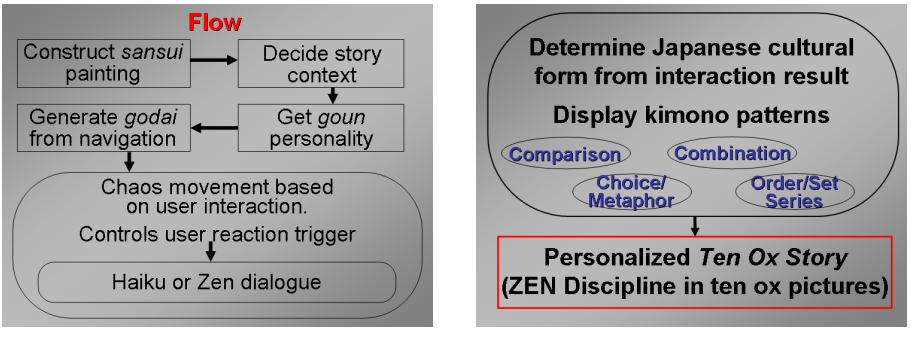

Fig. 9. Interaction process and context generation

7 Application in Context-Aware Environment

We installed this system in the Ubiquitous Home at the National Institute of Information and Communications Technology, making use of RFID (Radio Frequency IDentification) and floor pressure sensors, as well as computer-controlled displays, to transform ZENetic Computer into a context-aware interactive experience. We took

advantage of the context-aware environment to recognize the presence of people in the room, their entrance and exit, and their movement around the room.

Using these embedded sensors as an interface enriches the interactive experience by allowing the user to communicate with the system indirectly. For example, when someone walks into the living room, the display turns on and a voice welcomes the user. The user's identity is detected by reading the RFID tag she's wearing, so she may choose to work on a previous painting or start a new one by clicking on a wireless tablet-computer interface.

After the user begins painting with the tablet computer, a voice encourages her to stay if she tries to leave before finishing the painting. However, once the painting is finished, ZENetic Computer allows free interaction with the system. The system watches movement on certain areas of the living room floor, using people's movement as a trigger to play haiku poems or natural sounds related to the elements of *sansui*. Walking front of the display triggers the painting's perspective to shift in the direction of movement, transforming the three dimensional *sansui* ink painting into a dynamic work of art.

By taking advantage of RFID and pressure sensors, displays and speakers embedded in this kind of "house of the future", the ZENetic Computer experience opens up from a single touch-screen interface and display to a physical space encompassing an entire room.

Fig. 10. ZENetic Computer at the NICT Ubiquitous Home

8 Evaluation and Future Outlook

At the 32nd UNESCO General Conference, the meaning of culture was defined once again. Culture encompasses all of customs, images, expressions, knowledge, skills, as well as related tools, goods, artificial objects and cultural spaces. Not only physical cultural relics, but also information exchange systems, communal, spiritual, and philosophical systems are included in the definition of culture.

In 2004, ZENetic Computer received second place in the UNESCO-sponsored Digital Storytelling Competition of Intangible Heritage. In the future, as the processing power of computers, high quality displays and input devices approach the limits of human perception, it is expected that high technology will enter the spiritual domain. In the West, Japanese Zen is an old and mysterious philosophy. Indeed, although books try their hand at explanation, it is difficult to truly understand Zen by reading alone. ZENetic Computer tries to convey the spirit of a culture through experiences such as participating in Zen dialogues, listening to *haiku* and exploring *kimono* patterns.

In the future, there will likely be a strong desire for the thought and design of cultural computing for universal communication, boldly making this kind of cross-cultural connection. ZENetic Computer was planned with this intent in mind, and for its realization the authors made use of advanced game design, graphics, and interactive displays. We are certain that the methods used in ZENetic Computer will flourish in the broad field of education and will make possible experience-based cross-cultural understanding.

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