Co-creation System and Human-Computer Interaction

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Abstract

The purpose of this research is to realize a "Co-creation System." Co-creation means co-emergence of real-time coordination by sharing subjective space and time between different persons. Human communication with emergent reality like this is essential to improve communicability in social systems, and we assume such communication needs two kinds of information process at the same time. One is explicit communication such as the transmission of messages and the other is implicit embodied interaction such as the sympathy and direct experience. The conventional IT system mainly covers the former process but we have been pointing out the importance of the latter process. Especially, this implicit process is related with rhythmic interaction between humans, such as entrainment of body motion. From this background, using these implicit and explicit processing complementarily, we are developing co-creative man-machine interfaces and communication media. We think this dual-processing based new technology will be effective for recovering human linkage and mutual-reliability that has been weakened in modern IT society.

1. Introduction

As the background to this research, we have already pointed out the limitation of the intelligence realized in artificial systems. To clarify this point, intelligence of human being is classified into two different categories: "search" and "emergence."

A searching algorithm based on "completeness" of intelligence has been widely used in IT systems. This kind of intelligence is applicable to definite situations in which every solution can be previously defined (Fig.1a). However, in indefinite and complex situations, such as the system which is including human behaviour and social communication, searching cannot be used. If we want to apply this type of intelligence to such situation, the system should prepare a lot of solutions to adapt to the complex situation. As a result, the size of the system becomes bigger and bigger and finally it becomes a large black box [1,2].

From this consideration, another type of intelligence is required to adapt to unpredictable conditions, and the intelligence with emergence is essential for overcoming the limitation of the conventional approach. We think this is the limitation of design principle of artificial systems, and how to realize such new intelligence with real-time emergence?

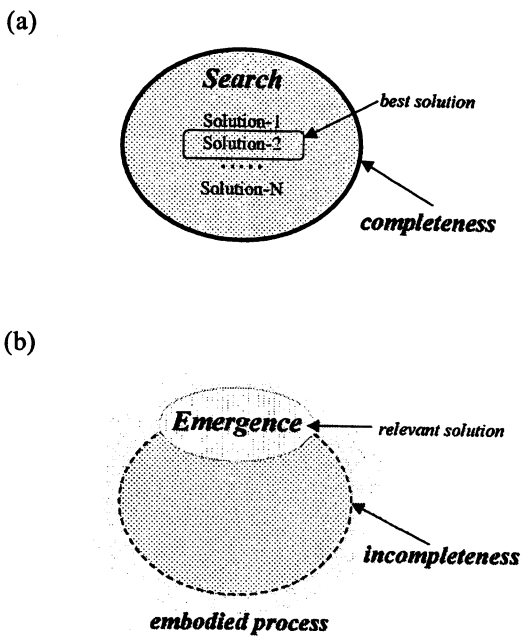

Figure 1: Search and emergence

2. Incompleteness and Co-creation

In the present IT systems based on the framework of searching, the relationship between human and system is in one-sided transfer from the system to human. Please imagine any application software used on your PC, you can easily find many buttons or icons presented on the screen as shown in Fig.2a. If you select one of them, you can get one function. This is a simple example of one-sided transfer from the system to human.

As a result, every function should be previously equipped in the artificial system, and the size of the information space in the system-side becomes extremely large. This is a kind of big black box for user, because the number of function is large and there is no context

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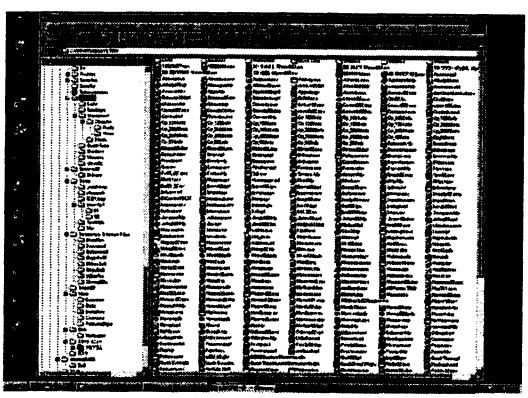
generation in this information system. This makes the human passive and we have already pointed out this is a serious problem of present design principle based on intelligence with completeness.

On the other hand, Japanese culture has very different traditional background, i.e. emergence in real-time. Japanese think artificial systems should be incomplete, but this is a kind of active "incompleteness" to realize an emergent reality with humans (Fig.1b). Due to this incompleteness, coordination between the system and the human is co-created in real-time depending on the context of the situation. In this process, embodied interaction plays an essential role for realizing a relevant function with real-time coordination.

The stone garden Ryoanji temple in Kyoto would be an example. There are 15 stones in this garden, however you can never see all stones at the same time (Fig.2b). Some stones are always hidden by other stones. This is a kind of active incompleteness. So if you want to get a whole image of the garden, you have to walk around in the garden as a part of the garden. This is a kind of embodied process to share the context between human and the system. Then you will be able to co-create the whole image including you as a part of the garden. This is the design principle of the co-creation system that is based on active incompleteness and embodied process. [3] However, how to realize such process in an IT system is still an open question.

(a)



(b)

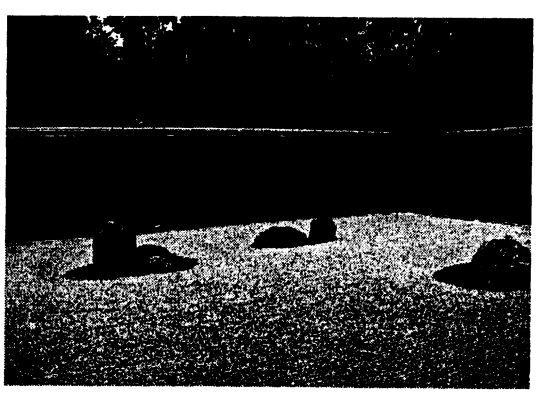


Figure 2: IT system and Japanese stone garden

3. Dual-dynamics Model

To achieve this target, the design principle of the co-creation system should be investigated. In our group, the concept of "duality of self" was proposed as a hypothesis for realizing co-creation [4-8].

This hypothesis assumes that our human intelligence is composed of two different processing modes. One is the process of "explicit self" and the other is "implicit self." This explicit self is concerned with consciousness and realizes the intelligence with completeness. In other words, this intelligence is our causal operation in formal logic. On the other hand, the implicit self is concerned with embodied process with active incompleteness. This realizes the interaction between the system and the indefinite actual world. Here, the information circulation between these two processes is the emergence process called "mutual constraint." We regard this emergence process as a co-creation process of intelligence as shown in Fig.3.

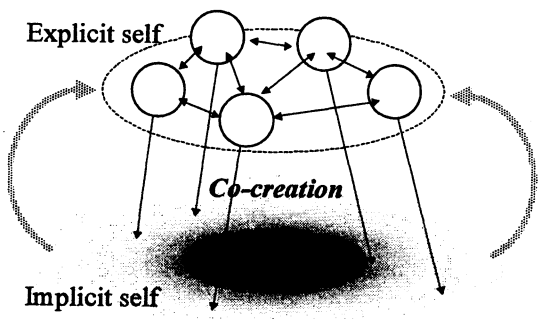
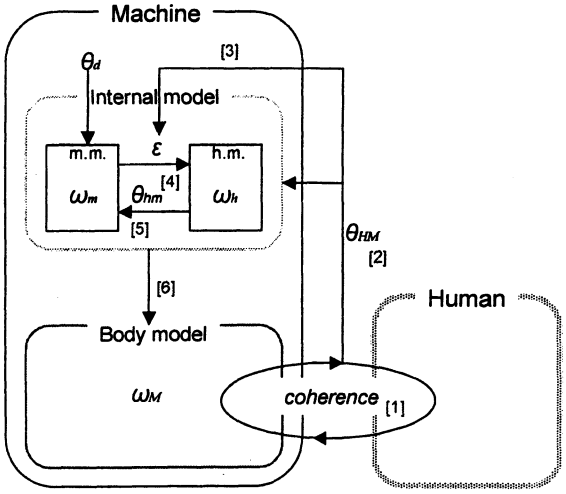


Figure 3: Co-creation process

From this hypothesis, we have already proposed a model of co-creation system as shown in Fig.4a [9]. This "dual-dynamics model" is composed of two sub-models. One is an "internal model" to show the explicit process and the other is a "body model" to represent the implicit process. Since the synchronization phenomenon of the body motion is widely observed as a typical dynamics of the embodied process [10], a non-linear oscillator model and mutual entrainment are used to realize the dynamics of the body model that can be embedded as a part of the indefinite world. This is an example of mathematical expression of active incompleteness of the system, and temporal coherence can be self-organized in such open space. The internal model is a coupled oscillator as a closed space to represent the processing based on completeness. This is a kind of searching process to find the best solution. Through the mutual constraint process between these two sub-models, an emergent process of intelligence is simulated. The algorithm of this mutual constraint process is shown in Fig.4b.



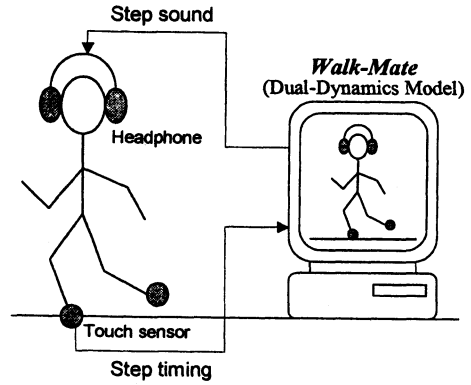
1. Self-organize coherence between human motion and body model
2. Get the organized coherence as phase difference θ_{HM}
3. Modify the internal model parameter ε such as $min(\theta_{HM} - \theta_d)$
4. Search ω_h such as $min(\theta_{HM} - \theta_{hm})$ under the fixed ω_m in internal model
5. Search ω_m such as $min(\theta_d - \theta_{hm})$ under the fixed ω_h in internal model
6. Change ω_M in body model corresponding to searched ω_m
7. Back to 1

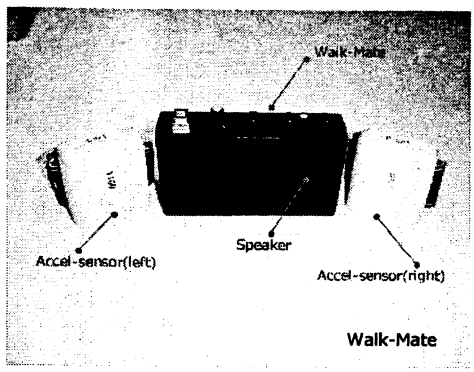
Figure 4: Dual dynamics model

4. Co-creation in Human-Computer Interaction

This model was represented as a part of the co-creation process in the interface between human and computer. Especially, cooperative walking between human and virtual robot was used as an example of this process, because synchronization of motion rhythm is an embodied dynamics in human communication. And the rehabilitation of human walking can be regarded as an example of co-creation process, because their walking ability is redeveloped through the cooperative walking between the therapist and client in the rehabilitation for elderly people.

Our dual-dynamics model is equipped in a personal computer as a virtual walking robot and footsteps are exchanged between the robot and human walker as shown in Fig.5. The footstep sound of the robot is transmitted to the human through headphone and the footstep of the human is detected by an acceleration sensor and feed backed to the robot. Everyone has had this kind of experience when walking with another person. In this system, temporal coherence of footsteps between two persons is spontaneously organized by





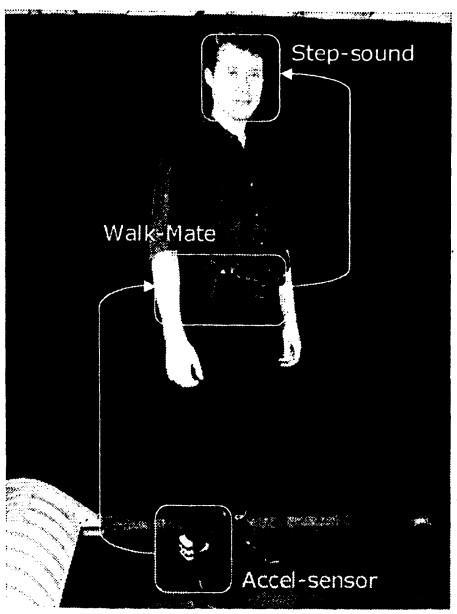


Figure 5: Walk-Mate

mutual entrainment. This co-creation robot was named "Walk-Mate" [11].

To evaluate the effectiveness, interaction between Walk-Mate and a human with walking impairment was analysed. As a result, three characteristic properties were observed as in Fig.6. The first is mutual adaptation between the human walker and Walk-Mate. The periods

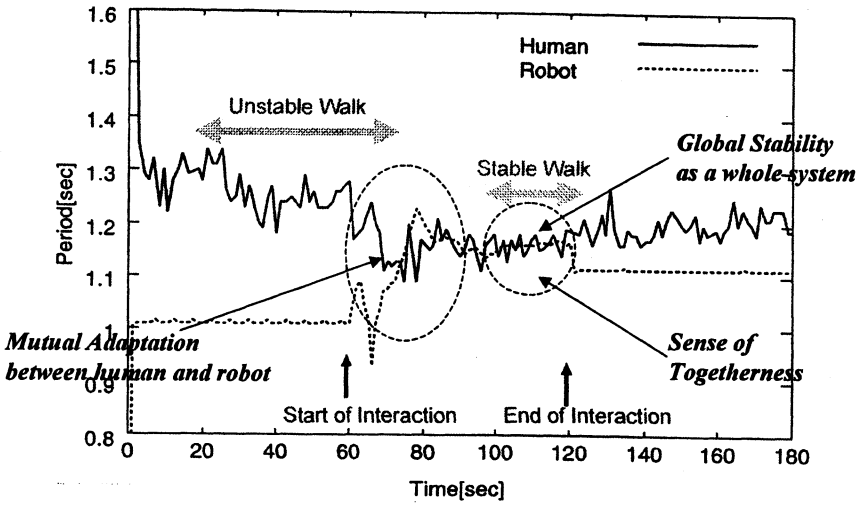


Figure 6: Co-creation process

of their footsteps mutually coincided with each other after the start of interaction. This is a kind of co-creation dynamics in walking. The second is the emergence of global stability including both the dynamics of the human and the Walk-Mate. Fluctuation of the footstep period due to the walking impairment was significantly decreased in this co-creation process. The third is the sense of togetherness emerging through this process, suggesting this process also realizes the emergence of our mental connection.

These results show that our proposed framework could be effective for establishing a co-creation process between humans and artificial systems. Recently, we are developing this framework in other applications, such as ensemble support system and dialog support system.

5. Conclusion

In this way, we are developing co-creation technology in a man-machine interface. In the next step, this framework should be extended to a network system to support co-creative communication in human linkage. On the Internet, exchange of explicit information is very easy but the implicit process cannot be shared there. This means there is no co-creation on the Internet. As such network system has penetrated into daily life, relation-building problems, such as mutual reliability in a virtual community and togetherness between remote families has become an important subject. This co-creation technology has the potential for overcoming the problems of the modern network society.

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