Journal of Robotics, Networking and Artificial Life, Vol. 2, No. 1 (June 2015), 46-49

A modeling of collaboration mechanism of design process based on Channel Theory

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Abstract

Collaboration is one of the effective approaches that help us to share knowledge together and exchange ideas within team members. Sometimes, helpful new knowledge that is not held by the members emerges as a result of the collaboration. Such knowledge often contributes to get prime solutions in the collaboration process. However, the way to generate such new knowledge is implicit. In this paper, a method of creating a model, which represents effects of collaboration in a design process is proposed. By using this scheme, we can illustrate what new knowledge can be gotten from a collaboration and we can know the effects of the collaboration.

Keywords: Collaboration, Channel Theory, design process, synergetic effects

1. Introduction

Collaboration is a communication process in which two or more people from different disciplines participate in knowledge transfer to achieving a goal of team [1]. It is one of the effective approaches that help us to share knowledge together and exchange ideas within team members. During collaboration process, synergetic effects among team members may contribute to generate novel knowledge. Thus, effective collaborations are expected in a group work.

In design area, viewpoints of designers play an important role to bring about a novel design idea [2]. Different experiences and knowledge cause different viewpoints [3], and designers can share their viewpoints through collaboration process. Thus, collaboration is a promising method, which assists designers to create more outstanding design and increase ability to fulfill client's requirement more perfectly. However, the way to generate new knowledge is implicit. Thus, this study aims to represent the process of generating such knowledge by using mathematical model.

As a result of precious synergetic effects, new knowledge is produced within the collaboration process. To investigate effective collaboration, a representation model of collaboration mechanism is proposed. Channel

Theory [4] is introduced to create the model. Moreover, Chu space [5], that is a mathematical construction, which represents scheme of infomorphism, is adopted to account for knowledge in collaboration system.

2. Literature reviews

2.1. *Related works*

There are many researches have applied Channel Theory to study about communication system. For example, Suto et al. have proposed a representation model for communication medium with Channel Theory [6]. This model is used to describe a semantic information flow, which is corresponding to a kind of medium. Kawakami et al. have proposed a modeling system framework that involves diversity and context dependencies base on Channel Theory [7]. It has the potential to model diversity using the arbitrariness of information flows. Schorlemmer [8] proposed a formalization of knowledge sharing scenarios by using diagram in the Chu category, etc. Basic idea of Channel Theory is referred briefly in the following section.

2.2. *Channel Theory*

Channel Theory provides a mathematical framework of qualitative theory of information. The basic concepts of Channel Theory consist of classification, local logic, infomorphism, and information channel.

A classification $\boldsymbol{A = \langle tok(A), typ(A), \vDash_A \rangle}$ consists of

(i) a set, $tok(A)$, of objects to be classified, called the "*tokens of A,*"

(ii) a set, $typ(A)$, of objects used to classify the tokens, called the "*types of A,*" and

(iii) a binary relation, $\vDash_{\boldsymbol{A}}$, between $tok(A)$ and $typ(A)$.

A classification is represented with indicating the types to which tokens to be classified.

Given a classification A, a pair $\langle \Gamma, \Delta \rangle$ of subsets of $typ(A)$ is called a "*sequent of A.*" A token $a \in tok(A)$ satisfies $\langle \Gamma, \Delta \rangle$ if a is of type α for $\forall_\alpha \in \Gamma$ then a is of type β for $\exists_\beta \in \Delta$. If every token $a \in A$ satisfies $\langle \Gamma, \Delta \rangle$, say $\Gamma \vdash_A \Delta$, and $\langle \Gamma, \Delta \rangle$ is called a "*constraint*" supported by A.

A local logic $\mathcal{L} = \langle A, \vdash_{\mathcal{L}}. N_{\mathcal{L}} \rangle$ consists of a classification A, a set $\vdash_{\mathcal{L}}$ of sequents of A called the constraints of $\mathcal{L}$, and a set $N_{\mathcal{L}} \subseteq tok(A)$ of tokens called the normal token of $\mathcal{L}$, which satisfy all the constraints of $\mathcal{L}$.

An infomorphism is important relationship between two classifications and provides a way of moving information back and forth between them. Infomorphism $\langle f^\wedge, f^\vee \rangle$ is a pair of functions, in which $f^\wedge$ is a function from the types of one of these classifications to the types of the other, and $f^\vee$ is a function from the tokens of one of these classifications to the tokens of the other. Given two classifications, A and B, an infomorphism from A to B written as $A \rightleftharpoons B$ satisfies the following Fundamental Property of Infomorphisms:

$$f^\vee(b) \vDash_A \alpha \text{ iff } b \vDash_B f^\wedge(\alpha) \qquad (1)$$

for each token $b \in tok(B)$ and each type $\alpha \in typ(A)$.

A channel C is an indexed family $\{f_i : A_i \rightleftarrows C\}_{i \in I}$ of infomorphisms with a commom codomain C, called the "*core of* C." I is an index set.

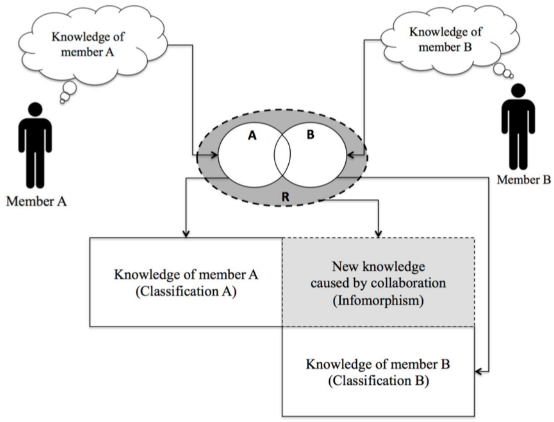

Fig. 1. A framework of collaboration mechanism represented by using Channel Theory

3. Proposed model and example

3.1. *A model of collaboration mechanism*

The framework of proposed model is shown in Fig. 1. Each solid circle indicates a set of knowledge held by a member. Due to synergetic effects in collaboration, team performance cannot be calculated as simple union of the abilities of each member. Possibility domain of collaboration can be described as $R - (A \cup B)$. This situation can be represented by using classification of Channel Theory as shown below the circles in Fig. 1. Here, we can deduce the knowledge, which can be obtained from synergetic effects by using infomorphism.

By using this scheme, we can demonstrate effective collaboration by representing what new knowledge can be gotten from collaboration.

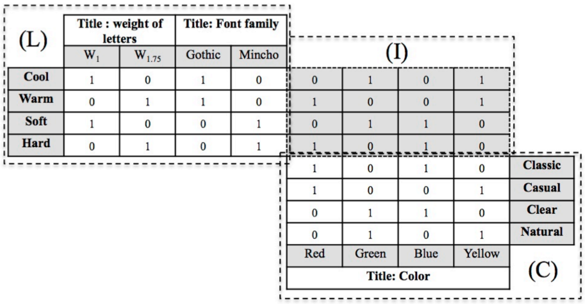

Fig. 2. A model of collaboration in webpage design between layout designer and color designer

3.2. *Example*

A collaboration between designer A, who is practiced on layout design and designer B, who is proficient on color design is considered as an example.

Classification of layout design knowledge (L): The classification of layout design knowledge is described as a classification as following:

$$tok(L) = \{Cool, Warm, Soft, Hard\}$$

$$typ(L) = \{W_1, W_{1.75}, Gothic, Mincho\}$$

$Cool \vDash_L W_1$, $Cool \vDash_L Gothic$, $Warm \vDash_L W_{1.75}$, $Warm \vDash_L Gothic$, $Soft \vDash_L W_1$, $Soft \vDash_L Mincho$, $Hard \vDash_L W_{1.75}$, $Hard \vDash_L Mincho$.

Here, each token stands for impression and each type stands for layout items, font weight or font style.

Types W_1 and $W_{1.75}$ mean weights of letters, which define as normal and bold respectively. Types Gothic and Mincho mean font styles of letters in title part, which define as Gothic and Mincho styles respectively. For example, when weight of a font is thin and the style is Gothic (Japanese Serif style), it gives cool impression to the observers. The classification can be represented as a Chu map shown in Fig. 2 (L).

Classification of color design knowledge (C): The classification of color design knowledge is described as a classification as following:

$$tok(C) = \{Classic, Casual, Clear, Natural\}$$

$$typ(C) = \{Red, Green, Blue, Yellow\}$$

$Classic \vDash_C Red$, $Classic \vDash_C Blue$, $Casual \vDash_C Red$, $Casual \vDash_C Yellow$, $Clear \vDash_C Green$, $Clear \vDash_C Blue$, $Natural \vDash_C Green$, $Natural \vDash_C Yellow$.

Here, each token stands for an image and each type stands for color decorating. For example, when a webpage is decorated with Red and Blue, it gives classic image to the observers. This classification can be represented as a Chu map shown in Fig. 2 (C).

Infomorphisms from *L* to *C* (I): An infomorphism from L to C is derived as shown in Fig. 2 (I). Eventually, this situation can be represented as matrices shown in Fig. 2 by using the proposed method. In this case, the model consists of three classifications, i.e. L, C, and I. Each line in the (I) means a combination between a token in classification L and a token in classification C. For instance, Cool in (L) is combined with the Natural in (C) because the first line of (I) has the same element of the fourth line of (C). While, each column in the (I) means a combination between a type in classification L and a type in classification C. For instance, Red in (C) is combined with $W_{1.75}$ in (L) because the leftmost column of (I) has the same element of the second column from the left in (L).

In this case, infomorphisms are established from

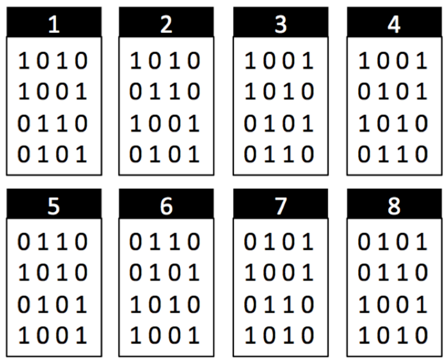

Fig. 3. Infomorphisms from layout design knowledge to color design knowledge

"classification of layout design knowledge" to "classification of color design knowledge." Eight infomorphisms have been obtained as shown in Fig. 3. Each situation explains new knowledge, which layout designer and color designer obtained from cooperation in the design process. It means there are eight situations that might occur when layout designer and color designer collaborate in a design process. However, we cannot say that all situations are proper understanding in the context because the proposed method derives all possible situations. For example, in Fig. 3., infomorphism 1 shows that

$$f^{\wedge}(Cool) = Classic, \quad f^{\wedge}(Warm) = Casual,$$
$$f^{\wedge}(Soft) = Clear, \quad f^{\wedge}(Hard) = Natural.$$

From this infomorphism, we can see that the designer understood that the design, which has cool impression is corresponding with classic image, while warm impression is corresponding with casual image. Moreover, soft impression is corresponding with clear image and hard impression is corresponding with natural image. This new knowledge appropriate because this knowledge is consistent in semantics. Meanwhile, infomorphism 2 shows that

$$f^{\wedge}(Cool) = Classic, \quad f^{\wedge}(Warm) = Clear,$$
$$f^{\wedge}(Soft) = Casual, \quad f^{\wedge}(Hard) = Natural.$$

From this infomorphism, cool impression and hard impression can be implied as same as infomorphism 1. But soft impression is corresponding to casual image and warm impression is corresponding to clear image. It must be misunderstanding because warm impression is conflict with clear image according to the theory of color science [9].

4. Conclusion

A modeling method of collaboration mechanism has been proposed based on Channel Theory. An example of webpage design case was shown as a case study. The example illustrates the situation that two designers who have different knowledge, collaborate in a webpage design process. In the example, designer A is practiced on layout design whereas designer B is proficient on color design. They could have much possible knowledge as a result of the collaboration.

We can say that the proposed model can explicitly represent the situation, which possible to occur in collaboration in a webpage design process. However, we cannot say that all situations are correct understanding because all possible situations are derived with the proposed method. Nevertheless, with using the proposed model, we can find mistakes that may occur in collaboration, and we can prepare some procedure to prevent such a mistake.

Acknowledgement

This work was supported by Grants-in-Aid for Scientific Research from Japan Society for the Promotion of Science (23611025, 15K00486) and Grants-in-Aid for research advancement from Muroran Institute of Technology (2014).

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