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Innovation support system for creative product design based on chance discovery

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ABSTRACT

Under a turbulently changing and highly competitive market, discovery of a chance is always significant for many companies to launch new and creative products or services in time, fulfilling consumers demands for occupying more market share. Many available methods on market research for designing new products are more focused on the analysis process, so that product designers run short of ideas discovery. In this paper, we present a novel innovation support system (ISS) based on chance discovery with data crystallization to assist human innovation in designing new products, especially creative products. The ISS is a human-centric system to enable value cognition and follows the following process: (1) visualized scenario graph generation, (2) human value cognition, (3) value co-creation based on shared knowledge, and (4) emerging chances evaluation. The result of a case study validates the effectiveness of ISS.

1. Introduction

In the dynamic and competitive market, many companies have to release new and creative products or services to fulfill the consumer demands for occupying much more market share. Many methods available on market research for designing new products, such as detailed questionnaires followed up with further analysis, are more focused on the analysis process, which makes the product designers suffering from fewer requirements. An interview and requirement meeting is an effective communication technique between product designers and customers (Carrol, 2000). However, the requirements obtained from customers are usually incomplete information. The reasons are as follows:

1. The designers failed to understand real customer needs. Sometimes the requirements from customers are too ambiguous or abstract to understand for designers.
2. The designers misunderstand real consumer needs. The original requirements of customers are too vague.

Kushiro and Ohsawa (2005) established a new scenario elicitation method to solve the above issues by combining the chance discovery and the requirements engineering methods. Chance discovery is to become aware of a chance and to explain its significance, especially if the chance is rare and its significance is unnoticed (Ohsawa, 2002).

Chance discovery is a human–computer interaction process to detect rare but important chances for decision making. A chance in chance discovery means to understand an unnoticed event or situation which can be uncertain but significant for making a decision (Ohsawa, 2003a, 2003b). Keygraph is a text mining visualization tool and used to build scenario graph with the Keygraph algorithm to assist the process of chance discovery (Ohsawa, 2003a, 2003b). That is, Keygraph can recognize and display relations between events and event clusters in a document, and event clusters can be read as special meaningful scenarios by domain experts. Through human–computer interaction for some times, a decision from decision makers is to choose one from possible scenarios in the future. In the last few years, chance discovery has been widely applied in various research areas, especially in creative product design (Horie & Ohsawa, 2005;Horie, Maeno, & Ohsawa, 2007;Ohsawa & Usui, 2006).

However, researchers have recognized a new problem of how to discover the important events that are not in the data, which is beyond scope of the chance discovery. Such invisible events are named dark events. Ohsawa (2005) extended theory and method of chance discovery where dummy nodes are inserted into the original data corresponding to the dark events. The data including dummy nodes is visualized and the dark events are understood by human cognitive process. For human easily understanding the visual scenario graph, Maeno and Ohsawa (2007) proposed human–computer interactive annealing method (HIAM) to discover invisible dart events. Horie, Maeno and Ohsawa (2007) applied the data crystallization with HIAM to design products in a real company and got good performance in the market.

How to develop a systematic method, which not only can capture important but low or even zero frequency data, but also combine visual technologies with the methods of raising cognition capability of human, to support human to discover future chances such as creative products, has become an important research topic.

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In this paper, we present a novel innovation support system (ISS) based on chance discovery with data crystallization to assist human innovation in designing new products, especially creative products. The ISS is a human-centric system to enable value cognition and follows the following process: (1) visualized scenario generation, (2) human value cognition, (3) value co-creation based on shared knowledge, (4) emerging chances evaluation. The rest of paper is organized as follows. In Section 2, we present a method for making scenario based on chance discovery with data crystallization. A tool for aiding innovative thoughts and communication is introduced in Section 3. A method to effectively evaluate these emerging chances (creative ideas) is proposed in Section 4. In Section 5, we use a real example to illustrate the process of ISS. The conclusion is discussed in Section 6.

2. Chance discovery with data crystallization

2.1. Keygraph as a visual tool of chance discovery

Chance discovery is a human–computer interaction process. For assisting the process of chance discovery, we developed a visualization tool named Keygraph for human cognition of chances. The visualization graph is shown in Fig. 1. Suppose that data D is stored in a document. The data format is as below:

$D =$ Item1, Item2, Item3,
Item1, Item2, Item3, Item4,
Item3, Item4, Item5, Item6
.....
.....

The main steps of Keygraph algorithm are outlined as follows.

Step 1: Obtain the clusters composed of co-occurrence high frequency items.
(1) Extracting high-frequency items. Items in the data are sorted by frequency of occurrence. These high-frequency items are represented as black nodes in the graph G.
(2) Extracting high-frequency item-pairs. High-frequency item-pairs means item-pairs occurring in the same line of data have high co-occurrence frequency. Item-pairs are also sorted by frequency of occurrence. High-frequency item-pairs are linked with black solid line in the graph G, thereby forming clusters. A measure of co-occurrence of item-pairs is defined as the Jaccard co-efficient

$$J(I_i, I_j) = \frac{Freq(I_i \cap I_j)}{Freq(I_i \cup I_j)} \quad (1)$$

where I_i and I_j are the high-frequency items. $Freq\ I_i \cap I_j$ is the probability of item and co-occurring in the same line. $Freq\ I_i \cup I_j$ is the probability of either item I_i or I_j occurring in the line.

Step 2: Obtain chance candidates. The items strongly co-occurring with clusters are obtained as chance candidates.

(1) Extracting high-key items. The measure of the tightness between an item I and a cluster C is defined:

$$Key(I) = 1 - \prod_{C \subset G} [1 - J(I, C)] \quad (2)$$

The key value of each item in the data is calculated by Eq. (2). The high-key items are added as nodes with red color if they are not already in the graph.

(2) Extracting chance links. According to the Eq. (1), each high-frequency item and each high-key item is calculated. Links connecting to high-frequency are sorted by their J values for each high-frequency item, and are added in the graph with red dot lines.

In chance discovery, human make consciousness of the visual graph made by Keygraph. The clusters obtain could imply a basic context. The red nodes linking different clusters are considered as candidates of chance that could be important for decision making in the future.

2.2. Data crystallization as an extension of chance discovery

For incomplete or ill-structured data, the methods introduced above in chance discovery cannot deal with this kind of problems well. Some important events probably do not exist in the data. Therefore, how to detect unobservable significant events is desired to solve. Data crystallization is proposed to present the hidden structure among events including unobservable events.

The process of data crystallization is as follows:

Step 1: Inserting the dummy-item. Given the data D, a dummy-item is inserted into each line of the data D, obtaining a new data D'. If there are the same dataset in two or more line, these lines should be inserted the same dummy-item.

$D' =$ Item1, Item2, Dummy-Item1
Item1, Item2, Item3, Item4, Dummy-Item2
Item3, Item4, Item5, Item6, Dummy-Item3
.....
.....

Step 2: Visualizing the data D' by Keygraph, see Fig. 2. Dummy-items appear between the clusters.

Step 3: Getting rid of meaningless dummy-items. The dummy-items which do not appear in the graph and connect different clusters as a bridge are deleted from D'. For example, in Fig. 2, dummy-item3 does not show in Fig. 2, thus the dummy-item3 should be deleted in the data D'.

According to the graph, human try to sense potential meanings of the dummy-items as unobservable events.

3. Innovation is a game of emerging chance: innovators market game (IMG)

3.1. Basic introduction of IMG

We gradually found that only depending on the individual ability or experience to make value sensing is really hard work, and the effectiveness of value sensing is not good enough for decision making. Value sensing should dynamically communicate and interaction between humans, not only by human–machine interaction. Therefore, we propose a method to assist humans for improving humans' capacity for sensory perception.

Innovators market game (IMG) supplies the players a creative environment where players can communicate each other to elevate their innovative abilities. While the players called innovators as core players present combinatorial business ideas based on prepared basic ideas and game board which shows a visual graph generated by Keygraph, the other players called customers evaluate these ideas created by inventors. Finally, potential business ideas emerge from their communications in IMG. IMG was organized many times in real companies of Japan (Ohsawa, 2009; Ohsawa,