Neurocomputing 142 (2014) 60–72

Contents lists available at ScienceDirect

Neurocomputing

journal homepage: www.elsevier.com/locate/neucom

A crowdsourcing development approach based on a neuro-fuzzy network for creating innovative product concepts

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ARTICLE INFO

Article history:
Received 18 January 2014
Received in revised form
11 March 2014
Accepted 31 March 2014
Available online 9 May 2014

Keywords:
Crowdsourcing
Target analysis
Task allocation
Cheating control

ABSTRACT

As an effective way to aggregate a crowd's wisdom, crowdsourcing has attracted much attention in recent years. Especially for product innovation, crowdsourcing shows huge potential for generating more creative ideas in terms of quantity and innovativeness. However, there are still some deficiencies in the existing crowdsourcing work: i) lack of a crowdsourcing system under a systematic or unified framework to support product innovation; ii) lack of an effective quantitative method to assist the design of crowdsourcing tasks; and iii) insufficient anti-cheating concerns in the initial stage of task design. In this article, a prototype crowdsourcing system is proposed to tackle these problems. Through the establishment of a task development model which consists of i) an innovation target analysis module, ii) an innovation-oriented HIT (human intelligent task) allocation module, and iii) a cheating control module, the proposed system is able to analyze and decompose the innovation target. In addition, it can identify suitable tasks to facilitate innovation and to embed anti-cheating measures in task design. To demonstrate the proposed prototype system, a case study on a future PC design is presented. Through control testing, it appears that the proposed system is effective in generating more valid and innovative ideas.

1. Introduction

In new product development, a good product concept can bring about more opportunities to succeed in the fierce market competition. Amongst the most popular products today, Apple's iPhone is regarded as a leading product in innovative design. Its unique and revolutionary design has gained tremendous advocacy worldwide. Inspired by Apple's case, a number of studies have been conducted to explore the secrets of the successful development of innovative products. However, enterprises still face the challenges of developing innovative product concepts effectively.

Crowdsourcing is defined as 'the act of a company or institution taking a function once performed by employees and outsourcing it to an undefined (and generally large) network of people in the form of an open call' [15]. It is an important method to draw upon large numbers of people to contribute their knowledge. With the rapid development of the Internet, Web 2.0 provides an open platform to connect enterprises with worldwide consumers. Firms have more channels to communicate with users and can acquire useful knowledge from Internet users. Taking Proctor & Gamble as an example, the most challenging problems are solved by 'InnoCentive', and the problem solving rate has increased to 30%. In another example, Dell has set up an idea storm platform to collect comments and suggestions for all Dell products from Internet users. In addition, Wikipedia, Amazon's Mechanical Turk and iStockPhoto.com are all good examples that take advantage of the tremendous numbers of Web users. Therefore, crowdsourcing appears to be a promising way to solicit external resources to improve product competitiveness.

Nowadays, a number of research studies have been devoted to crowdsourcing, the scope of which has covered the authentication of crowdsourcing's power in acquiring useful data [3] and in the identification of factors which may influence the crowdsourcing effect [5]. Poetz and Schreier [24] conducted a study in which crowd workers showed stronger power to create innovative ideas. Regarding the task design methods, Khasraghi and Mohammadi [13] pointed out that crowdsourcing tasks should be distributed based on crowd workers' interests and skills. In addition, the tasks can be designed with CAD/CAM (2D or 3D) to capture participants' cognitive activities [19]. For the issue of cheating, some studies have been developed to detect cheating by organizing preference testing [32], calculating the reputation rank of participants [21], and investigating the relationship between the 'meaningfulness' of a task and a workers' effort [9]. Considering the potential of crowdsourcing in supporting the creation of innovative concepts and emerging research effort in enhancing crowdsourcing methods,

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http://dx.doi.org/10.1016/j.neucom.2014.03.044
0925-2312/

it can be expected that a unified and improved crowdsourcing system, which systematically integrates the concerns of task design and cheating, may bring about more chances to achieve effective product innovation [1,34].

Nevertheless, there are still three major research gaps in the current work: first, a crowdsourcing system under a systematic or unified framework for supporting product innovation has not been well addressed; second, it is imperative to attain an effective quantitative method to support the design of crowdsourcing tasks; and third, few anti-cheating concerns have been embedded in the initial stage of task design. Based on this understanding, a unified crowdsourcing system has been developed in this work. The proposed prototype system stresses a crowdsourcing task development model which is comprised of three cohesively interacting modules: namely, an innovation target analysis module; an innovation-oriented HIT (human intelligent task) allocation module; and a cheating control module. A case study on future PC design has been used to illustrate and validate the system.

2. Research background and related work

Crowdsourcing is a relatively new approach to aggregate the wisdom of the undefined online workforce. Compared with conventional product development approaches, the results of crowdsourcing depend on solvers' education level, capability and initiative, however, crowdsourcing might be more efficient in knowledge acquisition. In this section, crowdsourcing is introduced from the following perspectives: (1) a brief overview of crowdsourcing, (2) potential of crowdsourcing for creativity, and (3) gaps in establishing a crowdsourcing system for creating innovative product concepts.

2.1. A brief overview of crowdsourcing

The term '*crowdsourcing*' is a portmanteau of '*crowd*' and '*outsourcing*'. It was first coined by Howe in the article 'The Rise of Crowdsourcing' in 2006 [15]. Actually, there were a number of notable examples that acquire the manpower of the crowd to accomplish tasks before this concept was proposed. As an example, the Oxford English Dictionary, which made an open call to the community for contributions to identify all words in the English language, received over 6 million submissions over a period of 70 years. This indicates that the power of the massive workforce is significant. Nowadays, the Internet is developing rapidly, and modern crowdsourcing has transferred mainly to the Internet.

Generally, crowdsourcing can be schematically depicted as in Fig. 1. As shown in Fig. 1, the employer/assigner (right side) submits a task (human intelligence task – HIT) to a mediator, viz. the crowdsourcing platform, and defines the requirements, reward rules, and task duration. Online workers/providers (left side) who are interested in this task can work on it and submit their solutions to the mediator after completion. These solutions will be forwarded to the employer who will pay the participants if their solutions are approved.

2.2. Potential of crowdsourcing for creativity

Florida [30] holds a view that creativity can be exhibited through '*increased spending on research, high-tech startups, and a new social milieu, all converging in an age of pervasive creativity permeating all sectors of society*'. In this regard, Cook [34] has a similar view that increased participation can be a contribution revolution as crowds may offer the potential for creativity.

Firstly, crowdsourcing is useful in devising innovative or better solutions. For example, Heipke [6] pointed out that the crowdsourcing technique is helpful to geospatial mapping and change detection in real time with considerable data at a low cost. In the same sense, the general public is also viewed as an important data source for hydrologic at measurements [25]. In the manufacturing industry, crowdsourcing brings about the chance to activate crowds to assist the identification of efficient product and material cycles [36]. In website building, crowdsourcing can be an efficient approach to usability testing [10]. Moreover, crowdsourcing has also been successfully used to obtain optimal resource planning [22] and to perform fast and reliable information retrieval [28].

The above reviews advocate that crowdsourcing appears very important in discovering better solutions using crowd wisdom, and various techniques are considered to be integrated to enhance the applicability of crowdsourcing. A new probabilistic graphical model was developed to jointly model the difficulties of the questions and the abilities of participants in grading collected solutions [40]. A novel method applying crowdsourcing and Human-Computation to tackle the problem of enumerating the stimuli–response space of a conversation was proposed [4]. Moreover, collective intelligence was coordinated to demonstrate the feasibility of crowdsourcing through helping individuals reappraise stressful thoughts and situations [31]. To model tasks with multiple-choice questions, a novel probabilistic graphical model was constructed to insert a decision-theoretic controller into the crowdsourcing process [7].

Furthermore, diverse studies have been emerging to optimize crowdsourcing, which were then exploited to 'orchestrate' crowdsourcing (i.e. controlling knowledge mobility, appropriability and innovation seeking organizations to improve stability) [14]. Bernstein et al. [26] presented an analytical method using queuing theory to minimize cost and improve performance for real-time crowdsourcing. Similarly, a mathematical analysis was considered to reveal the potential relations of costs and accuracy for a crowdsourcing platform [23]. A crowdsourcing data analytics system was developed to estimate the accuracy of generated results, verify the quality and reduce waiting time [39]. To offer more accurate and efficient crowdsourcing, a hybrid human–machine approach was used to relocate the jobs [16]. To incentivize high-quality outcomes in

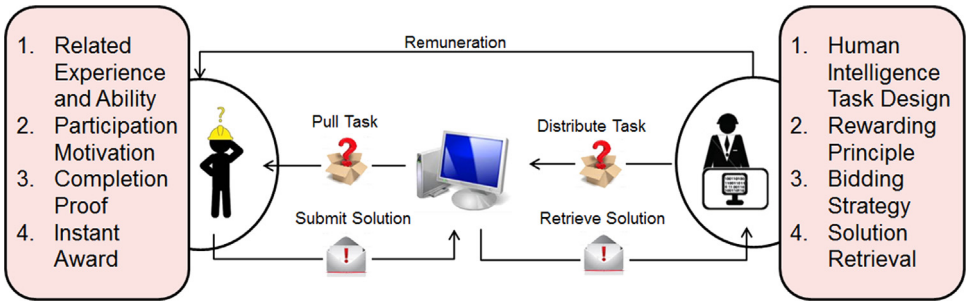

Fig. 1. Typical crowdsourcing scheme.