Aligning Subjective User Feedback for Reputation Computation in Virtual Reality

Hui Fang[1], Jie Zhang[1], Murat Şensoy[2], and Nadia Magnenat Thalmann[1]

[1]School of Computer Engineering, Nanyang Technological University, Singapore
[2]Department of Computing Science, University of Aberdeen,United Kingdom
hfang1@e.ntu.edu.sg

1 Introduction

Virtual Reality (VR) is defined as an artificial environment experienced through sensory stimuli provided by a computer. Current research on VR aims to develop a simulated reality that is realistic enough to satisfy human senses. As this technology is getting mature, its new application areas emerge, such as virtual marketplaces. Previous research has concerned about adopting virtual reality into constructing e-commerce, and validated whether and how virtual reality can influence trust and thus impact user decision making in advance [1]. Besides, there are inherited trust problems in virtual marketplaces. For instance, some sellers may be dishonest (*e.g.*, fail to deliver items as what they promised), or some sellers may have different competency (*e.g.*, provide only low quality products). In order to address the trust problem in virtual marketplaces, a five-sense oriented feedback provision approach has been proposed in our previous work [3]. The basic idea is to allow buyers to share their past experience about sellers in their feedback based on human buyers' five senses, namely, *vision*, *sound*, *touch*, *taste* and *smell*. Then, the reputation of sellers can be modeled based on the shared feedback. Information about five senses is synthesized by virtual reality simulators. As reported by Luca et al. [4], virtual objects can be created by copying the real products, such as using the 3D scanner to record *visual information* and using the haptic device to collect *tactile information*. With the aid of special equipments (*e.g.*, haptic gloves), users can also sense the virtual copies similar to the real objects, and can have the similar perceptions towards the attributes (*e.g.*, *softness*) of objects as in the real life. Thus, buyers can sense virtual products without time and space limitation compared to shopping markets in reality. However, this property of virtual marketplaces also brings several problems. For example, some sellers may cheat on the quality of products. They can always provide virtual objects copied from high quality products to attract buyers, but deliver lower quality real products. This further demonstrates the importance of reputation mechanism.

However, feedback in human users' five senses may involve users' own subjectivity by using the various subjective terms. For example, a simple concept like "soft" has different semantics for different users. The "adequately soft" perception of the user A may be interpreted as "inadequately soft" by another user B in some situations. Thus, if user B receives user A's feedback of "adequately soft", user B cannot use it directly. Instead, user B should interpret the feedback to "inadequately soft" according to B's own subjectivity. In this view, the step to firstly align the subjectivity involved in user feedback before computing reputation of sellers is indispensable and of great importance in assuring effective decision making for buyers. To effectively solve the above mentioned subjectivity problem in user feedback, we propose a subjectivity alignment approach by adopting virtual reality tools with the information available in human users' five senses. To do so, the agent of each user maps the subjective terms in its user's vocabulary onto objective sensory data in the form of fuzzy membership functions and shares these learned metrics with the agents of other users. Thus, for each buyer, collected feedback towards a target seller can be aligned according to his own subjectivity, and then the aligned feedback is used to compute the reputation value of the target seller.

2 Approach

Specifically, in our approach, each user in virtual marketplaces is assisted by a software agent and equipped with virtual reality simulators. A *concept learner engine* module is attached to the agent, by which it can well learn the semantics of its user's subjective terms in a shared vocabulary [2]. The agent learns the semantics of these subjective terms over time by exploiting the correlation between the subjective product evaluation provided by its user and the sensory data, simulated by virtual reality tools (*e.g.*, haptic tools) for products avatars. The semantic metrics are specified in the form of fuzzy membership functions and shared with the agents of other users. Thus, the feedback communicated among agents are composed of only objective semantic metrics. This allows the agent to clearly interpret the subjective feedback provided by other users and transform it into its own user's subjective terms (*i.e.*, perceptions). Based on the aligned feedback, the agent automatically evaluates the satisfactory degrees of past transactions conducted by other users according to its user's preference. In summary, through the subjectivity alignment approach, buyers can more accurately model sellers' reputation. In the next sections, we will describe our subjectivity alignment approach in more details and explain how we can use the aligned results to compute reputation of sellers.

2.1 Subjectivity Alignment

The agent of a user is responsible for modeling semantics of the subjective terms in its user's vocabulary. Here, using virtual reality simulators, the subjective terms of buyers are learned and mapped onto corresponding values of objective sensory data that are numeric in our system. Note that, the learning is an iterative process that requires sufficient interactions data between the agent and its user in order to obtain relatively precise mapping metrics. A basic learning unit is as follows, the agent provides a sensory stimuli to its user, and the user percepts the stimuli and provides to the agent a corresponding subjective term (*e.g.*, too soft) that best presents his perception in his vocabulary to the agent. Besides, the learning is also a continuous procedure because the perception of a user may change over time. For example, a user may become less sensitive to *tactile stimulus* as he gets older. Thus, the learned metrics should be updated every time after a certain time interval. Furthermore, in reality, it is common that human users cannot present their perceptions consistently towards some values of objective sensory data. That is, more than two different subjective terms may be provided by the same user as he has some fuzzy sensory zones. Hence, to more precisely specify the mapping metrics, we introduce the *trapezoidal membership function* with pseudo partitioning, ranging in the unit interval $[0, 1]$, to represent the degree of truth for the subjective terms. Here, 1 indicates the full membership of a given subjective term, referring that a user is completely confident about his perception. If the degree of truth $\rho \in (0, 1)$, it means that the user might sometimes describe his perception using this subjective term, and at other times use other terms in his vocabulary due to the perception sensitivity. After learning semantic metrics, each agent can align other users' feedback according to its own user's subjectivity. For example, both user A and user B use two subjective terms, *i.e.*, "inadequately soft" and "adequately soft", to describe their touching experience. When user A provides a feedback of "adequately soft", the agent of user B should firstly collects the user A's semantic metric of "adequately soft", S_1. Then, it computes the similarity value between S_1 with user B's two semantic metrics respectively. The subjective term with higher similarity value is considered to be B's perception according to user A's feedback of "adequately soft". Thus, the feedback from user A is aligned according to B's own subjectivity.

2.2 Reputation Computation

The main flow for the buyer B's actions to compute the reputation value of the seller S is illustrated as the following four steps: 1) The agent of the buyer B requests and collects a set of feedback about the seller S, where subjective terms are translated to objective semantic metrics represented as fuzzy membership functions; 2) Semantic metrics in the collected feedback are transformed into B's own semantic metrics; 3) Based on B's own preferences for different attributes and the aligned feedback of each past transaction, degrees of satisfaction are computed for the transactions; 4) The reputation of seller S is computed as the average degree of satisfaction.

3 Conclusion

This paper proposes a novel approach to align subjective feedback for reputation computation. It takes advantages of various virtual reality simulators in human users' five sense. We demonstrate how sensory data in virtual reality can be exploited in virtual marketplaces to handle subjectivity in user feedback and how the aligned feedback can be used in seller reputation computation. More specifically, the agent of each user is responsible for learning the subjective terms in its user's vocabulary, by mapping each subjective term into corresponding objective semantic metric. The semantic metrics are specified in the form of the trapezoidal membership function. This work represents an important initial step for constructing trust and reputation mechanism in virtual marketplaces. For future work, we will conduct experiments to validate that the subjectivity alignment approach can greatly improve the efficiency and robustness of existing trust and reputation mechanisms.

4 Acknowledgement

This work has been made possible thank to the Institute for Media Innovation at Nanyang Technological University who has given a scholarship to the first author.

References

1. A. Bogdanovych, H. Berger, S. Simoff, and C. Sierra. Narrowing the gap between humans and agents in e-commerce: 3d electronic institutions. In *Proceedings of the 6th International Conference on Electronic Commerce and Web Technologies (EC-Web)*, pages 128–137, 2005.
2. M. Şensoy, J. Zhang, P. Yolum, and R. Cohen. Poyraz: Context-aware service selection under deception. *Computational Intelligence*, 25(4):335–366, 2009.
3. H. Fang, J. Zhang, M. Şensoy, and N. M. Thalmann. Design of a reputation mechanism for virtual reality: A case for e-commerce. In *Proceedings of AAMAS Workshop on Trust in Agent Societies*, 2011.
4. M. Luca, B. Knorlein, M. O. Ernst, and M. Harders. Effects of visual-haptic asynchronies and loading-unloading movements on compliance perception. *Brain Research Bulletin*, in print, 2010.