Understanding Customers: Purchase Behaviors in Ubiquitous Market

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***Abstract*— Shopping is a typical daily activity to be supported by Networked Robotic Services. In a retail shop, networked robots will be able to support both customers and the shop by recommendation service if they can understand the customers' interest from the observed purchase behaviors. We have constructed an experiment environment called 'Ubiquitous Market' as an instance of ubiquitous networked robot system. Two types of customers' behaviors have been extracted. One distinguishes whether a customer purchases an item on a shelf or not from the local trajectories in front of the shelf. Another estimates whether a customer visits a shelf or not from the sequences of stop-by points and then recommends items.**

Researches on network robot systems (NRS)[1] have focused on cooperation among service robots which overcomes the limitations of stand-alone robots by having robots, environment sensors, and humans communicate and cooperate through a network. Aiming at the development of life support robots that coexist with people in human living environments, many types of robots will deployed to multiple locations with ubiquitous network technology as a social infrastructure. In the project, the common functionalities are implemented as Ubiquitous Network Robot (UNR) Platform[2].

Consider an interactive system installed in a real-world shopping mall where visible robots recommend items to the customers. The system plays three roles as interaction technology: as a ubiquitous environment that understands events occurring in the real world, as a recommendation system that chooses information to be presented to the customers, and as a persuasion system in which the robots persuade the customers. Ubiquitous Market is such an environment equipped with UNR technologies that understands customers' purchase behaviors and supports their daily shopping activities in brick-and-mortar shops.

When a customer intend to purchase several items from retail shops, a sequence of activities occurs on both the customer and shop agents. The customers' behaviors are observed by networked sensors that sometimes called as "ambient intelligence." Such behaviors should be symbolized to describe shopping support services. Kanda[3] extracted "spatial primitives" and "behavioral primitives" as structured environmental information. Knowledge from marketing science and consumer psychology also provides baseline for this symbol-grounding problem. The structure of environment should be defined and understood by integrating such kind of human behaviors. The customer has to understand what he or she wants to purchase, compare corresponding items, decide whether to buy or not, and then pick it up. Shop agents have to estimate items of the customer's interests and the certainty of purchase, and then provide appropriate information. Our approach focused on the trajectories of customers observed by a set of laser range finders in retail shop environment and extracted two types of customers' behaviors.

One distinguishes whether a customer purchases an item on a shelf or not from the local trajectories in front of the shelf. Though previous works estimated the degree of a customer's interest from duration of a stop, we focused on four characteristics for each segment of local movement: such as variance of vertical distance from the shelf, minimum of the vertical distance, total distance of horizontal movement, and total angle of direction changes. The proposed method distinguishes customers who purchase items even when their stop durations were not so long. Another estimates whether a customer visits a shelf or not from the sequences of stop-by points and then recommends items from robots on the shelf [4]. Another estimates whether a customer visits a shelf or not from the sequences of stop-by points and then recommends items from robots on the shelf. The proposed method estimates a shelf that a customer possibly visits after observing more than three stop-by locations. In our experiment, the precision of the estimation was 0.48 as a baseline. Compared to this baseline, recommendation from robots made the customers' move to the estimated spot with 0.76 of probability.

In this work, we focused on two methods for recognizing customers' purchasing behaviors observed with UNR environment. In the experiments, required knowledge about items and their categories were limited so that we could organize them by ourselves. To extend the scale of the shopping experiments, the UNR Platform should provide means to obtain such knowledge from the Web as proposed in Web-enabled Robot [5].

*This work was in part supported by the Japanese Ministry of Internal Affairs and Communications.

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References

[1] A. Sanfeliu et al., "Network robot systems," Robotics and Autonomous Systems, vol. 56, 2008, pp. 793-797.
[2] K. Kamei et al., "Cloud Networked Robotics," IEEE Network Magazine, vol.26, May 2012, to be published.
[3] T. Kanda et al., "A Communication Robot in a Shopping Mall," IEEE Trans. on Robotics, vol. 26, 2010, pp.897-913.
[4] H. Kidokoro et al., "You stopped by there? I recommend this: changing customer behaviors with robots," Proc. 13th Intl. Conf. Ubiquitous Computing (UbiComp2011), Beijing, 2011, pp. 569-570.
[5] M. Tenorth et al. "Web-enabled Robot," IEEE Robotics and Automation Magazine, vol. 18, Jun. 2011, pp. 58–68.