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A Survey on Agent-mediated Electronic Commerce

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Abstract

Software agent technology is still an emerging technology. Software agents have just started to be used in the electronic commerce domain, and they are already beginning to create a series of new possibilities for this arena. Agents can be used to automate, as well as to enhance many stages of the traditional consumer-buying behavior process. Software agents help automate a variety of tasks including those involved in buying and selling products over the Internet.

KEY WORDS: agent technology, electronic commerce, software agents.

1. Introduction

Software agent technology is starting to create a series of new possibilities for the area of electronic commerce [Bradshaw 1997]. Agents can be used to automate, and enhance many stages of the traditional consumer-buying behavior process. Through the minimization of transaction costs, elimination of geographic barriers and time issues, many new markets, not viable before, are now being created, traditional markets are becoming more efficient, and the role of the middleman has been changing drastically [Guttman 1997].

Software agents are programs to which one can delegate a task. They differ from “traditional” software in that they are personalized, continuously running and semi-autonomous. These qualities make agents useful for a wide variety of information and process management tasks. These same qualities are particularly useful for the information-rich and process-rich environment of electronic commerce.

Electronic commerce covers a broad range of issues including security, trust, reputation, law, payment mechanisms, advertising, ontology, on-line catalogs, multimedia shopping experiences, automate supply chain management and back-office tasks. Agent technologies can be applied to any of these areas where a personalized, continuously running, semi-autonomous behavior is desirable. However, certain characteristics will determine to what extent agent technologies are appropriate.

Electronic commerce poses a diverse array of challenges and opportunities for agent systems. From a Consumer Buying Behavior perspective, agents play roles in three primary stages: ***Product Brokering, Merchant Brokering, and Negotiation*** corresponding to *what* to buy, *who* to buy it from, and *how* to determine the terms of the transaction respectively. It is in these roles that agent system designers have the challenge to accurately identify and the opportunity to prescribe innovative ways of doing business.

Software agents will play an increasing variety of roles as mediators in electronic commerce. Software agents are related to electronic commerce in three main forms: *business-to-business, business-to-consumer, and consumer-to-consumer transactions.*

2. Software Agents

A software agent is neither a new concept nor a well-defined one. Although not clearly defined, agents have been used for quite some time in many different fields of computer science, and depending on the field of study, its definition may vary.

An agent is defined as a piece of software (not dependent on its implementation language) used to automate specific tasks [Bradshaw 1997]. This piece of software also needs to be proactive, to be capable of personalization, and to have a certain level of autonomy. Other features, such as mobility and collaboration, might be desirable for some applications, but are not considered as prerequisites.

The properties of software agents like Personalization, Proactive, Mobility, Autonomous, Intelligent and Interactive etc., provide a common ground for understanding what agents are like, and how they can automate a series of tasks, such as those for searching/filtering, buying and selling products over the Internet. However, there are some other factors that make them a compelling concept, especially for the electronic commerce domain:

- **Information overload:** Too much information available is not useful for making decisions if this information cannot be filtered on time.
- **Information ignorance:** Useful information relevant for making decisions is quite often not used, because the decision-maker is unaware of them.
- **Closer to perfect market:** In the digital world, transactions can occur independently of the physical location of the participating parties.

3. Agent Mediated Electronic Commerce

Agents have the distinguishing ability to automate repetitive and time-consuming tasks, including searching, buying and selling products over the Internet. Most of the tasks involved in the consumer buying behavior process can be automated. Stages, such as identification of needs, product brokering, merchant brokering, and negotiation, can now be assisted or automated by many different agent-based systems.

The two general goals of electronic commerce are *Interoperation* and *Automation*. In many cases, there is a dependency of automation upon interoperation. For example, in order to help automate the management of supply chains, there needs to be a semantically interoperable language and protocol for coordinating the parties involved. Unfortunately, there is currently a lack of common languages and ontology for electronic commerce interoperation.

Merchants are currently struggling to explore new channels to negotiate their products, looking for opportunities to maximize their profits and, at the same time, to satisfy consumers. However, most of the electronic commerce stores available on the web today still take the form of static “catalogs” of products, in which customers select items manually, and purchase them online. It is expected that software agents will turn existing markets into more efficient ones, and will change the role of the middleman, and make many small niche markets viable.

4. Consumer Buying Behavior Model

There are several descriptive theories and models that attempt to capture consumer buying behavior, for example, the Nicosia model, the Howard-Sheth model, the Engel-Blackwell model, the Bettman information-processing model, and the Andreasen model. Although different, these models all share a similar list of six fundamental stages guiding consumer-buying behavior. These six stages also indicate where agent technologies apply to the consumer shopping experience and allow for categorizing existing agent-mediated electronic commerce systems.

- ***Need Identification:*** This stage characterizes the consumer becoming aware of some unmet need. Within this stage, the consumer can be stimulated through product information.
- ***Product Brokering:*** This stage comprises the retrieval of information to help determine *what* to buy. The result of this stage is called the “consideration set” of products.
- ***Merchant Brokering:*** This stage combines the “consideration set” from the previous stage with merchant-specific information to help determine *who* to buy from.
- ***Negotiation:*** This stage is about *how* to determine the terms of the transaction. Negotiation varies in duration and complexity depending on the market.
- ***Purchase and Delivery:*** The purchase and delivery of a product can either signal the termination of the negotiation stage or occur sometime afterwards.
- ***Service and Evaluation:*** This post-purchase stage involves product service, customer service, and an evaluation of the satisfaction of the overall buying experience and decision.

From this Consumer Buying Behavior perspective, we can identify the roles for agents as mediators in electronic commerce. The distinguishing properties of the agents make them well suited for mediating consumer behaviors involving information filtering and retrieval, personalized evaluations, complex coordination, and time-based interactions. Specifically, these roles correspond to the Product Brokering, Merchant Brokering, and Negotiation stages of the Consumer Buying Behavior model.

4.1 Product Brokering

The *Product Brokering* stage is where consumers determine *what* to buy. This occurs after a need has been identified and is achieved through a critical evaluation of retrieved product information. *PersonaLogic*, *Firefly*, and *Tete-a-Tete* are some of the examples of the product brokering tools that help the consumers to find the required products.

4.2 Merchant Brokering

Whereas the Product Brokering stage compares product alternatives, the *Merchant Brokering* stage compares merchant alternatives. *Andersen Consulting's BargainFinder* was the first shopping agent for on-line price comparisons. *Jango* and *MIT Media Lab's Kasbah* is other examples.

4.3 Negotiation

The *Negotiation* stage is where the price or other terms of the transaction are determined. Examples of where we see negotiation used in commerce include stock markets (e.g., NYSE and NASDAQ), fine art auction houses (e.g., Sotheby's and Christie's), flower auctions (e.g., Aalsmeer, Holland), and various ad-hoc haggling (e.g., automobile dealerships and commission-based electronics stores).

5. Agent Technologies for Electronic Commerce

Most of the technologies supporting today's agent mediated electronic commerce systems stem from Artificial Intelligence (AI) research. AI technologies will continue to provide software agents with increased know-how to successfully mediate electronic commerce transactions. This section reviews several AI technologies that support agent-based systems.

5.1 Recommender Systems

The majority of product recommender systems are developed using content-based, collaborative-based or constraint-based filtering methods as their underlying technology.

- The *content-based filtering* system processes information from various sources and tries to extract useful features and elements about its content. The techniques used in content-based filtering can vary greatly in complexity.
- The *collaborative-based filtering* techniques use feedback and ratings from different consumers to filter out irrelevant information. These systems do not attempt to analyze or understand the features or the descriptions of the products.
- The *constraint-based filtering* uses features of items to determine their relevance. However, unlike most feature-based techniques which access data in their native formats, constraint based techniques require that the problem and solution space be formulated in terms of variables, domains, and constraints.

5.2 User Interface Approaches

The user interface, that most systems offer today, is an "Electronic Catalog" that resembles an enhanced price list with search capabilities. Unfortunately, these searchable lists still make it hard for consumers to associate a product with their specific needs and afford less engaging shopping experiences than their physical-store counterparts. Matching the system user interface with the consumer's manner of shopping will likely result in greater customer satisfaction.

The issue of trust is very important in any agent system, especially when money is involved. A crucial issue in developing trust in agent systems is the ability of an agent to exhibit somewhat predictable behavior and to provide an explanation for its actions. It is safe to assert that, as with any software system, agents that mediate electronic commerce transactions can greatly benefit from well-designed and well-tested user interfaces.

5.3 Negotiation Mechanisms

Negotiation is a form of decision-making where two or more parties jointly search a space of possible solutions with the goal of reaching a consensus. Economics and game theory describe such interactions in terms of *protocols* and *strategies*.

The *protocols* of a negotiation comprise the rules of the game. An example of a simple negotiation protocol is the Dutch auction where the only legal bidding action is an open outcry of “mines!” as auctioneer decrements the price of the good. For a given protocol, a bidder uses a rational *strategy* (i.e., a plan of action) to maximize the utility. Decision analyses tools help identify optimal strategies given a bidder’s preferences and knowledge (e.g., motivation, valuation, risk, information asymmetry, etc.).

The research area that merges negotiation with software agents is the broad field of Multi-Agent Systems that finds its roots in Distributed Artificial Intelligence (DAI). Early DAI work modeled negotiation as Distributed Problem Solving and assumed a high degree of *cooperation* among agents in order to jointly achieve a common goal. Much of the work in agent-mediated negotiations can be traced back to the *Contract Net*.

5.4 Infrastructure, Languages and Protocols

Related agent-based languages and protocols include KIF (Knowledge Interchange Format), KQML (Knowledge Query Manipulation Language), and Ontolingua, an ontology sharing protocol. For business-to-business electronic commerce, the dominant protocol is EDI (Electronic Data Interchange).

In addition to document and protocol standards, there is a need for electronic commerce component standards for objects and agents. There are several competing technologies in this space. Requirements for open, heterogeneous component-based commerce systems include backward-compatibility to legacy systems, fault-tolerance, efficient performance, extensibility, scalability, security, some concurrency control, and some registry mechanisms to tie all of the pieces together.

6. Conclusion

Today the first generation agent-mediated electronic commerce has already begun to reduce the transaction costs in a variety of business tasks and also contributing for the creation of new markets. However, there is a long way to go before software agents transform how businesses conduct businesses. This change will occur as Software Agent technologies mature to better manage various requirements. The greatest changes may occur, however, once standards are adopted and evolved for agent-based system modeling and designing.

Agent-mediated electronic commerce should focus more towards enhancing customer satisfaction and streamline business-to-business transactions, reducing transaction costs at every stage of the supply chain. The agent-based system should be able to create dynamic business partnerships that exist only as long as necessary.

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