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An Intelligent Information Management Environment for Mobile Commerce

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Abstract

This work proposes an intelligent information management environment for mobile commerce. The environment contains four modules, namely, interface manager, information repository, information analyzer, and information collector. The interface manager provides an intelligent interface for generating and collecting business information from the mobile device. The information repository contains the user-specific information and the meta-information of information sources. The information analyzer performs the tasks of user behavior analysis, quality of information service measurement, information repository management, cost evaluation, anytime information supporting, and information filtering. Finally, the information collector dispatches different information agents for collecting business information from different information sources.

1. Introduction

Mobile commerce (MC) provides the user best mediation to complete business activity and to receive valued-aided services through the wireless communication network [1][6][11]. The user can use mobile devices, such as, mobile phone, pocket personal computer, or personal digit assistant for obtaining services or merchandises. The service provider of MC tries to provide numerous functions to satisfy different requirements. However, they have not met the service requests since they still have some problems need to be solved. First, the portable and small display screen of the mobile device is not easily to display the transaction information clearly. It is not suitable for the small screen by using the dense hyperlinks in transaction process. Moreover, the limited processing capability of the mobile devices also obstructs the business information display. Second, the service providers of MC did not provide sufficient supporting information for the user to complete the business process. For example, they did not consider the communication cost and service charge of the user transaction [3]. Third, the service provider of MC did not use the user profiles for helping the business process. For example, they did not consider the geographical location and business behavior of the users [11]. Fourth, the service providers of MC did not personalize the transaction information based on the user interest. The large number of business information may increase the overloading of the user as well as the processing capability of the mobile devices. Finally, the specific specifications of the mobile devices, the different system interface of the operation environment, and the different transmission protocol of the communication networks may also limit the information usability of the user.

This work proposes an intelligent information management environment for mobile commerce. The environment contains four modules, namely, interface manager, information repository, information analyzer, and information collector. The interface manager provides an intelligent interface for generating and collecting business information from the mobile device. It uses the mobile commerce markup language (MCML) for displaying the business information. The MCML provides the meta description script to support the information manager to optimize the appearance of the business information in different mobile devices and operation platforms. Moreover, the interface manager collects the transaction behavior logs of the users in the business process. The information repository contains two models, that is, the user model and information source model. The user model manages the user-specific information, such as, user behavior, user interest, and transaction history. The information source model records the response time, information quality, and up-to-date data of the information source. The information analyzer is the main component of the system to analyze the user behavior from the transaction behavior logs, measure the quality of information service, manage the information repository, evaluate the communication cost, support anytime information, and filters information based on the irrelevant and valueless information based on the interest and geographical location of the user.. Finally, the information collector dispatches different information agents for collecting business information from different information sources.

2. System Architecture

The environment contains four modules, namely, interface manager, information repository, information analyzer, and information collector (Fig. 1). The interface manager provides an intelligent interface for generating and collecting business information from the mobile device. It uses the MCML for displaying the business information. The MCML provides the meta description script to support the information manager to

optimize the appearance of the business information in different mobile devices and operation platforms. Moreover, the interface manager collects the transaction behavior logs of the users in the business process.

The information repository contains two models, that is, the user model and information source model. The user model manages the user-specific information, such as, user behavior, user interest, and transaction history. The information source model records the response time, information quality, and up-to-date data of the information source.

The information analyzer is the main component of the system to analyze the user behavior from the transaction behavior logs, measure the quality of information service, manage the information repository, evaluate the communication cost, support anytime information, and filter information based on the irrelevant and valueless information based on the interest and geographical location of the user.

Finally, the information collector dispatches different information agents for collecting business information from different information sources.

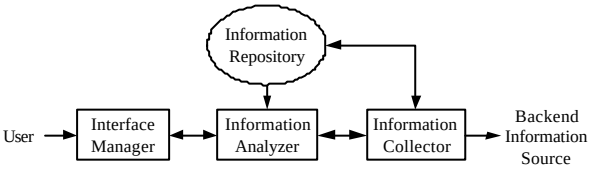

Fig. 1 System architecture

3. Interface Manager

The interface manager provides an intelligent interface for generating and collecting business information from the mobile device. Specifically, the interface manager uses a MCML for displaying the business information. The MCML is an information description language, which extends the Compact HTML (CHTML) [12] for mobile commerce. The MCML provides the meta description script to support the information manager to optimize the appearance of the business information in different mobile devices and operation platforms. Moreover, the MCML integrates the extensible markup language (XML) [13] and cascading style sheets (CSS) mobile profile [14] into the CHTML for enhancing the information display capability in small information appliance.

Furthermore, the interface manager collects the user transaction behaviors into transaction behavior logs. It collects the interaction message from the client and server-side. Each interaction message contains information regarding the interaction events and the message of interaction protocol. The interface manager uses the MCML and server logs to capture the user behaviors. The information analyzer then extracts the user information from the transaction information.

4. Information Repository

The information repository contains two models, that is, the user model and information source model. The user model manages the user-specific information, such as, user behavior, user interest, and transaction history. The user behavior records the transaction steps of the user for completing the business process. It uses the behavior network to represent the behaviors correlation of the user. Fig. 2 illustrates the topology of the behavior network. The square box is used to represent the business task, such as, bowering, searching, buying, and payment. The circular node is used to represent the name and frequency of the behavior with the interaction item. Moreover, the decorated link is used to represent the successive relations between behaviors and their frequency. The behavior network was updated after the user completed the business process. Notably, the behaviors use fuzzy relationship to represent the degree of relations. Fig. 3 and Table 1 exemplify the relations between transaction behaviors. The user interest records the favorite products and brand taste of the user. The transaction history records the user transaction information in mobile commerce. It uses cases to store the transaction history. Each case contains instances of the transaction time, geographical location, and product category.

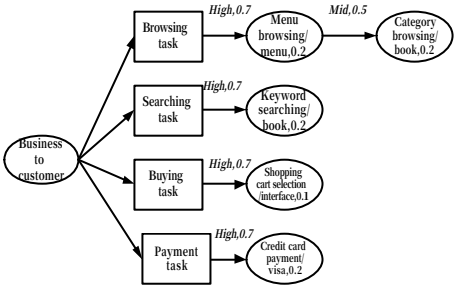

Fig. 2 Behavior network

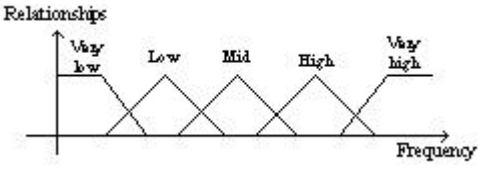

Fig. 3 Fuzzy partition of behavior relationship

Table 1 Example behavior relationships

Relationship	Menu browsing	Product browsing	Product selection	Shopping cart selection
Menu browsing		High, 0.7	Mid, 0.5	Very low, 0.1
Product browsing			High, 0.7	Low, 0.3
Product selection				High, 0.7

The information source model contains the service characteristics and quality of service information of the information source. The information source model records the response time, information quality, and up-to-date data of the information source. This information can support the information analyzer for providing the anytime service.

5. Information Analyzer

The information analyzer performs six tasks, including user behavior analysis, quality of information service measurement, information repository management, cost evaluation, anytime information supporting, and information filtering. The user behavior analysis uses the induction-based technique for mining the behavior relationships. It uses support vector machine [4] and k-means [2] to classify the user transaction behavior logs into different classes. It then uses the induction method [10] to find the behavior relationship of each class. The information analyzer uses the fuzzy behavior proximity (FBP) to update the behavior network of the user model.

$$FBP_{i,j}(k+1) = FBP_{i,j}(k) + a(\|A_{i,j}(k+1)\| - \|A_{i,j}(k)\|) \quad (1)$$

where i and j is the ith and jth behavior and i is the precedence of j, k is the kth business task, a is the learning rate, and ||Ai,j|| is the frequency of the behavior j follow the behavior i. Moreover, the user behavior analysis also analyzes the interests and brand taste of the user based on the transaction information [9]. The interests record the domain habits, that is, the visited or used terminology, of the user. The term frequency, T, is used to calculate the frequency of the terminology.

$$T=T_i/n \quad (2)$$

where T_i represents the occurrence of the terminology i and n is the terminology number. Additionally, brand taste records the brands that are frequently occurrence in the transaction behavior. The brand test, B, is used to compute the frequency of the operations.

$$B=B_i/n \quad (3)$$

where B_i represents the occurrence of the brand i and n is the brand number of the transaction behavior.

The quality of information service (QoIS) measurement computes the quality of service in the network and information services. The network service measures the response time, connectivity, and reliability of the information source. The information service evaluates the availability, timeless, accuracy, and consistency of the business data.

The information repository management records the user behavior relationship, user interest and taste, and quality of service information into the user model and information source model in the information repository correspondingly. The information repository management records the up-to-date information of each information source for providing the anytime service. Moreover, the information analyzer also update the information repository based on the analyzed user behaviors. The information analyzer then manages the transaction history of the users by case-based reasoning [8]. Fig. 4 illustrates the architecture of the case-based reasoning. The architecture contains three main modules, namely, the case library, case selector, and case evaluator. Basically, the case library contains instances of the transaction time, geographical location, and product category. The case library organizes the cases in the flat structure. Each case represents the data in the feature-value pair. The case selector selects the similar cases from the case library according to the transaction information. Moreover, the case evaluator compares the difference between the similar cases and transaction information. The case evaluator also abstracts the similar cases into prototype. Finally, the case evaluator then updates the case library by replace the similar cases into the prototype case.

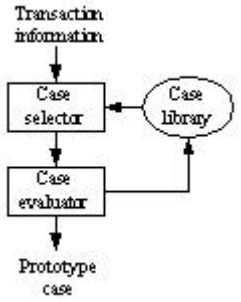

Fig. 4 Case-based reasoning

The cost evaluation predicts the transaction cost for the user by measuring the communication cost and service charge in the mobile commerce. It uses the information source model to predict the completion time of the business transaction from the service provider. It then computes the communication cost and service charge based on the QoIS measurement. This information may advise the user by considering cost and benefit before the transaction. The anytime information supporting also uses the QoIS measurement for providing the anytime information service for the user. The information source model may provide the anytime information when the QoIS was not good enough or the transaction data was time-invariant. The information filtering provides the personalized and location-based transaction information for the user. The information filtering filters out irrelevant and valueless information based on the interest and geographical location of the user. The information filtering then rearranges the information based on the user preference. These decorated transaction information were sent to the interface manager for displaying.

6. Information Analyzer

The information collector dispatches different information agents for collecting business information from different information sources, heterogeneous databank, or Internet-based information sources. The information agents were generated from the agent pattern

library that contains different agent components to do different tasks. The information collector instantiates and composites these patterns to construct different information agents. It retrieves, filters, synthesizes, and sends the most reliable data that the agent collected so far to the data analyzer. Fig. 5 shows the pattern of Connect_data_server in the pattern library.

```
Pattern name: Connect_data_server
Pattern task: Data server connection
Receiving: Data server location, database type
Production: Connection status
Context: N/A
Executor:
import java.rmi.*;
import java.sql.util.Vector;
public interface Connect_data_server extends Remote
{ void accept(Agent agent) throws RemoteException;
   Vector Connect() throws RemoteException,
      SQLException;
   }
public interface Agent extends jav.io.Serializable
{ void run();
   }
```

Fig. 5 The Connect_data_server pattern

The information collector also dispatches the information agents to get the service information from the service brokers in web service environment [5][7]. The information agent collects the functionality and value-added service information of the information sources from the brokerages. Finally, the information collector collects and synthesizes the business information to the information analyzer.

7. Conclusions

This work proposes an intelligent information management environment for mobile commerce. The environment contains four modules, namely, interface manager, information repository, information analyzer, and information collector. The interface manager provides an intelligent interface for generating and collecting business information from the mobile device. It uses the MCML for displaying the business information. The MCML provides the meta description script to support the information manager to optimize the appearance of the business information in different mobile devices and operation platforms. Moreover, the interface manager collects the transaction behavior logs of the users in the business process. The information repository contains two models, that is, the user model and information source model. The user model manages the user-specific information, such as, user behavior, user interest, and transaction history. The information source model records the response time, information quality, and up-to-date data of the information source. The information analyzer is the main component of the system to analyze the user behavior from the transaction behavior logs, measure the quality of information service, manage the information repository, evaluate the communication cost, support anytime information, and filters information based on the irrelevant and valueless information based on the interest and geographical location of the user.. Finally, the information collector dispatches different information agents for collecting business information from different information sources.

In summary, the proposed intelligent information management environment exhibits the following interesting features. First, the proposed system has an intelligent interface that supports different mobile devices to display the business information. Moreover, the MCML provides the XML-based meta description script with device-independent information for different mobile devices. Second, the information analyzer uses the user model to personalize the transaction information and to analyze the user behavior. Notably, the task of user behavior analysis and user model management was supported by the support vector machine and k-means. Third, the information analyzer uses the information source model for providing the cost evaluation and anytime supporting. The network and information service evaluation was supported by invoking the information quality measurement. The information analyzer manages the information source model by computing the QoIS and recording the up-to-date data of the information source. Finally, the information agent was dispatched to collect the transaction data within business process. These agents were cooperated with each other to collect data from diverse databank and Internet-based information sources by using the agent communication languages (ACL). Moreover, the information agent can also be dispatched to collect information from the web-service-based environment.

Acknowledgement

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