

Personalized Advertising Recommend Mechanism for the Mobile User

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Abstract: Due to the internationalization of the domestic business environment nowadays, competitions that every company has to survive have come not merely from the challenges of other local companies but from everywhere around the world. In order to support high quality service to contribute the most to business interest so that companies can stay highly competitive, optimized, standardized and flexible advertising recommend mechanism must be developed. With a view to exploring how to digitally turn the customer transaction information into real value for business organizations, in this study, we shall focus on the establishment of mobile advertising recommend mechanism. In this paper, we propose a two level personalized mobile advertising recommend mechanism. The method of Genetic Algorithm (GA) is used at first and then the method of Back Propagation Network (BPN) is used to extract the customer characteristic information and increase the accuracy in the learning rate. To start with using e-ticket shopping that it raises security while add cryptography, then employ mobile agent will collect and merge the information of e-ticket transaction records and personal local site. On these grounds, the proposed model can reduce the cost of manpower, promote the service quality and performance and offer automatically proper solution to increase the customer satisfaction.

Key words: Wireless communication, wireless hand-held device, mobile advertising, genetic algorithm, back propagation network, customer relationship management

INTRODUCTION

For upcoming globalization, the enterprises not only have to face the local competitions but also have to compete with enterprises from all over the world. How to keep the customers in such a competing environment has been a goal of every enterprise. In today's world full of knowledge industries, more and more people are inclined to depend on the technologies that combine the Internet and mobile communication tools. The customers can obtain their desired products' information on an instant over wireless network. Because they can obtain the information, they want very easily and quickly, they have more choices before they make the decision. This in turn leads to more intense competitions between enterprises. How to raise the customers' loyalty by making them the long-term customers has been a crucial topic in enterprises' competition.

Because of the fast advancement of technology and wireless communication in recent years, mobile communication has rapidly infiltrated in our daily lives and become a necessary communication tool, while it maintains 80% popularity, a percentage of popularity second to the TV media. While every enterprise has a limited budget, spending the least to obtain the most profound advertising effect from the highly popular

mobile communication as a medium is the best choice to make.

Generally speaking, traditional advertising models such as TV, newspaper and broadcasting always convey the information unidirectional to the public. Such information is not only of large quantity, but it is also unorganized. On the contrary, mobile advertising can be "short", "accurate" and "precise". Being "short" means a short advertising that clearly describes the products and presents a 'seeing is believing' in simple paper form to affect the customers so they may shorten the time of making decisions. Being "accurate" means a personalized mobile advertising that accurately aims at certain customers and accommodate their needs according to their order of preference and shopping habits, doing so may even cause their resonance that increases feedbacks and responses and enhance enterprises' images. Being "precise" means an appropriate mobile advertising that precisely takes place about where customers are (i.e. fixed points) even if they are at other places.

An increasing advancement of information technology and development of technology have led to an explosive-like information expansion. In this information flooding, users must enrich themselves from reading a lot of information to better competing against others; yet at the same time, they may waste their time on

some spamming junk information. Spamming junk information causes a strong dislike and may negatively affect the enterprises' images. Therefore, to provide appropriate personalized information is one of our main research goals here.

To satisfy personalize mobile advertising needs, our research proposes the following:

- (1) Users use eTickets to purchase products.
- (2) Mobile agents collect from eTickets the information about personal shopping habits and personal fixed points.
- (3) With basing Back Propagation neural Network (BPN for short) training in neural network as primary and Genetic Algorithm (GA for short) as secondary, predict the customers' preferences by their shopping characteristics to achieve potential sales.

Wireless communication devices are usually slim with less storage and lower end processors; they are not appropriate for complicated calculation, yet using eTicket enhances the efficiency and security in transaction. Mobile agents provide mobility and autonomy, they do not have to be kept always in use and thus lowering the network loads so as to increase wireless networking efficiency. Through BPN training and exact predictive capability provides users instant, personalized mobile advertising. BPN training in which genetic algorithm is taken for best overall weight to solve the problem of BPN which it fall into local minimal.

Our paper is divided into four sections. Section two is related works discussion on the technology employed. Section three explains our research methods. Section four is our conclusion.

Related works discussion: In this section, the entire process of information technology architecture used will be separately explained, including the characteristics of eTicket, process of mobile agents, genetic algorithm and back propagation neural network architectures.

Electronic ticket: eTicket: Wireless communication devices are quite different in terms of processing power than that of desktop computers. Because the size of wireless communication devices is slim and small, their internal storage and processing power are also lower, which are not appropriate for complicated calculation. On the other hand, wireless communication devices must be designed in the way to be able to generate instant response so a too complicated calculation which requires more time and resources for the transaction will drive customers away. In this case, eTicket is used as

transaction mechanism for enhancing transactional efficiency and security.

According to the research by Fujimura *et al.*^[1], eTicket is a digital certification that details the exact rights after authorization, which permits the owner to redeem. Users only need to, through the wireless communication devices, purchase eTicket as a paid receipt from the on-line eTicket Center. According to the characteristics of eTicket proposed by Patel and Crowcroft^[2,3] it is stated as the following:

- Light weight: Wireless handheld devices are simple and light weighted so their storage and processing power are lower. Therefore, the processing calculation of eTicket cannot be overcomplicated and in which the amount of data contained should be small.
- Flexible: eTicket have wide aspect of uses such as user configuration, devices and services for user requirements. For example, wireless service provider, to serve large number of mobile subscribers, has to provide the service compatible on any platforms.
- Secure: A legal eTicket seller can guarantee providing mobile subscribers eTicket and verify their validity before using for on-line shopping.
- Simple: Wireless handheld devices have simple input and output interfaces; a simple interface is necessary when dealing any transaction with clear stated buttons to minimize any wrong inputs that may be entered.

To protect the customers, transaction mechanism must be a secure mechanism. eTicket is a digitalized ticket, which makes it different from general paper ticket it is easier to duplicate. A more secure mechanism is necessary for eTicket in which it has the following security requirements:

- Prevent forgery and alteration: To verify the integrity of transactional information and protect the redemption right of legal ticket owner. In legal ticketing transactional system, only legal ticket issuers have the right to issue the tickets. Forgery is prohibitive to other units.
- Prevent reproduction and duplicate redemption: To establish a mechanism that looks for any duplicate redemption with serial number and time tag for web stores protection.
- Provide non-repudiation: To establish non-repudiation for ticket transaction and redemption so that the customers cannot deny having participated

in any transaction gone through or used ticket already. This way, both rights of the buyer and seller are protected and there is less likelihood of any conflicts.

- Ensure privacy: An anonymous mechanism is employed in transaction to ensure the privacy.

To meet various demands from different customers, eTicket must be able to be used for any type of shopping. eTicket is divided into five categories from its uses in the following^[1,2,4,5,6]:

- Plane ticket: There is personal identification information printed on the plane ticket. To transfer the information, the ticket has to be sent back to the unit that issues the plane ticket to be effective.
- Coupon: Coupons are meant to enhance the company image and popularity as well as promotion. In this case, coupons are allowed to reproduce without making any form of payment and to be used by third parties.
- Transport ticket: Users can use transport tickets for public transportation. However, there are considerations to be taken on the number of passengers and departure time; for example, train, users must therefore arrive early for confirmation to avoid insufficient number of passengers.
- Even ticket: This type of ticket is one-time use, for example, concert, ball games, circus performance... etc; it cannot be used more than once therefore it is very important to prevent such things from happening.
- Software license: Generally, there are two types of uses. One of which is users need to provide the software authorization for verification purpose before installation. The other is users must first go through the software authorization check before enabling it.

Ericsson predicts that, by 2003, the number of people who connect to the Internet through their cellular phones would be greater than those who connect through fixed networks. From what he says, wireless handheld devices are already put in wide uses of high popularity. With combining multi-function and secure eTicket payment mechanism, users are more flexible and conveniently served.

Mobile agent: Mobile agents^[7-9] are one of the widely-used agent technologies in recent years. Mobile agents are developed for two distinct characteristics, namely mobility and autonomy. Whatever tasks users assign to them, mobile agents will complete the assignments by

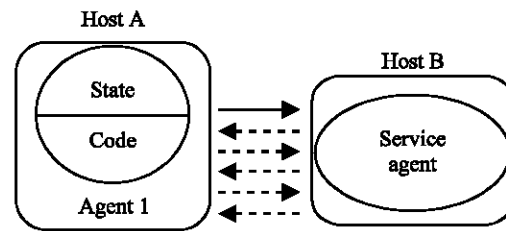


Fig. 1: The concept of client server

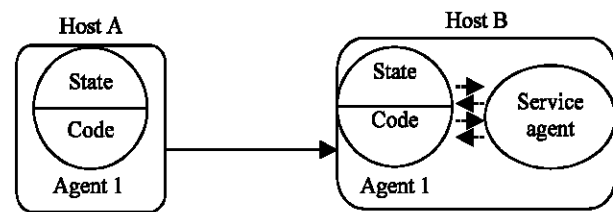


Fig. 2: The concept of mobile agent

autonomous mobility under certain rules. Users do not have to do anything after they assign the mobile agents and the mobile agents will complete the assignments and bring back to the users. That is to say, the mobile agents can effectively replace the users' tasks to improve the efficiency.

On the other hand, mobile agents break the traditional master-slave relationship; they do not have to be controlled in any way after they are assigned. In addition, it is in this way that an always-on connection is not necessary so as to reduce network loads, avoid data transfer failure, unstable connection and lags. Moreover, when mobile agents are dealing with complicated tasks, they can automatically reproduce themselves first and divide themselves for different tasks then integrate the tasks in the end; what is good about this is there are less processing time required and lower network transfer cost, different from traditional master-slave architecture that bears the drawback of single point access. Fig. 1^[10] is a Client-Server concept chart in which application programs from both ends complete the task through data transfer over the Internet. Fig. 2^[10] is a Mobile Agent concept chart in which Host A sends the task program agent to communicate with the program in Host B to complete the task, without transfer over the Internet.

Genetic algorithm (GA): Genetic algorithm was proposed by John Holland in 1975^[11], its main purpose is the following:

- (1) Explain in a scientific method the evolving process of "survival of the fittest" in nature.

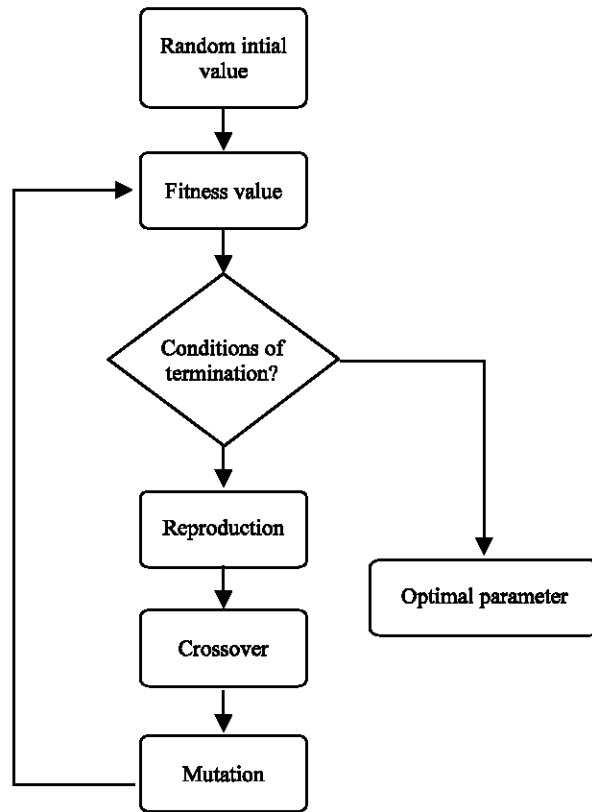


Fig. 3: The framework of genetic algorithm

- (2) Conduct a model manipulation on important genetic evolving mechanism in biological world by information science software.

Theory of the genetic algorithm is based on the evolving process of species breeding. Each species competes against each other and gets eliminated under certain situation and only the fit species survives and breeds. The fittest species is capable of bearing the next generation species through evolving process in reproduction, crossover, mutation and what not. After numerous repetitions, only the fittest survives at last^[12]. The genetic algorithm architecture (Fig. 3).

On the other hand, genetic algorithm can go by multi-dimensional and bouncing searching. Plus genetic algorithm keeps the information of evolving process but a simple searching to obtain the best entire solution instead of a best local solution. Thus, it is an effective and efficient searching method. Genetic algorithm employs the concept of biological evolution, which it only calculates the fitness function without aiming at any specified system design so it is widely used.

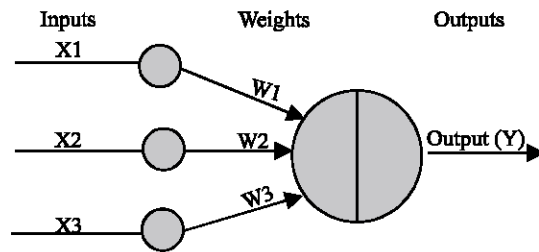


Fig. 4: Neuron structure

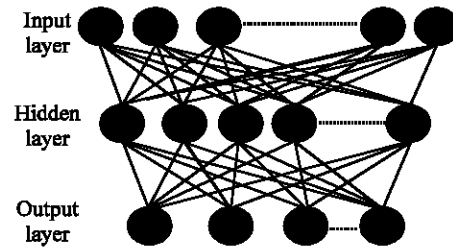


Fig. 5: Back propagation natural network

Ticket based authentication and payment model

- Mobile User V.S. Bank
 - Open an account and deposit money. A confirmation message will be sent back to the mobile user upon approval.
 - Deposit money into the account at any time.
- Step 1: Mobile user purchase the ticket from eTicket Center.
- Step 2: eTicket Center confirms with the bank if there is sufficient money in the user's account. The bank replies the related information back to eTicket Center.
- Step 4: eTicket Center sends the eTicket to the user and the related information to the web stores at the same time to prevent any forgery or duplication.
- Step 5: Mobile user can use any transaction medium from the wireless communication device and shop on-line with the eTicket.
- Step 6: Web stores will send the order to the user.
- Web Store V.S. Bank
 - Web stores send transaction information from different users back to the bank and the bank will send the money back to the shops.

Fig. 6: eTicket based authentication and payment model

Back propagation neural network (BPN): Back propagation neural network consists of numerous artificial neurons. Artificial neurons are known as neural units, artificial neurons or processing elements. Each processing element output is sent in fan-like and is therefore the input of many other processing elements. After the outside information input, every piece of information will be given different weight according to its order of importance and then calculated by summation and transfer functions before it becomes an input variable (Fig. 4).

Back propagation neural network was first proposed by Werbos in 1974, in which it was based on the learning algorithm of hidden layer. Currently, the most representative and widely used neural network learning

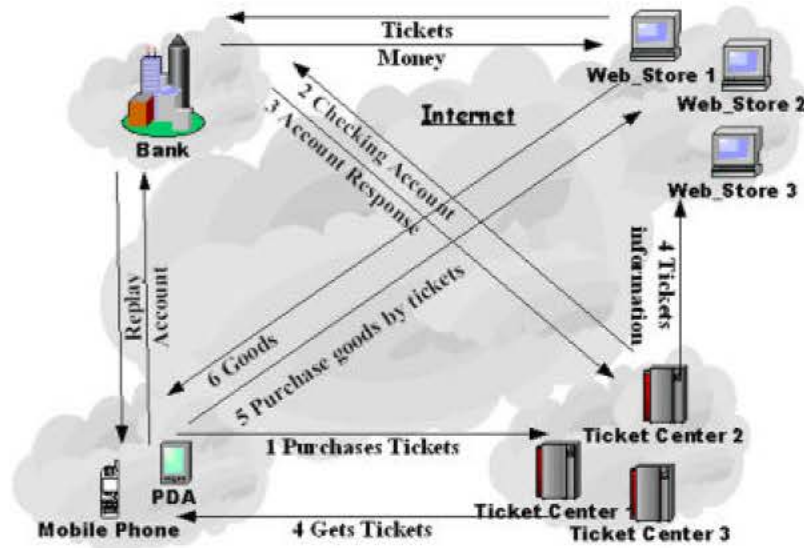


Fig. 7: The progression of eTicket based authentication and payment model

The description of eTicket structure

$eTicket = (id_T, sn, g^a, P_U, data, TS_T, Sig_T(h(id_T, sn, g^a, P_U, data, TS_T)))$

id_T : The identifier of eTicket

sn : The series number of eTicket

g^a : Public key agreement key

P_U : Public signature verification key

$data$: The transaction data

TS_T : Time stamp

Fig. 8: The description of eTicket structure

Transactional Agreement of Mobile User V.S. Bank

- Step 1: Mobile user randomly generates a m , public key agreement key g^a and Public signature verification key P_m . He continues to generate a u , temporary Public key agreement key g^u and encrypted session key $L = g^{mu}$ and the eTicket generates a Public key agreement key g^t . Then the user sends to bank the values of g^a , g^u , P_m and the encrypted id by session key L .
- Step 2: Upon receiving first message, bank randomly generates session key $L = h(g^u || r)$ formed by r and g^u and predicts $h(L || r || id_b)$ then sends to the mobile user and using hash function for further calculation to prevent from illegal alternation and forgery.
- Step 3: Upon receiving second message, mobile user will check the hash value $h(L || r || id_b)$ to confirm if the bank owns the session key L . When the number obtained from $h(L || r || id_b || number)$ is the same as the number of rear $number$, it indicates that the information is the right one without being altered in any way. ||
- Step 4: Upon receiving third message, bank will crack the session key L with $(sig_m(h(g^a || g^u || r || id_b || number)))_L$ to verify if this request is sent by the user.

Fig. 9: Transactional agreement of mobile user v.s. bank

model is back propagation neural network. This is mainly due to it has the highest learning precision. BPN^[13] can handle complicated sample identification as well as high-degree nonlinear function synthesis and is equipped with rapid response mechanism. In back propagation neural network model which is composed of many layers, every layer consists of some processing elements in which the processing elements in the input layer inputs information

Transactional Agreement of Mobile User V.S. Web Store

The eTicket is passed from Mobile User to Web Store_iG

- Step 1: Upon receiving first message, Web_Store will authenticate the eTicket and randomly generate session key $K = h(g^{aw} || r)$ formed by r and g^{aw} and predict $h(K || r || id_w)$ then send to the mobile user, so the time tag TS_w as well as $Cert_w$ as proof for the web store identity and ch_date as well as fee related information are sent also.
- Step 2: Upon receiving second message, mobile user will predict session key $K = h(g^{aw} || r)$ and check the hash value $h(K || r || id_w)$ to confirm if the web store owns the session key K .
- Step 3: Upon receiving third message, Web_Store can crack the session key L with $(sig_m(h(Ticket || K || r || id_w || ch_date || TS_w)))$ and thus verify if this request is sent by the user.

Fig. 10: Transactional agreement of mobile user v.s. web store

from the outside and the processing elements in the output layer outputs information to the outside. A layered neural network is usually made up of some hidden layers; the existence of hidden layer is to provide neural network the interaction between the elements and the ability of inter-structure (Fig. 5).

Basic concept of back propagation neural network model is to take advantage of Gradient Steepest Descent Method and to minimize the energy function (a.k.a. error function) as shown in Formula 1 where η is the learning rate and E is the energy function. With one training example for each learning, whenever one training example is entered, the network will slightly adjust the weight. In addition, each network will go through N times of training over and over again until the network learning achieves the convergence.

$$\Delta W_{ij} = \eta \cdot \frac{\partial E}{\partial W_{ij}} \quad (1)$$

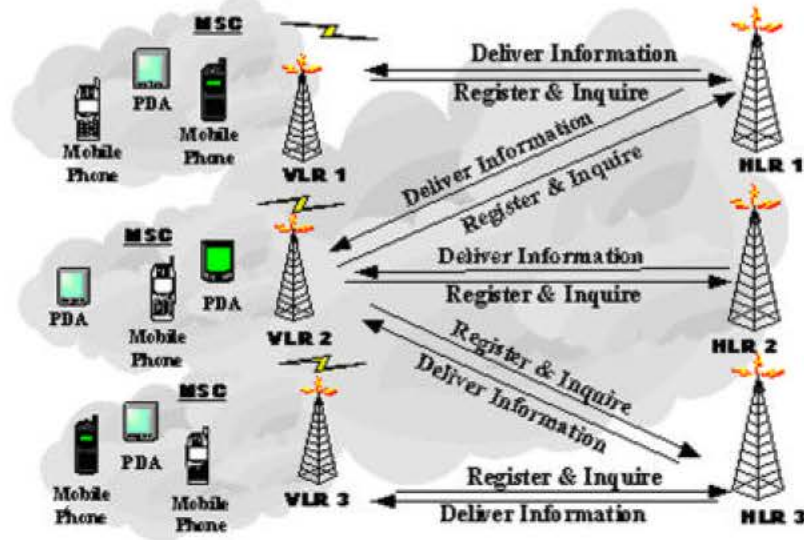


Fig. 11: The progression of wireless transmission process

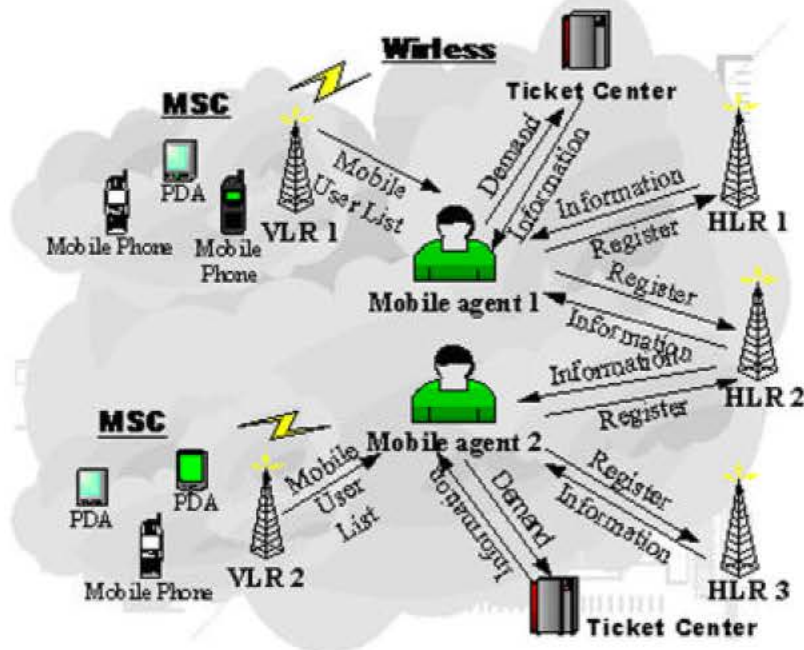


Fig. 12: The framework of wireless transmission combine mobile agent

Research methods: A full explanation on the proposed architecture will be provided in this section and this includes transaction, data collecting, data training and predicting processes.

Transaction process: eTicket is purchased through the wireless device then stored in wireless devices; it is non-physical but has book value. Because it meets the characteristics of wireless networking, it can be properly

used in wireless handheld devices for instant response requirement. Our research proposes eTicket Payment Model. The model flowchart (Fig. 6). The information transfer takes place mainly in four parties, namely eTicket Center, bank, web store and mobile user. In Fig. 7, the mobile user only need to open an account once and deposits money at any time. In other words, mobile user purchases the ticket from eTicket Center in step 1, provided that he must open an account beforehand;

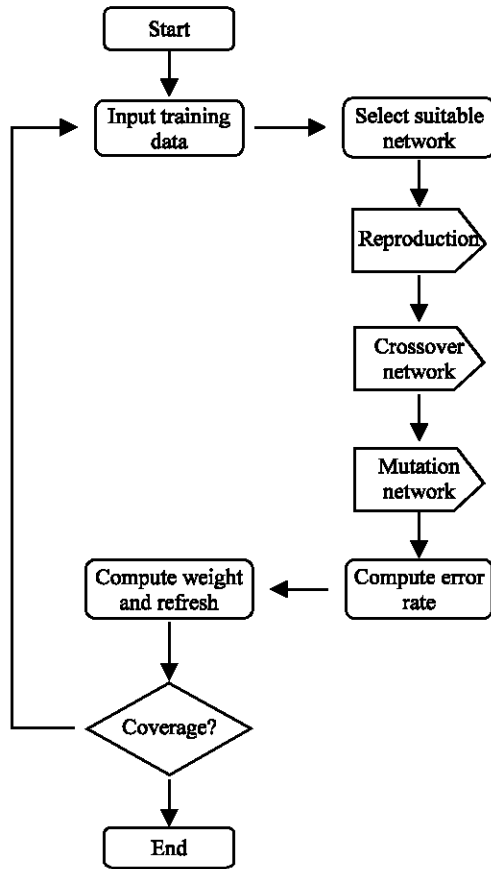


Fig. 13: Back-propagation network combine genetic algorithm framework

or else he will be turned down from purchasing the ticket in step 3.

The eTicket structure $\text{Sig}_T(h(\text{id}_T, \text{sn}, g^u, P_u, \text{data}, \text{TS}_T))$ (Fig. 8) as a proof that the eTicket is issued by eTicket Center and is valid. For example, at some specific exhibitions, their names are printed over the tickets for validity. In addition, the hash function is used to prevent the data from being illegally altered and forged. When the obtained information calculated from the hash function is the same as original information, it means the information is the right one without being altered.

In mobile transaction, there are two main sets of agreements: Mobile User V.S. Bank and Mobile User V.S. Web Store, respectively. The whole transaction of Mobile User V.S. Bank with our proposed agreement (Fig. 9). The whole transaction of Mobile User V.S. Web Store with our proposed agreement (Fig. 10).

Using eTicket can enhance the transactional security and efficiency. Collect the customers shopping habits from eTicket Center and from their order of preference use back propagation neural network to predict their

preferences then recommend the appropriate mobile advertising to the customers.

Data collecting: In wireless communication network, each domain has a specific Mobile Switching Center (MSC for short). When the user accesses the domain, Visited Location Register (VLR for short) is responsible for recording all the International Mobile Subscriber Identity (IMSI for short) within the domain and registering on Home Location Register (HLR for short). Whenever the information is sent to the user, HLR can reveal the specified domain of user whereabouts.

In wired disperse networking that has high bandwidth and efficiency, data transfer is not limited much. In wireless networking, the users move at any point and time so data access is under dynamic networking. Furthermore, the wireless bandwidth is lower and the data transfer is relatively unstable due to signal intensity and network loads. In addition, the wireless handheld device has limited battery power so it cannot be constantly connected that the data transfer may not be complete. Our research proposes that adding mobile agents between VLR and HLR to improve data transfer (Fig. 11). Mobile agents are mobile and autonomous. When the agents are assigned the tasks, they can autonomously complete the task while roaming over any nodes of Internet without being further controlled, also the reason they are used in wireless network. In our research, Fig. 12, in which the VLR provides the list of mobile subscribers in the MSC domain and every mobile agent be assigned to collect all users' location in the MSC domain, integrate the users' shopping information in eTicket Center, register the users' location on HLR and obtain the authentication information. Through a number of mobile agents, the time for data transfer are minimized, the number of transfers of disperse information are also minimized and the speed of transfer is increased that the overall performance is improved.

If users want to look up information over wireless network, they have to first find all the possible information and screen which requires more time. In addition, the amount of data over the Internet is not only huge but is also complicated, there are many limitations for data transfer. Therefore, our research proposes a method of recommending mobile advertising to customize user location related information. Say the user loves to shop around, when he is anywhere near Shin Kkong Mitsukoshi Department Store, he will receive some advertising messages on discounted sales in his cellular phone. This not only tells the user he is near the Shin Kkong Mitsukoshi store but also informs him of any discounted sales going on and he can just use the instant message to obtain the discount.

Data training and predicting processes: Collect the information from mobile agents and train the back propagation neural network model. Through the training process, the customer characteristics are becoming more obvious. Now enter the customer information and be able to predict his preference so an appropriate mobile advertising can be thus provided instantly. In back propagation neural network, there are issues such as learning rate is too big or too small for convergence. To cope with this issue, genetic algorithm is employed. Its multi-dimensional searching capability leads to the best entire solution without best local solution, thus achieving convergence is faster. The model is to take the network weight as the chromosome in genetic algorithm, in which the difference between the predicting value and actual value is the fitness function in genetic algorithm. From the genetic algorithm searching, minimized error network architecture can be obtained (Fig. 13). Especially in huge amount of data, the training process usually takes a lot of time. Yet combining the back propagation neural network model with genetic algorithm, the training efficiency is greatly enhanced and achieving convergence is faster.

The advancement of wireless communication has made the global communication as convenient as a global village. Although the communication is very convenient, the enterprises now face the global competition and not local competition anymore. For enterprises, innovative products are necessary. This brings a question: how to achieve advertising to those who may be interested in the new product when it comes about. In the past, this is usually done in TV media, paper media, Internet advertising and so on. As with the mobile communication is increasingly popular than ever, the total number of mobile users will be greater than the number of fixed e-commerce users in 2003. By 2004, as predicted, there would be seven billion mobile e-commerce users and mobile applications are more and more welcomed.

"Mobile advertising" is different from traditional TV media in that TV programs are only played during specific point of time and paper media is limited to its space and its cover is dull. Mobile advertising offers an interactive interface. Whatever the user desires, they can get instant response so they save their time and cost over communication, high time-wise efficiency and lost cost. For general enterprises, the advertising budget is best spent on mobile advertising that gets the most efficiency. Mobile advertising can predict some prospective customers to minimize the customers of choice and from there provide them with the appropriate advertising. Our research proposes a highly efficient and secure personalized mechanism. For on-line shopping in mobile advertising, eTicket offers a good payment method and is under control in terms of efficiency and security. The mobile agents collect users shopping habits from

combining the genetic algorithm and its improved back propagation neural network training to recommend faster and more appropriate mobile advertising.

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