Automatic trading environment in the field of e-commerce assisted by intelligent software agents.

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***Abstract*—E-commerce has become a business challenge due to its functionality, however phases such as: the search and selection of products, search and selection of the seller and the negotiation mechanisms in web environments, important elements in the consumer's purchasing model, are quite manual tasks. Nowadays, for a user to acquire a product, he must visit dozens of virtual stores on many occasions, to end up on many occasions giving up on acquiring the desired good.**

E-commerce offers many more opportunities to improve the way businesses or companies interact with their customers. The objective is to take advantage of the real potential that an electronic environment can provide, to go a step further, and to introduce automatic negotiation processes into the systems.

Auto-trading can allow large-scale comparison of products with a large number of features, lower costs, offer more personalized services, and make transactions more agile. Given the nature of the tasks involved in e-commerce, agent technology can play a very important role, where agents will act as buyers, sellers, mediators, information providers, in short, agents will automate some or all of the necessary tasks in the processes of commercial transactions. [1]

The idea of this paper is to present the implementation of a Web multi-agent system implemented in the JADE platform, which solves some phases of the automatic negotiation model.

***Key Terms*— E-commerce, automatic negotiation, Multi-agent systems, JADE, FIPA, Ontologies.**

I. INTRODUCTION

E-commerce has become a business challenge due to its functionality, customers can arrive at an e-store at any time, go shopping and fill a full cart, but leave the store without needing to buy anything. Therefore, attracting customers and persuading them to buy is not an easy task. It has become one of the most important issues in recent years.

Customers are generally knowledgeable about the products or services that meet their needs, and they are happy with this new way of doing business, while salespeople are happy to sell their products or services through this medium.

Therefore, e-commerce becomes a prominent strategy. Some customers compare the prices of the same product from multiple stores before making a purchase decision.

In the traditional way, users visit commercial establishments and compare store to store, which involves a lot of time. The e-marketplace offers more advantages to customers, they can go online and search for the required products. However, it is not so easy for the customer to meet their needs due to the thousands of options that can be found on a website.

A software agent can be used at this point due to its properties of autonomy, negotiation capacity, reactivity and proactivity. [2]

The basic idea is to design and implement trading platforms that allow software agents to automate some phases of the buying behavior model, namely: product search and selection management, seller search management, and automatic negotiation. [3]

The automatic negotiation phase is not normally identified, but it is a major challenge in the field of agent-mediated e-commerce. In human negotiations, two or more parties interact with each other to determine the price or some other term of the transaction. In an automatic negotiation, it is the software agents that carry out similar processes to reach the same end. Basically, what is done is to prepare offers that are sent to the other agents involved, and analyze the offers that are received with the aim of achieving the maximum benefit for the user they represent. These tasks are carried out in accordance with a negotiation strategy, which will be limited by the established negotiation protocol. This protocol defines the rules of encounter between agents, that is, who can say what, to whom and at what time. Given the wide variety of possibilities, there is no universal approach or technique to the problem of automatic negotiation. Instead, protocols and strategies have to be adapted according to the different situations or scenarios that arise. [3]

The present work aims to illustrate a Multi-agent system in a Web environment implemented in the JADE platform, which tries to automate the phases of purchasing behavior, namely: in the management phase of search and selection of the product, agents will reason about a predetermined service ontology, which is used by commercial establishments to describe the products they sell. In addition, e-commerce stores will be equipped with intelligent systems, such as: recommendation systems based on collaborative filtering techniques and subscription systems in order to offer products and services of interest to a user automatically.

In the selection phase of the salespeople, there will be a decision module that allows you to choose the best sales agents, based on the characteristics of the products offered by the commercial establishments.

In the negotiation phase, the FIPA Contract-NET coordination protocol is considered in the first instance, which allows purchasing agents to request offers from sales agents on products of interest.

The basic scenario that can be considered is, there are purchasing agents implemented on the JADE platform that are configured by a particular customer through a web application and whose basic task is to search, select and establish a negotiation with sales agents (representing commercial establishments) that offer products that meet their customer's needs.

II. RELATED WORKS

A. Intelligent AuctionBot for Forward and Reverse English Auction

Mohammad Zahidur Rahman, Mohammad Fozlul Haque Bhuiyan, Nur Afroza Khurshed from Jahangirnagar University Bangladesh. They propose an Intelligent AuctionBot, based on an English auction system where bids can be made by both software agents and human agents.

They present two parameterizable operating strategies. An English Forward Auction, in which a seller publishes an item or a group of items and buyers place bids for a time specified by the seller, wins the highest bid before the expiry time. And a reverse English Auction, in which buyers post a purchase request for an item or a group of items. Sellers place bids until the time specified by the buyer expires, the lowest bid wins.

AuctionBot's architectural design features two elements: a Web interface for humans and a TCP-IP interface for software agents. The interface and auction program update a centralized database system. Human agents or system users initialize an auction by configuring a series of Web forms, software agents perform the configuration in an agent-specific interface. The final data form and auction schedule is inserted into the database and is marked as unprocessed until the user sends a confirmation of the configured data.

The negotiation process is controlled by a daemon that is constantly monitoring the database and registers the events of each of the auctions, in order to be informing the owner users. Among the parameters requested by the AuctionBot interface are: The item to be acquired or purchased, the type of auction (Reverse or forward), the owner of the auction, the category, the start time, the end time, the minimum or maximum bid accepted, number of bids to be made, payment methods, Purchase options, geographical location in which the auction applies, shipping terms.

Among their future developments, they plan to develop mechanisms to support the participation of users registered on a Web platform in simultaneous auctions, and of which they can know their evolution through the portal itself. **[4]**

B. Model of Multi-Agent Based on Personalized Transactions in Electronic Commerce

CHEN Xiao-fang, WANG Ying, from the School of Management, WuHan University of Technology, P.R.China, carry out a study of different evolution patterns in e-commerce systems, such as: *Customer – Seller*, in which customers acquire the good by making a direct contract with the seller, the Customer – *Supermarket – Seller* pattern, in which there is an intermediary in charge of marketing different products of the sellers, in which; the client carries out the negotiation with the supermarket and the supermarket is in charge of carrying out the negotiation with the sellers and the *patron Client - Web Agency - Seller*, in which there are Web agencies that are responsible for holding auctions of sellers' products according to the configuration made by the latter and the buyers place bids on the published products. Based on the study of these patterns and the analysis of the characteristics of consumers and buyers, they conclude the need to automate the processes of buying and selling products and propose a model of multi-agent systems based on the personalization of electronic transactions, using the JADE and JESS platforms, which consists of making a model in which buyers have configurable purchasing agents (in product, price, payment method), sellers have configurable selling agents (in list of products, product characteristics: price, payment method) and there is an agency of agencies with an architecture that supports semantic Web technologies where agent meetings and automatic negotiations can be carried out in which control can be carried out over contracts and payment of products.

Additionally, they propose the incorporation of a Bayesian neural network in charge of analyzing all electronic transactions, in order to look for patterns of consumer behavior in order to have a decision support system for future purchases. **[5]**

C. GAMA (Genetic Algorithm driven Multi-Agents) for E-Commerce Integrative Negotiation

Dr. Magda B. Fayek, Dr. Ihab A. Talkhan, Khalil S. El-Masry of Cairo Univ. Faculty of Eng propose GAMA, an intermediary purchasing agent that allows buyers to consider a wide number of merchant proposals before making purchasing decisions. The system helps buyers in two important elements: Product search and negotiation. The search for products is carried out by purchasing agents, using as a basis a generic algorithm that directs the search space, based on the best products offered considering the criteria specified by the buyers. In the first instance, it creates a random initial population of individuals, each individual represents a specific product offered and each gene represents an attribute of the different items to be considered in the product.

Fitness is calculated based on customer satisfaction criteria, configured by the user using the multi-criteria utility theory. Selection, crossing, and mutation are applied to the population to evolve into the next generation.

Negotiation is implemented using the technique of collaborative genetic algorithms. The negotiation protocol is based on the comparison of identical items. Each item is a product to be sold. In addition, each item has a name and a list of attributes, each attribute has a name and a relative weight indicator and a relative weight to the criterion specified by the buyer. The GAMA sales agent maintains a local price list along with a list of elite products to offer characterized by each of

their attributes. **[6]**

D. Kasbat: An agent MarketPlace for Buying and selling Goods

Authony Chevez, Pattie Maes of the MIT Media Lab. They propose Kashbat, a multi-agent system for e-commerce implemented on the Web, where users can configure and parameterize autonomous agents to restrict their operation in actions of buying and selling products. Kashbat was developed in CLOS (Common Lisp Object System) using Harlequin Lisp and incorporates a negotiation platform that allows the meeting between buying and selling agents. Purchasing agents are proactive agents; Basically, they take the initiative and look for agents on the trading platform to sell the products requested by the users they represent. One of the important elements of the platform is that the user is the one who has control over the trading strategies of the agents. The user can specify a decay function, this in order to guide the agent on the mechanism to lower the price offered on a certain good. The user can choose between three trading options: Linear, Quadratic and Cubic. More sophisticated traders may have different parameters to define their trading strategies. **[7]**

E. Agent-based Price Negotiation System for Electronic Commerce

Jinkai Wang, Youlin Chen, from Tongji University, developed a price-based trading agent for an e-commerce system, the authors propose a framework for the development of agents whose function is to perform automatic price-based trades and a trading model using game theory techniques.

The architecture of the system focuses on the structuring of a multi-agent system, with a definition of tasks for each of the agents that make up the system, which are: Interface Agent which is responsible for obtaining the information of the products required by customers.

A cognitive agent, which takes that information and sends the classified information to the study agents and processing agents.

The study agents are in charge of ensuring that the products and tasks designated by the users are fulfilled, for which they carry out a decomposition and administration of them, in order to know if they should delegate responsibilities to other agents of the system. The processing agent combines the information transferred by the study agent and the cognitive agent with a library of models that allows all the information to be processed and determine if the established objectives can be met.

For the communication of the agents, they propose the design of their own communication protocol, basically text strings with a pre-established form.

Regarding the negotiation process carried out in the application of the basic concepts of cooperative game theory in which a group of actors collide to establish an agreement on the purchase of a product. **[8].**

III. CONCEPTUAL FRAMEWORK

A. Multi-agent systems

A multi-agent system is a set of intelligent entities called agents, generally heterogeneous and potentially independent that coordinate and work together to solve individual or global problems.

Although there is no universally accepted definition of agent, in the case of this work, we can consider it as a computer application that has the ability to: be part of a social organization, use coordination and cooperation strategies to achieve shared objectives and use intelligent negotiation strategies. There are many platforms for the development of multi-agent applications, with JADE (Java Agent Development) being one of the most widely used.

JADE is a software framework that simplifies the development of multi-agent systems in accordance with FIPA specifications for the interoperability of intelligent agent systems**.** It is a free and open source software, which has been developed by the CSELT of the Telecom Italia group, in part of the European research project ACTS AC17 "FACTS". Both JADE, and the agents that the user defines for a specific application, use the JAVA development language, which gives the platform total independence from the operating system or systems used.

The agent platform can be distributed among different machines and its configuration can be changed at any time, since JADE allows the mobility and cloning of agents from one machine to another. JADE, following FIPA specifications, implements those aspects of a multi-agent system, which are not internal characteristics of the agent and are independent of the type of application. **[9]**

FIPA protocols define the communicative acts and coordination rules that must be followed to use agent interoperability. Among the FIPA protocols we can name: FIPA-ContracNet, FIPA subscription that are used in platform.

The ContractNet class set allows you to implement the FIPA-Contract-Net protocol. This interaction protocol allows the Initiator to send a Call for Proposal to a set of Responders, evaluate their proposals, and then accept the preferred one of all (or even reject them all). This interaction protocol is deeply described in the FIPA specifications.

The Initiator solicits proposals from other agents by sending a CFP message specifying the action to be taken and, if necessary, conditions on execution. Responders can then respond by sending a PROPOSE message including the preconditions they prepared for the action, for example, price or time. Alternatively, Responders can send a REFUSE message to reject the proposal or, eventually, a NOT-UNDERSTOOD to report communication issues. The initiator can then evaluate all the proposals received and make his choice of which agent proposal will be chosen and which will be rejected. Once Responders whose proposal has been accepted (e.g., those who have received an ACCEPT-PROPOSAL message) have completed their tasks they can finally respond with an INFORM with the outcome of the action (eventually just as the action has been performed) or with a FAILURE message if anything has gone wrong.

Before the action has been carried out and the last message has been received, the initiator may even decide to cancel the protocol by sending a CANCEL message. **[10]**

The Subscription class set allows you to implement the FIPA-Subscription protocol. This interaction protocol allows the Initiating agent to send a SUBSCRIBE message to the Responder agent indicating that it wants to subscribe. The Responder agent processes the message and responds, either accepting or rejecting the subscription. If the Responder rejects the request, it communicates a REFUSE message, but if it agrees it communicates an AGREE message, which is optional. If you don't understand the message, send NOT-UNDERSTOOD.

If the Responder agrees, it communicates all content by matching the condition of the subscriptions using an INFORM-RESULT, for example, an INFORM communicative act with a result predicate as content. The Responder continues to send INFORM-RESULT until the Initiator cancels, communicating it with a CANCEL message, or until the Responder fails, communicating it with a FAILURE message. **[10]**

In addition to the support of the FIPA specification, Jade presents a series of behaviors that agents can use to define their actions, among which we find: OneShotBehaviour, CyclicBehaviour, these types of behaviors correspond to the SimpleBehaviour class that represents atomic behaviors, which usually perform simple tasks. **[11]**

B. Recommendation Systems

Recommendation Systems (SRs) are an invaluable tool in the field of electronic commerce. When an e-store's product offerings are very large, users can feel overwhelmed by having to choose from a wide variety of alternatives. SRs are able to constrain this set of alternatives and provide the user with a subset of those that are likely to best fit their needs and tastes. There are several models that can be followed to build an SR: collaborative, content-based, demographic, knowledge-based, and utility-based. **[12].**

Recommendation systems based on collaborative filtering algorithms use users' ratings on certain items in the total set to predict ratings on the rest of the items and recommend those with the highest predicted rating.

There are a number of computer tools for this purpose, however one of the most promising and best performing is the Apache Mahout project, which aims to implement algorithms for machine learning, among its subprojects is one directly linked to collaborative filtering techniques. **[17]**

IV. SOLUTION APPROACH

To support each of the operations listed, the following elements were developed, illustrated in Figure 1.

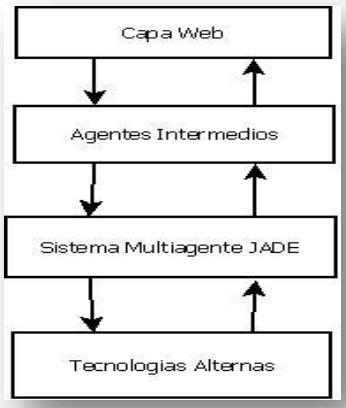

Fig 1. Components Built Application

1. **Web Layer:** The Web portal of the project, is specialized in the sale of musical instruments over the internet, contains all the basic elements so that users interested in acquiring musical products can do so, for the structuring of this components the MVC architectural pattern (Model – View – Controller) was taken into account based on the following layers:

Presentation Layer (View): This layer includes flat HTML pages (user information pages), JSP pages (user interaction pages), style documents, JAVAScript code (dynamic presentation functions).

Business Layer (Model): In this layer are the logical facades, represented by JAVA classes, which provide the functionality that can be accessed from the controllers. Similarly, in this layer are the VO (Value Object) that represent each of the entities that comprise the domain of the problem and that process the different requests made in order to provide a response and, in the same way, to send and consult the necessary information to and from the persistence layer. respectively.

Persistence Layer: This layer includes the JAVA classes that make up the persistence façade, and the DAOs (Data Access Objects) that are responsible for managing system persistence tasks.

Controller: In this layer are the servlets controllers in charge of processing the requests sent from the presentation layer, additionally there are specified Gateway servlets in charge of establishing communication with the intermediary agents, after a request from the users of the platform.

2. Intermediate Agents:

In this layer are located the agents in charge of communicating the servlets and the multi-agent platform, it should be taken into account that the communication between JADE and the Servlets is achieved thanks to the configuration of a servlet class (ServletGateWay) that serves as an interface and an agent (AagentGateWay) that will receive data at the time

of executing the command "JadeGateway.execute(message)". In this way the servlet is configured in the method of its initialization (init()) with the location of the Jade GateWay agent (GateWay Agent). This way we will be able to maintain communication between these two technologies, allowing us to send java Objects to the Jade agents with information for their configuration, managing to establish rules for their behavior. **[11]**

3. JADE Multi-Agent System:

The project's Web portal is specialized in the sale of musical instruments on the internet providing several additions. Among which are a service called "Guitar to the size of your pocket", where an authenticated user can search for a guitar that fits the size of their pocket, this means that if the user has a specific amount of money they can register it and wait for possible offers from other guitar stores on the internet associated with ours and the system will choose the best offer based on the conditions of the user (price, brand, among others).

For the implementation of this system, JADE agents configured with the FIPA-Contract-Net Protocol were used, where each of the different guitar stores is represented by a TiendaMusical agent, which is configured with a specific amount of money that represents the offer of each store, for each of the products offered. The Buyer is an agent who carries as a parameter the name of the authenticated user and the size of his pocket, that is, the amount of money he has to make the purchase of the guitar. After the best offer is found and the negotiation is made, the Buyer agent saves in the platform's database, the data of the offer made by the TiendaMúsica agent, so that the user can then see his offer and decide whether to buy or reject it.

As another addition to the Instrument Store, a newsletter was implemented to which authenticated users can subscribe by choosing a theme from four available: Guitars, Basses, Drums and Amplifiers. The subscription has a predetermined lifetime, this means that from the first day the subscription is created, you can see the news of the chosen topic and when the subscription expires it can be renewed at no cost by choosing the same or a different topic. The news is entered or deleted by the site administrator and every time a user enters their account they will be able to see it immediately.

For the implementation of this system, agents configured with the FIPA-Subscription protocol were used, where every time a user subscribes to the newsletter, a SubscribeSubscribe agent sends the subscription data (username, topic) to a SubscriptionResponderAgent agent, which analyzes it and if it conforms to the predefined rules, accepts it.

At the time of accepting a subscription, the SubscriptionResponderAgent agent sends a message to the SubscribeSubscribe agent notifying the success or failure, in case of success the agent saves the subscription in the platform's database, so that the user when entering the page can see the news related to his topic.

In the implementation of the FIPA-SUBSCRIPTION protocol, the SubscribeR agent needed to send a series of data to the SubscriptionResponderAgent agent, so it was necessary to use an ontology. The implemented ontology "Bulletin-ontology" is based on the data that a subscription must have in order to be sent to the database. To use the "Bulletin-ontology" ontology, both agents must register the "codec2" language and the instance of the ontology.

Additionally, the web portal offers a notification system, at this time it can be configured to monitor when there are new products, pending offers and new news. The user can configure what they want to be notified.

The notification is carried out by means of an agent with cyclical behavior (CyclicBehaviour) which queries the database of e-commerce stores from time to time. When the user enters the main screen of the portal, they are presented with notifications and news.

Finally, the web portal offers a recommendation system, using collaborative filtering techniques, that is, through a product ranking system for each user, the system is able to make recommendations to other users with similar tastes.

For the implementation of this system, a Recommender Agent with Cyclic behavior was built, which executes the algorithm every certain interval, to try to find products that users may be interested in. It is worth mentioning that because this process is quite heavy, it is done offline and the results are stored in the platform's database system.

As can be seen, the developed platform automates some phases of consumer purchasing behavior: search and selection of the product through agents, search and selection of the seller and automatic negotiation mechanisms. Additionally, essential elements for e-commerce stores were added, such as: agent-controlled subscription systems, recommendation systems using collaborative filtering techniques and automatic notification systems.

4. Alternative Technologies:
For the implementation of the recommendation system, the libraries provided by the Apache Mahout project were used, which allow recommending products to similar users, calculating the users most similar to a particular profile, therefore the provided API was used and integrated as mentioned in the previous item with a Recommender agent[13].

V. CONCLUSIONS

1. With the definition and implementation of ontologies as the basis of the messages exchanged by the agents in the messages, it is possible to transmit varied information with an objectual approach and avoid having to define textual communication protocols, which must be structured or processed in tasks of sending and receiving information.

2. The definition of communication and coordination protocols between agents using the FIPA standard, and the use of multi-agent system platforms such as JADE, becomes a key element,

due to the fact that a predefined and understandable format is followed, which facilitates implementation, maintenance and scalability tasks. Although there are more advanced interaction mechanisms than the ContraNet and Subscription protocols, they met expectations according to the planned objectives, in later versions English and Dutch auction mechanisms will be implemented in order to offer more interaction capabilities and allow auction strategies.

3. The definition of information and product publication mechanisms, so that software agents consume information, allowed the administrators of e-commerce establishments to only have to make minimal configurations, because the agents automated internal processes, which some time ago had to be executed manually. Due to the success of these mechanisms, in later stages they will be integrated into available e-commerce systems, such as: Oscommerce and Apache OfBiz, platforms for the implementation of open source virtual stores.

4. The use of collaborative filtering techniques becomes an important marketing strategy for e-commerce systems, because products that interest users of the system are offered and therefore become potential purchases. The integration of such systems with software agents implemented in JADE, was a successful strategy in the development of this project, because the agents encapsulate this behavior and proactively find products of interest based on the ratings made by users to the products offered on the platform.

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