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An Online Agent-Based Estate Trading System

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ABSTRACT

The conventional system of real estate trading system in which a human being run as an agent connecting sellers and buyers of real estate properties used by real estate practitioners poses a great challenge to real estate industries because of its inadequacies such as problem of identifying the right buyer and seller, agent commission fee, improper valuing of the properties, static negotiation nature, time wasting and insecurity. To overcome these problems, this research proposes a solution in the area of software oriented multi agent based system for real estate trading. The system consists of buyer agent for buying and seller agent for selling collaborating with each other to achieve optimal solution. Both agents exhibit some level of rationality and intelligence that they will be able to value properties (houses) and negotiate with the buyer and the seller. These agents receive instruction from the keyboard and act upon the environment by displaying on the screen and sending response to the seller using short message service (SMS). The proposed system will adopt Google map technique to ascertain the location of the house. The system was implemented using Java Agent Development Environment Framework (JADE), PHP and bootstrap. Database was created and maintained using SQL database server using Apache framework. The methods adopted in carrying out the research include study of the existing system, interview, questionnaire and the use of object oriented analysis and design method (OOADM) to design and implement the new system.

Key words: real estate, multi agent system, buyers, sellers, autonomous and artificial intelligence.

1. INTRODUCTION

Today, many researches are being undertaken on the use of online agent based software for real estate trading. Such development is anticipated to bring a lot of stabilities into real estate trading system. Real estate is "property made up of buildings and the land it is built on, together with its natural resources such as crops, minerals or water and so on; an attention conferred in this together with an item of real property, buildings or housing collectively. Business of real estate is the profession composed of buying, selling, or renting land, buildings or housing." Real estate management is both science and art, increasing the worth of your asset through careful stewardship of its physical space, tenant relationships and general standing in the market place [1].

Secondly, the serious issues in real estate management is bringing buyers and sellers together and assisting negotiation of contracts between them, where the solution is traced to an agent based software for real estate that act as an interface between buyer and seller and perform the negotiation of contracts with them. The developments in artificial intelligence in the area of expert system have experienced a major interest in agent oriented technology and a distinct trend has evolved to the research and development work on intelligent agents. The architecture of an agent based technique is greatly influenced by its environment in the sense that it perceives and acts upon the environment. An Agent is any entity that perceives from its environment via sensors and act on the environment via actuators. Multi agent system is a collection of software agents that communicate and collaborate with each other [2]. Agents are computational entities that may act on behalf of other entities. They are dedicated problem solving entities with well-defined boundaries capable of communicating with other agents. They are designed to achieve a precise purpose and display flexible and pro-active behaviour known as agent behaviour. They are autonomous in the sense that they can operate on their own and they have control both over their internal state and over their actions [3].

A multi-agent system (MAS) is a collection of agent with their own problem solving capacities which are able to interact among them in other to reach an overall goal. Multi-agent systems can be used to solve problems that are difficult or impossible for an individual agent or a monolithic system to solve [4]. Agents usually operate in a dynamic, nondeterministic complex environment. This paper proposes a solution in the area of software oriented multi agent based system for real estate trading. This paper is divided into the following sections: introduction, objective of the study, literature review, methodology, results, summary, conclusion, recommendation and future work.

1.1 Objectives of the Study

The specific objectives of the study are:

1. To develop a software agent system that performs the duties of human brokers and agents such as buying and selling of properties remotely.
2. To design and develop a multi agent-based software platform for real estate trading that will negotiate price among each other.
3. To develop a multi agent software system that comprises of buying agent and selling agent that will remotely identify the right buyers and sellers.
4. To demonstrate a multi-agent based system that support online real time management of real estate trading and shows the map location of the property.

2. REVIEW OF RELATED LITERATURE

2.1 Agent Technology for Distributed Computing

Authors in [5] stated that with growing technology, agents are now a possible choice for distributed computing and systems with requirements on reliability and scalability. Services to applications developed as agents are provided by agent platforms. Evaluation of agent platform is emphasized in the important properties of performance, security and scalability. They concluded that all platforms perform very well, but the performance is heavily influence by the platform architecture. According to [6] the popular computing press and within the artificial intelligence and computer science communities, the word “agent” is presently in vogue. This offered the reader with a brief summary of what an agent is and of three key agent application areas.

In [7] the author addressed Multi-Agent systems as being extensively used to address many distributed combinatorial real-world problems. Example of such problem is meeting scheduling (MS) that is basically characterized by two features: its fundamentally distributed and dynamic nature. However, in real world applications, users usually have differing preferences, which make the search for an optimal solution very hard. Though, the majorities of the existing works on MS tackle it as a static problem, allow for the relaxation of any constraints and do not deal with reaching any level of stability.

2.2 Computerised Methods for Locating Real Estate Property

In [8] a computer-based methods for finding real estate which relates to a computerized map-based real estate search system is introduced in which a user can zoom in on a map to greater levels of detail, in order to get a more accurate view of the location of an available piece of property. The mapping system is pointed about a user-selectable landmark, and the different maps that are generated are also pointed about the landmark. There is a linked property database accessible remotely either by searching by specified criteria or by using the mapping system. Presented in [9] is a computer software system that creates and maintains both a real estate property database and a corresponding file of hard-copy real estate property listing advertisements, which allows searches of the database. A centralized computer "host system" having a database can be searched from "remote" computer systems using a public domain software program that is menu driven and exact search location boundaries are identified using a graphical locator interface.

Covered in [10] is an on-line map-based real estate search system that works in a similar manner to the '989 patent. The system shown in this patent also permits a user to search criteria after narrowing the map-based search down to the city level, thereby permitting a criteria-based search in addition to a location-based search. In [11] the patent noted that it is necessary to view the picture of the property simultaneously when accessing property data via a computer, therefore, it was directed to an interactive multimedia real estate database including interior images and exterior images of the selected house, the floor plan of the house, a textual description of the property, etc. Additionally, there is a provision of links on the exterior image of the house that, when clicked, allows the user to view the inner part of the corresponding room. The above-mentioned patents want a user to be located at a computer distant from the property. This technology condemns the idea of a buyer driving past a certain piece of property and would like additional information about that property. It would be expected of a prospective buyer accessing information relating to a piece of property online at any time of his choice, and whether or not the property showed a "for sale" sign. This type of information is ideally suited to be transmitted via a wireless device.

According to [12] an Internet-based method were introduced which permits users to list their real estate properties on respective web site pages, edit their pages, and create new pages for additional listings. Such web site creation and editing may be made whenever the user wishes by accessing a home page, entering a corresponding service function such as editing an existing page or creating a new page. The user can then carry out the selected function from a personal computer over the Internet. The domain name may correspond to a parameter of the property such as its street address.

In [13] a solution of finding real estate property is introduced that is made up of a map-based and a street-based search tools. The map-based search tool lets a user enter geographical coordinates by drawing a shape on a map. A map coordinate database is being queried by map-based search tool to determine geographical coordinates that define the drawn shape. The map-based search tool queries a property coordinates database and a parcel map database to find a first set of properties that are within the coordinates and to find a second set of properties displayed on a parcel map that also displays at least one property in the first set of properties. The street-based search tool allows a user to enter a number of street names and queries a parcel map database to find properties that are displayed on a parcel map that also displays the streets identified by the street names. In respect to [14] the idea of automating and restructuring real estate transactions by automatically submitting or transmitting required detailed information to companies providing real estate related services were initiated. The information is auto-populated from an electronic real estate form, a computer database, or a software application or internet application used by real estate professionals into an auto-submission screen. Preferably the information contained within an auto-submission screen or screens is electronically transmitted to the service provider through a computer network.

In [15] introduced a computer based real estate information system accessible using a computer network for selectively providing information to users concerning real estate properties. Finally, [16] explain computer system for locating real estate service providers by navigating an aerial image map of a geographic region. The system determines a search region corresponding to the geographic region by use of geospatial information related with the geographic region. Once the search region is determined, the system searches a database for real estate service providers that are related with the search region and that fulfil certain predetermined criteria.

2.3 Concept of Software Agent

Author in [17] presented a topology of agents. They placed agents in context, defined them and further outline critically the rationales, hypotheses, goals, challenges and state-of-the-art demonstrators of the various agent types in their typology. Therefore, it tried to make explicit much of what is usually implicit in the agents' literature. It also proceeded to outline other universal issues which pertain to all the types of agents in the typology. In respect to [18] the authors presented an agent-based application for the insurance industry. They developed a system to automate the process of information exchange between a Dutch, a German and a Belgian insurance company when handling cross-European motor vehicle accident insurance claims using agent. This article gives an overview of the system, the development process, the challenges encountered and how they were overcome.

2.4 Software Agent that can Buy and Sell

In [19] their paper presented a real world e-commerce based multi-agent application using JADE (Java Agent Development Environment), the system applied Kasbah negotiation strategies to automate an English auction in order to minimize human intervention and ensures product is being sold at its maximum price. Two types of agents created by them are as follows, the Buying Agent responsible for buying product on behalf of buyer and the Selling Agent responsible for selling product on behalf of seller.

In [20] the author states how software agents influence the present marketing prototype in interactive media. It focuses on the importance of these in E-Commerce. E-Commerce is a platform for the online activities of commerce; increase in the activities of trade in cyberspace increases the business opportunities over internet which real estate is one of it. He explains the role of Software agents as the useful tools to help individuals to undertake their activities on E-Commerce environments. Software agents create different paths for communication. Software agents increase the effectiveness and efficiency in several levels of market processes. The agent technology builds the bridge between the previously existing physical market and consequences of virtual markets. As the name indicates software agents acts as mediators for the processes of choosing products and merchants.

2.5 Software Agent that can Negotiate Price

Article in [21] applies Case-Based Reasoning technology negotiation agent to capture and re-use previously successful negotiation experiences. The experience based negotiation (EBN) agent offers adaptive negotiation strategies that can be generated dynamically and are context sensitive. This negotiation agent is being demonstrated in the context of used car trading.

2.6 Online Computerized Methods on Real Estate Property

In [22] authors developed a method for locating real estate having desired attributes includes storing, in a profile database, at least one user profile, the user profile including a user identifier related with a user and at least two preferences of the user, storing, in a locality database, at least one locality, defined by at least one locality attribute other than zip code, receiving, by a receiving unit, one or more properties not currently for sale within the at least one locality.

2.7 Research Gaps in Literature: the way forward

After a comprehensive review of related literatures, no work has explored a multi agent platform for real estate trading system. In this proposed system, a novel approach is designed in the area of real estate trading system that software agents buys and sells houses remotely. A unique approach that the agents negotiate price is introduced. The proposed system is incorporated with an SMS API (Application Program Interface) that sends real time notification to the buyers and sellers of the houses automatically. The system will introduce an online multi-agent classified advertisement system with support for negotiation to minimize human intervention and ensure that real estate property is being sold at its maximum price.

3. METHODOLOGY

The methodology used in analysing this system is Object Oriented Analysis and Design Methodology (OOADM). Analysis looks at a system in terms of problem-domain concepts and seeks to bring about natural interactions and discover natural constraints. Design performs the task of converting the analysis model into concepts and abstractions present in the programming style of the target language. The basic technique used in this system both in the analysis phase and in the design phase is Object Oriented Modelling (OOM). The Unified Modelling Language (UML) tools used in this work are modified from the standard UML diagrams such as: Use case diagram, Class diagram, Activity diagram, etc.

3.1 Description of the Existing System

The real estate agency existing in Nigeria is mainly human-based (manual) their processes include the following:

- a) Real estate properties declared for sell by the owner manually using sign boards, play board and so on.
- b) The owner assigns human agent(s) to bring the right buyer based on commission.
- c) Real estate properties are shown to the buyer physically (manually).
- d) Manual negotiation between the buyer and the human agent.
- e) Buyer buying the property by paying to the seller.

The following problems were associated with the existing system after thorough analysis.

- i. Manual declaration of property for sell cannot give massive awareness and leverage that the on-line declaration will render.
- ii. Involving human agent attracts agent commission fee and time consuming.
- iii. Real estate properties cannot be viewed or accessed except by going to the place.
- iv. Inability of the buyer to negotiate directly with the seller which gives human agents room to add money to actual amount given to them by the owner.
- v. Transaction records can easily be misplaced and the owner can easily sell the same property to many people at the same time.

3.2 Description of the Proposed System

The proposed system (**AOLABRETS**) which stands for An On-line Agent-based Real Estate Trading System is purely a web application. Considering the problems and limitations of the old system, the new system aims at addressing some essential problems identified in the traditional system of real estate trading where human agent is contracted to connect the right buyers and buying and selling is done manually. This is with the aim of providing an effective on-line software agent based real estate trading system and to make available on the internet details of some real estate properties which are declared for sale by the owner via the proposed system. The application is used by researchers, real estate companies, real estate practitioners, non-governmental organizations and interested individuals over the internet.

3.2.1 Use Case Diagram

Internal and external influences of system design requirements are gathered using use case diagram. The act of analysing a system to gather its functionality involves the preparation of use case and the identification of actors. The use case diagram of the system is represented in figure 1 below.

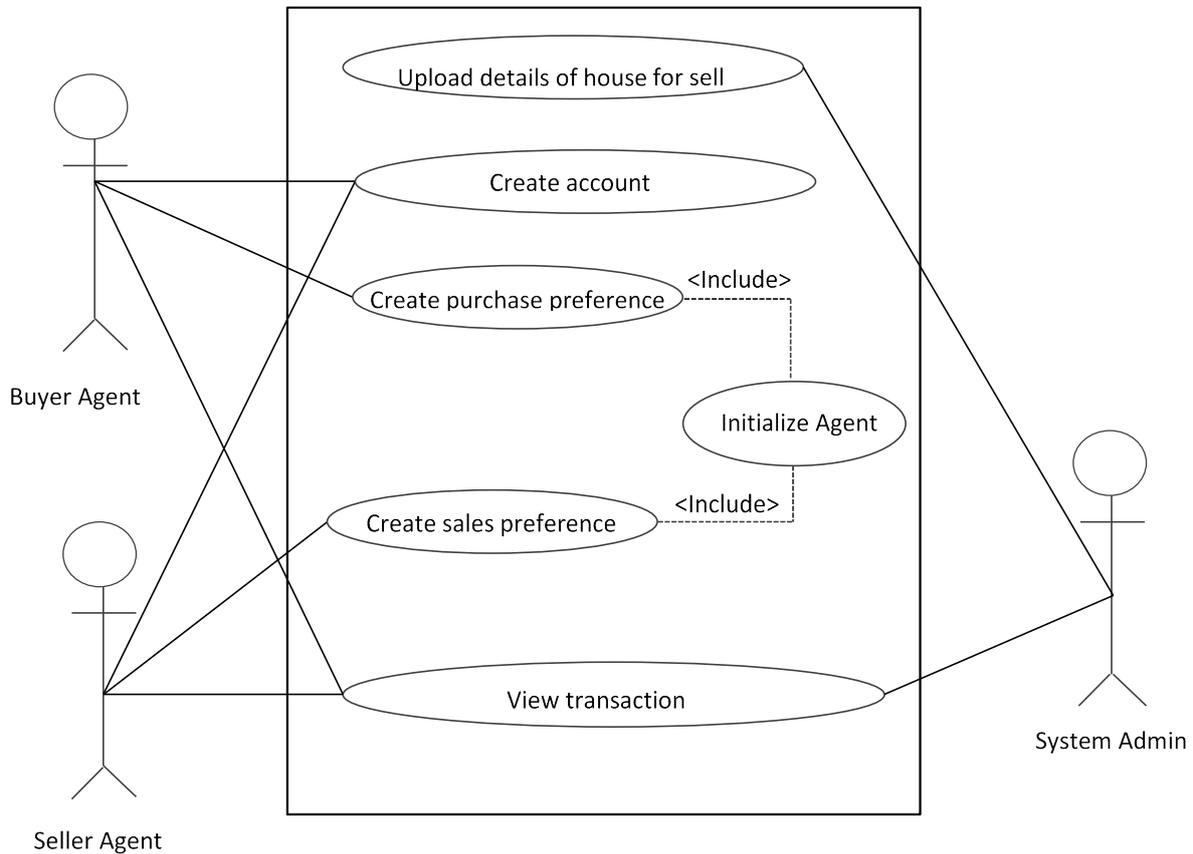


Figure 1: Use Case Diagram of the Proposed System

The role of each actors represented in the use case diagram

1. Seller Agent: This is the agent that handles selling of houses. The agent can equally view transaction.
2. Buyer Agent: This is the agent that handles buying of houses. It can equally view transaction.
3. System Administrator: He uploads details of houses for sell and can view transaction.

3.2.2 Class Diagram

The outline of the target system is provided by the class diagram by defining the objects and classes of the system and the relationships between them. It provides a wide variety of usages from modelling the domain-specific data structure to detailed design of the target system. With the share model facilities, class model in the interaction diagram can be used for modelling the in depth design of the dynamic behaviour. Figure 2 below is the class diagram of the system.

Class diagram

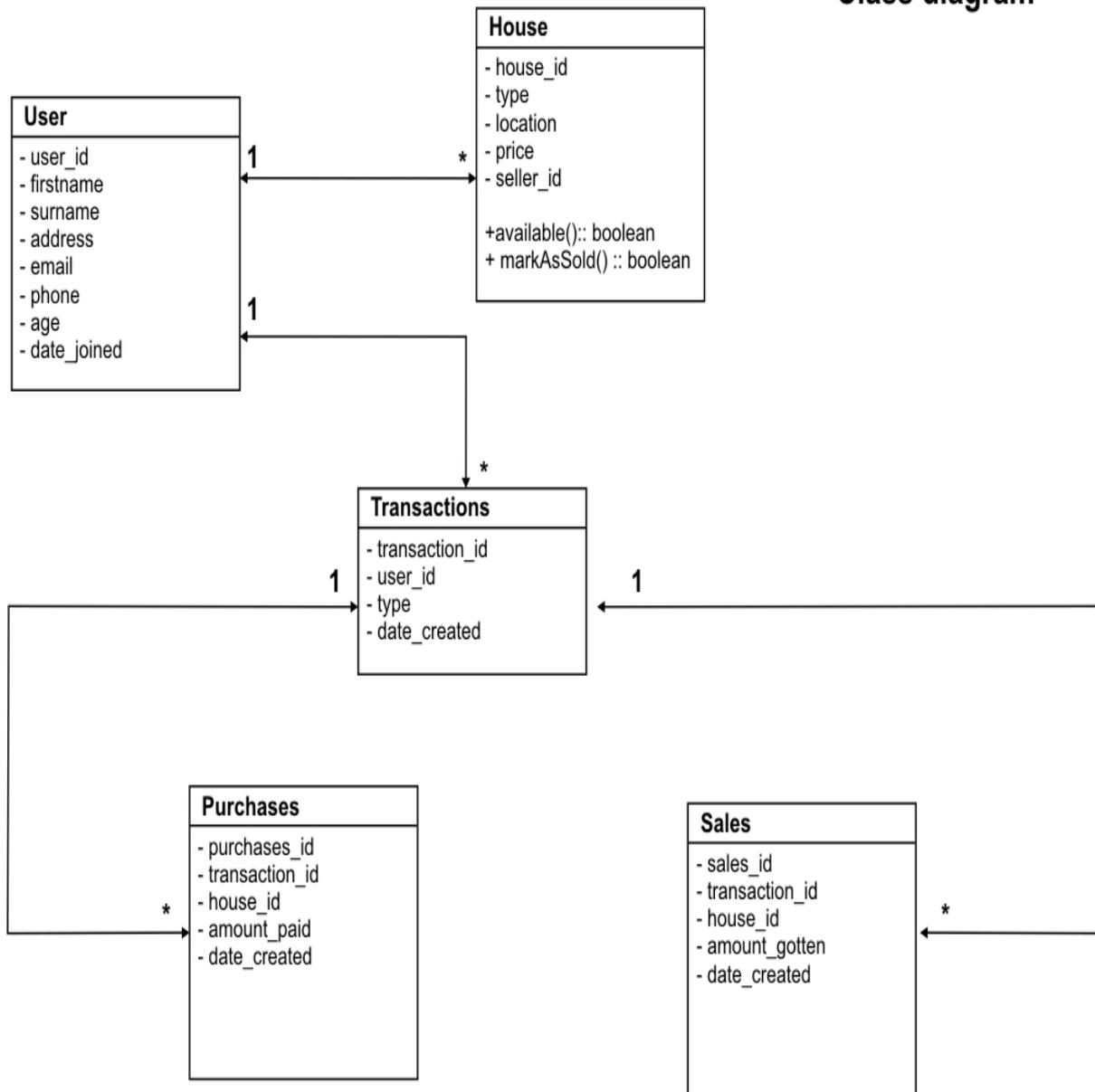


Figure 2: Class Diagram of the Proposed System

This proposed system will be designed basically on classic 3-layer system architecture: the data layer, the middle layer and the presentation layer respectively. The presentation layer shows the programming that provides the graphical user interface (GUI) and application specific entry forms or interactive windows. The middle layer or the business logic acts as the server for user request from workstations. In turn, it determines what data is needed (and where it is located) and act as a client in relation to a third layer of programming that might be located on a mainframe computer. The data layer which is the third layer includes the database and a program to manage, read and write access to it. **MYSQL** is the database management system used in the development of this system. The architecture of the proposed system is shown in figure 3 below.

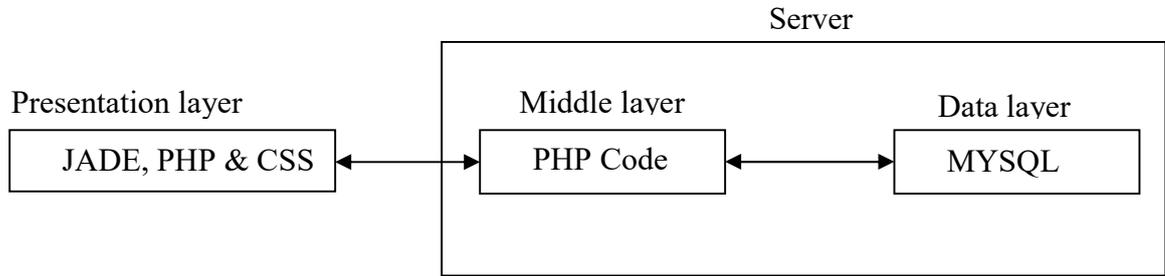


Figure 4: Architecture of the Proposed System

3.3.4 Implementation Architecture

Figure 4 shows the logical view of the architecture for implementing the system. The architecture shows the various logical flows at every module in the system.

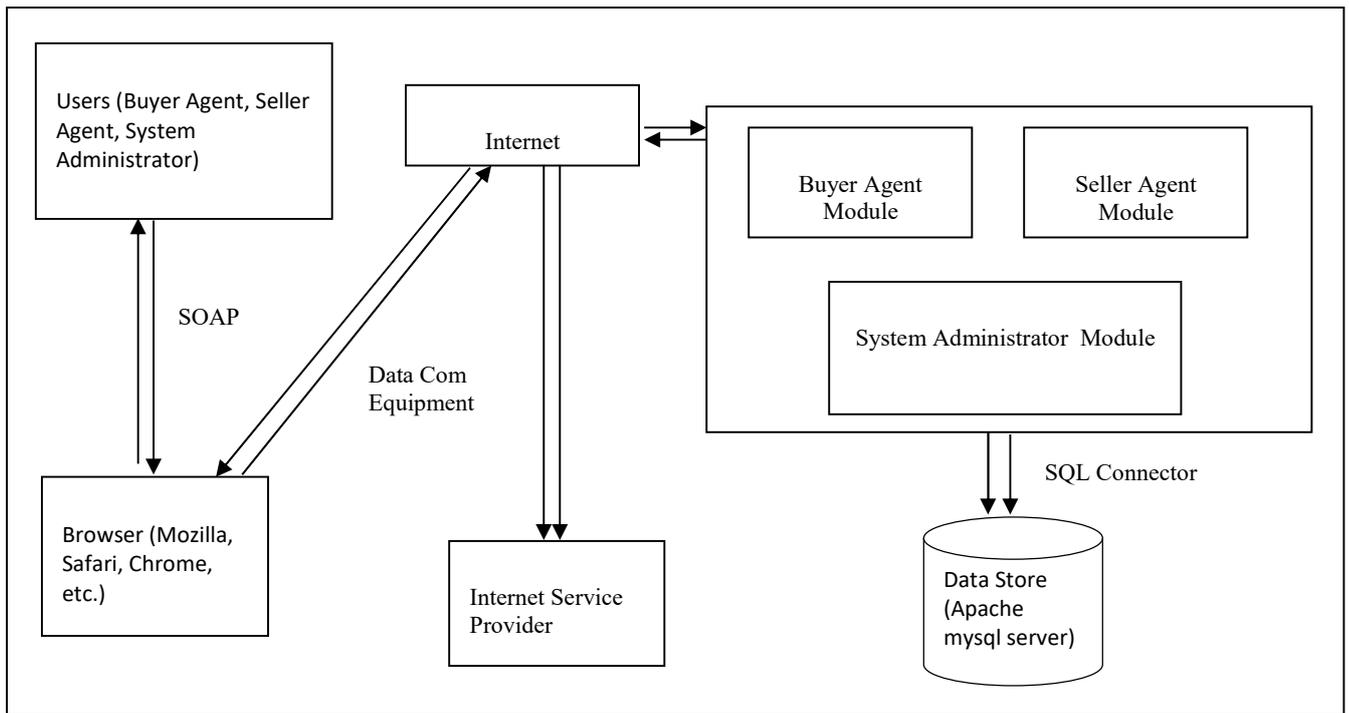


Figure 4: Logical View of the Architecture

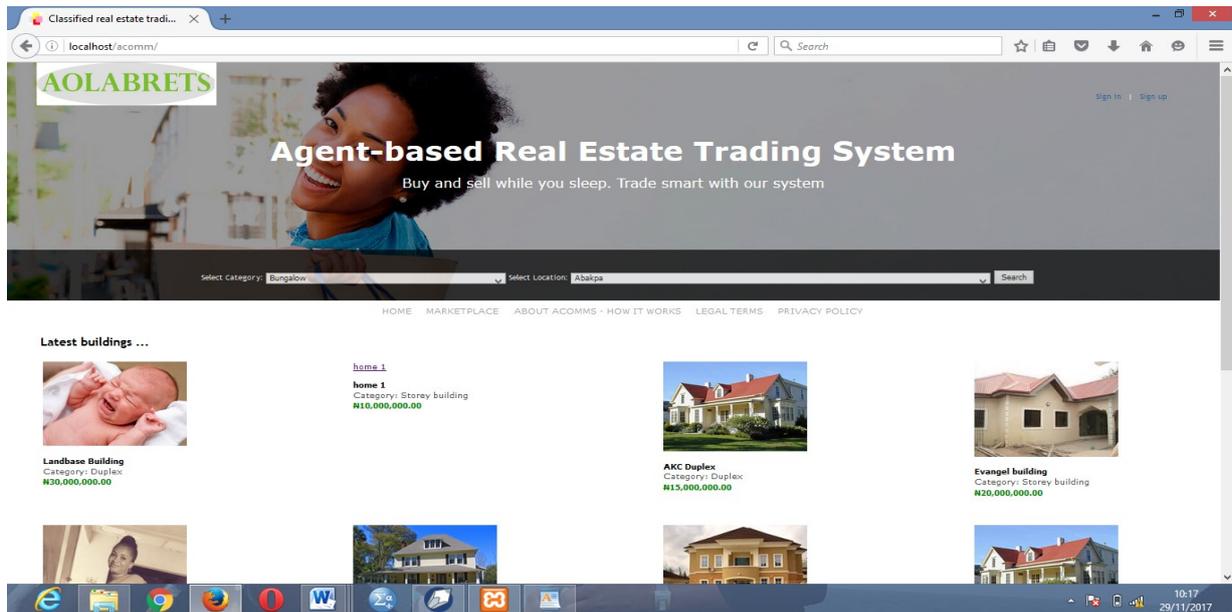


Figure 5: The Home Page

Figures 6, 7, 8 and 9 show active agents-buyer and seller negotiations.

1. JADE RAM windows showing active agents - Buyer and Seller through negotiation

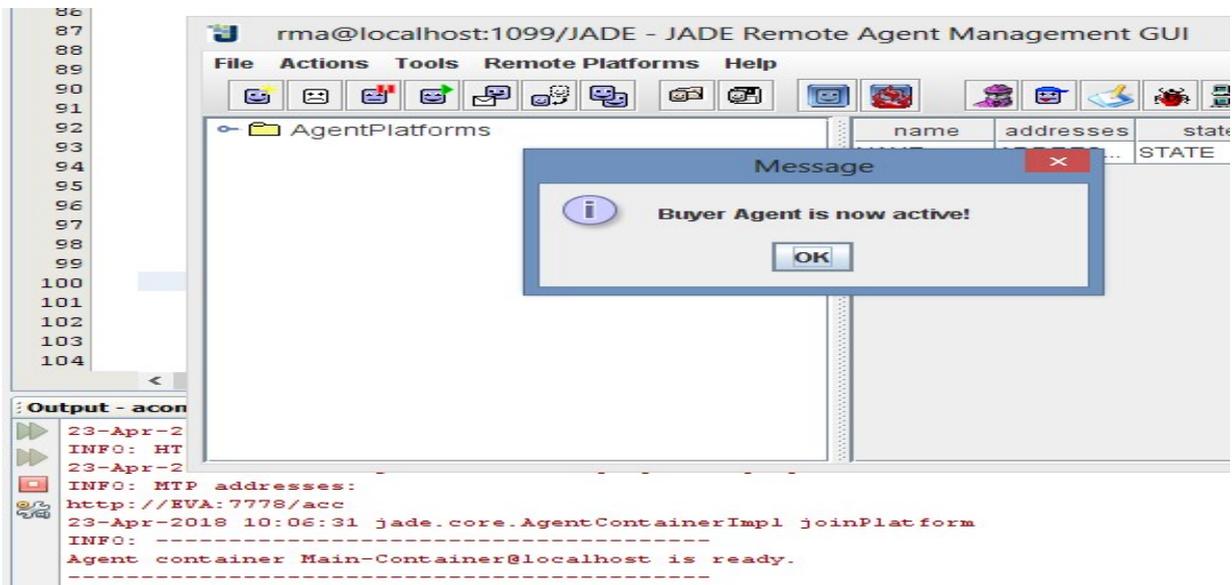


Figure 6: Buyer Agent Active

The screenshot shows a Java IDE with several tabs open: Acomms.java, ActiveSale.java, AgentMenu.java, Building.java, BuyerAgent.java, and Seller. The main editor displays the following code for the Seller agent's action method:

```

81     public void action() {
82         //receive message from buyer
83         ACLMessage msg = receive();
84
85         if (msg != null) {
86
87             if(msg.equals("pay")) {
88
89                 makePayment(buyer, MIN_PRICE);
90
91                 msg.setContent()
92
93                 null, "SELLER: p
94
95
96
97
98                 if (MIN_PRICE + 1000000 <= MAX_PRICE) {
99
100                     MIN_PRICE += 1000000;
101

```

A dialog box titled "Message" is overlaid on the code, displaying the message "Seller is now active" with an information icon and an "OK" button.

The console output at the bottom shows the following log messages:

```

Output - acomms (run)
23-Apr-2018 17:23:39 jade.mtp.http.HTTPServer <init>
INFO: HTTP-MTP Using XML parser com.sun.org.apache.xerces.internal.jaxp.SAXParserImpl$JAX
23-Apr-2018 17:23:39 jade.core.messaging.MessagingService boot
INFO: MTP addresses:
http://EVA:7778/acc
23-Apr-2018 17:23:39 jade.core.AgentContainerImpl joinPlatform
INFO: -----
Agent container Main-Container@localhost is ready.
-----

```

Figure 7: Seller Agent Active

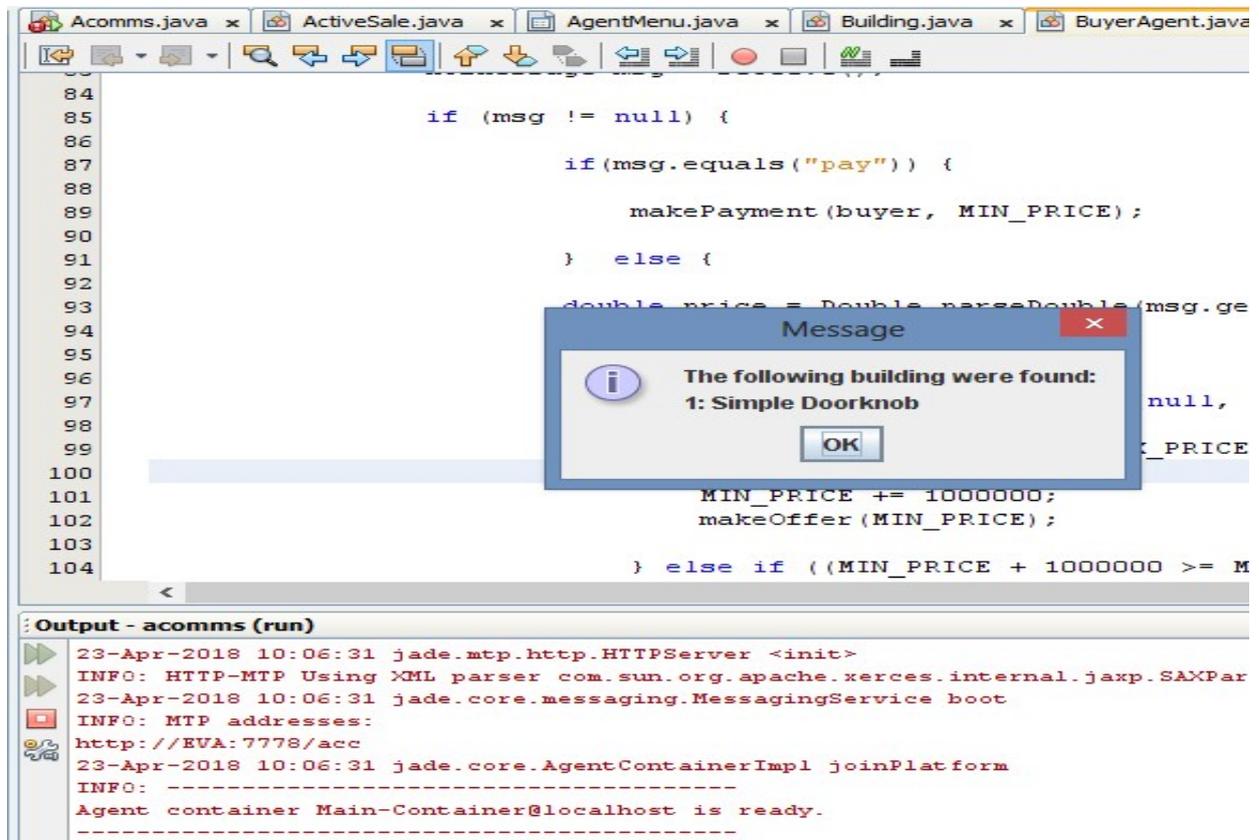


Figure 8: Seller Agent Response

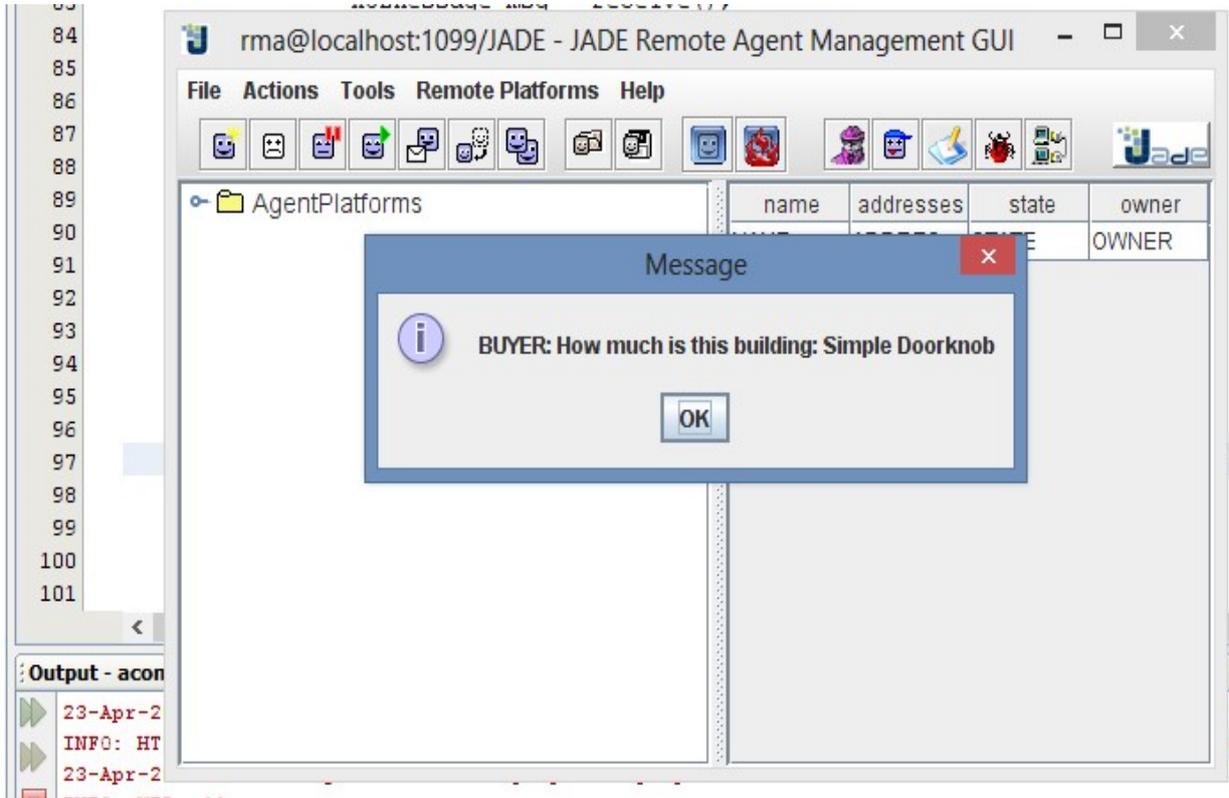


Figure 9: Buyer Response

Figure 10 below shows Java Output Window showing running status of Agents.

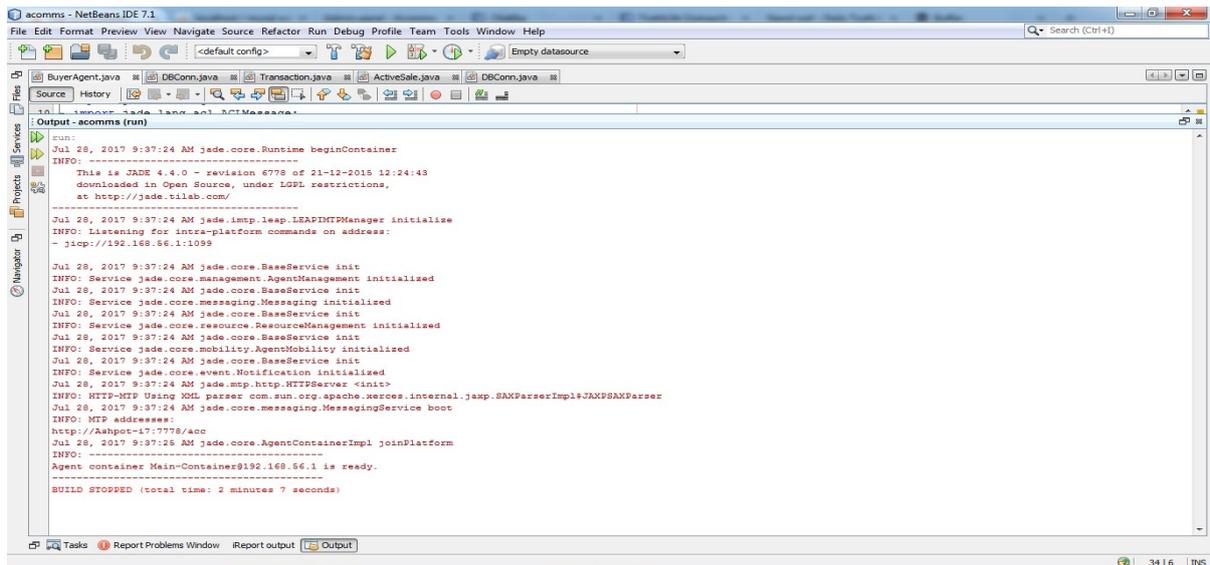


Figure 10: Java Output Window showing running status of Agents.

5. SUMMARY

In a bid to meet the task of providing reliable software agent-based real estate trading, an on-line software agent-based real estate trading system was designed to perform the activities of human agent such as connecting the right buyer and seller, negotiate price with the users dynamically over the internet as real estate properties (houses) are being uploaded on a daily bases remotely. The on-line software agent-based real estate trading system is an agent oriented web application system developed using JADE as agent platform, PHP as a scripting language, CSS as a style sheet and MySQL server as a database. Object Oriented Analysis and Design Methodology (OOADM) was used for the analysis, design and development of the system and unified modelling language (UML) was used to model the software.

5.1 Conclusion

The manual real estate trading system established has suffered a lot of backdrops, especially when it has to do with management of buying and selling of real estate houses. This application serves as a model tool that will help real estate industries, real estate practitioners and individuals to effectively trade real estate properties (houses) with ease. This research work has succeeded in demonstrating the practicability of deploying usable on-line software agent-based real estate trading system that makes available on the internet real time information and notification of real estate transaction, connection of right buyer and seller and negotiate price with the users. The focus of this research work has been on re-assigning the duties of human agent to software agent to reduce the involvement of human beings in real estate trading system. Finally, the adoption of the product of this research work when deployed in real estate industry offers a good contribution for the industry to meet up with some of the challenges curtailing the proper management of real estate trading system.

5.2 Recommendation

From the result of this study, the system is recommended for use in real estate industry for reliable buying and selling of houses, because it brings professionalism into the profession, saves time, reliable, efficient, Online and real time. It will also help real estate practitioners to trade real estate properties without necessarily being present. In addition, government, nongovernmental organisations, researchers can also use the application as a benchmark for research and real estate management.

5.3 Future Work

Considering the fact that the scope of this work is limited to trading of houses as a real estate property, the application could be boosted by including other activities of real estate industry like renting, leasing of both houses and empty lands to cover the activities of entire real estate industry. Next researchers should host this new system Online and link it with Netbeans IDE so that the agent functions of negotiation and communication will be implemented at the front end not at the back end. Cryptographic techniques could be used to introduce security mechanism that ensures the confidentiality and privacy of sensitive real estate transaction records in the system.

Secondly, classification techniques of machine learning could be incorporated in the system which finds patterns in information and categorizes them into different classes. This will classify the available houses according to their characteristics and features to form cluster groups of related houses to ease searching, selection and help to estimate price. With the increasing number of real estate trading data generated and stored electronically within the system, data mining techniques could be used to find trends and patterns in an abundance of information from many difference sources to discover, analyse and compose the data for more productive trading processes by real estate practitioners and real estate industries.

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