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Intelligent Agent Services in Distributed System

A Thesis

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بسم الله الرحمن الرحيم

﴿نَرْفَعُ دَرَجَاتٍ مَنْ نَشَاءُ وَفَوْقَ كُلِّ ذِي عِلْمٍ عَلِيمٌ﴾

صدق الله العظيم

سورة يوسف

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DEDICATION

To...

My family

My dear parents

My dear husband

My kid Yousif

All our distinguished teachers those who paved the way for our science and Knowledge.

Reem A. Qader

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Initially and foremost I deeply thank God, Lord of the worlds, for all the grace and helping to bring this thesis to its end.

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ABSTRACT

Global services with an agent or a multi-agent system are a promising and new research domain. However, several measures have been proposed to demonstrate the benefits of agent technology by supporting distributed services and applying smart agent technology in web dynamics. This thesis is a design to build a Semantic Web on the World Wide Web (WWW) to enhance the productivity of managing electronic library applications, where there is a problem that researchers and students endure, which is the process of exchanging books from e-libraries where they are slow or that the library needs large system data.

In this work a solution of this problem is found by using agent technology based on the "WebSocket," any user can use this library to get fast communication and high information based on the model existing in the e-library, a simple and small model is considered. In addition, the library does not need an employee library responsible for entering information into the library database, as it was placed in Firebase it's a cloud-based database that synchronization data across every client in Real-time, and supply offline functionality. Any researcher can access the form by logging in. This application is installed on the central library server and every user who uses this library gets a quick result. This work is proven in our current thesis. In average 10 requests in HTTP take 25 ms and in Socket.io take 19 ms , while 100 requests in HTTP need 168 ms and in Socket.io take 30 ms, as well, 500 requests in HTTP take 779 ms and in Socket.io take 102 ms, in addition 1000 requests in HTTP take 1520 ms and in Socket.io need 172 ms, Therefore, The proposed model is

about 5-7 times faster than the model being used HTTP. Also, in this thesis, the data transfer process and loading benchmarks were calculated.

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LIST OF ABBREVIATIONS

Abbreviations	Meaning
AI	Artificial Intelligence
AJAX	Asynchronous JavaScript and XML
API	Application Programming Interface
BaaS	Backend as a service platform
BCT	Block Chain Technologies
CAI	Computer Aided Instruction
CBT	Computer Based Training
CCA	Client Checker Agent
CDN	Content Delivery Network
CERN	Conseil Européen pour la Recherche Nucléaire
CLI	Command Line Interface
CMD	Command Prompt
COSMO	Customer Services M. Owl
CPU	Central Processing Unit
CSS	Cascading Style Sheet
DAFFODIL	Distributed Agents for User-Friendly Access of Digital Libraries
DARPA	Defense Advanced Research Projects Agency
DLs	Digital Libraries
DRA	Database Repository Agent
ECMA	European Computer Manufacturers Association
eLib	Electronic Libraries
FTP	File Transfer Protocol
GCP	Google Cloud Platform
GEMs	Global education management systems
HTML5	Hypertext Markup Language
HTTP	Hyper Text Transfer Protocol
HTTPs	Hyper Text Transfer Protocol Security
I/O	Input /Output
IA	Intelligent Agent
IAG	Intelligent Agents Group
IB	Intelligent Building
ID	Identification Data
IDS	intelligent distributed systems
IETF	Internet Engineering Task Force
IOS	iPhone Operating system
IoT	Internet Of Things
IT	Information Technology
ITS	Intelligent Transportation Systems

Abbreviations	Meaning
JISC	Joint Information Systems Committee
JIT	Just-in-time
JOSN	JavaScript Object Notation
JS	JavaScript
MAS	Multi-Agent Systems
MAST	Multi Agent Service Testing
MCA	Middleware Controller Agent
MUA	Mobile Urgent Agent
NLM	National Library of Medicine
NOSQL	Not Only SQL
NPM	Node Package Manager
PC	Personal Computer
PIN	Personal Identification Number
Pip	Pip Installs Packages , Pip Installs Python
PSSs	Power System Stabilizers
RDBMS	Relational DataBase Management System
RDF	Resource Description Framework
RFC	Request for comments
SDK	Software development kit
SMS	Short Message Service
SQL	Structured Query language
SSH	Secure Shell
SSL	Secure Sockets Layer
TCP	Transmission Control Protocol
TLS	Transport Layer Security
UI	User Interface
URL	Uniform Resource Locator
VR	Virtual Reality
W3C	World Wide Web Consortium
WS	Web Socket
WWW	World Wide Web
XML	Extensible Markup Language

LIST ALGORITHMS

Chapter One

Introduction

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Introduction

1.1 Overview:

Artificial Intelligence (**AI**) has revolutionized information technology (**IT**). **AI** is a subfield of computer science that includes the creation of intelligent machines and software that job and interact like human beings [1]. The field of **AI**, goes further still: **AI** attempts not just to understand but also into building smart entities. **AI** is one of the modernistic fields in engineering and science [2]. Work started in earnest soon after World War II, 1956 John McCarthy created the term Artificial Intelligence [3]. The subject of artificial intelligence (**AI**) is rooted in different research disciplines, such as philosophy [4, 5], computer science [6, 7], or futures studies [8, 9].

AI research is discrete into different research streams [10]. These streams vary on the one hand as to the topical of **AI** application (acting vs. thinking), on the other hand as to the type of decision making (an ideal, rational decision vs. targeting a human-like decision). This distinction leads to four research flows which are depicted in Table (1.1) According to the "Cognitive Modeling" (i.e. thought humanly) stream, an **AI** must be a machine with the mind [11]. This also contains performing human thinking [12], not only based on the same product as a human when given the same input but likewise on the same logic steps which led to the conclusion [13]. The "Laws of intellect" stream (i.e. thinking rationally) requires an **AI** to reach the rational decision despite what humans might answer.

Table 1.1: AI research streams based on Russell & Norvig [10].

Objective / Application to	*Humanly*	*Rationally*
Thanking	**Cognitive Modeling**	**laws of thought**
Acting	**Turing Test**	**Rational Agent**

Therefore, **AI** must follow-up the laws of thought through using computational models [14] which mirror logic. The "Turing Test" (i.e. acting humanly) includes that an **AI** must act intelligently when interactive with humans. **AI** must perform human tasks at minimum as pretty as humans [15]. These requirements can be tested by means of the Turing Test [16] finally, the "Rational Agent" flow considers **AI** as a rational [10] or intelligent [17]. This agent does not only act autonomously but also to achieve the rationally ideal score. **AI** and its Applications gets used in different fields of a lifetime of humans such as in Education, Computers have been used in education for over 20 years. Computer-based training (**CBT**) and computer-aided instruction (**CAI**) were the first such systems deployed as an attempt to teach using computers [18]. Application of artificial intelligence techniques in the design of power system-

stabilizers (**PSSs**), network penetration detection, in the medical field, in accounting databases, and in computer games, etc. [19].

In 1996, Broadcom Ireland formed a research collaboration with the Department of Computer Science at Trinity College Dublin, to explore the research in the domain of Intelligent Agents **(IA)** to use this new technology to applications in communications. The result of this collaboration was called the Intelligent Agents Group (**IAG**), Intelligent Agents are important topics in Information systems at the moment, and the first goal of **IAG** review is to report on researches in the accelerated evolution area of software agents and to highlight the possibility of application of this technology [20].

The agent is anything that can be viewed as perceiving its environment through sensors and acting upon that environment through effectors [21]. A human agent has ears, eyes, and other members for sensors, and legs, mouth hands, and other parts for effectors. A general agent is represented in Figure 1.1.

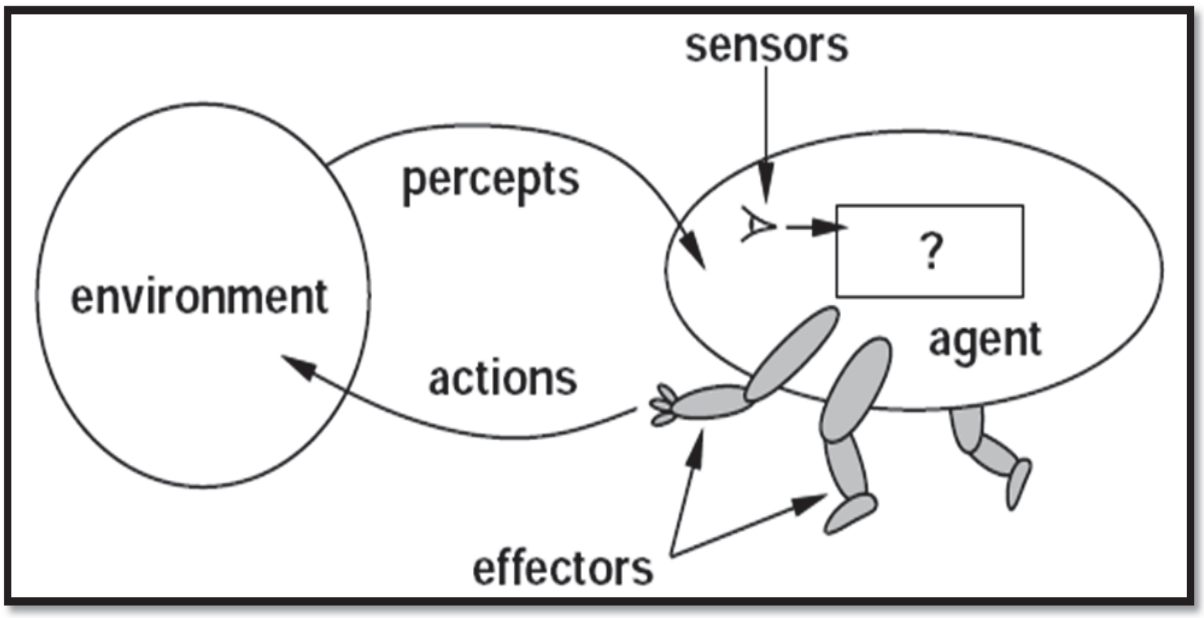

Figure 1.1 Agents interact with environments through sensors and effectors [21]

Applications of the intelligent agents can be classified according to their type of agent, by the domain of application and by technologies that used to implement the agent. The aim of producing this classification is simply to give a feel for the variety and breadth of agent applications. Here are the main applications of intelligent agents such as Industrial, Commercial Medical, Entertainment, and Comments Applications [22].

An intelligent agent is an autonomous computer system that has a smart technique that suite the environment to solve complicated problems. Any agent interacts with the environment through an agent life cycle, which means observe by sensing, deciding, and taking an action. To solve the most complicated problems that cannot be solved through a single smart entity, the modern approach agent services are developed. The distinguishing features of Agents are agents having an individual viewpoint and local control to solve a part of the problem meanwhile, all agents decentralized data and asynchronous processing in the agent's society. Smarter entities within a society can change the way of interaction between individuals belonging to this society. Human beings, intuitively, follow smarter people and adapt their behavior. An agent society is a society of software modules with socialization capabilities and two types of behaviors: firstly the individual behavior that launches from knowledge base built upon the creation of the entity plus reforming occurred due to the interaction with the environment. Secondly, social behavior is the dominant behavior [23].

Many software systems are generally distributed systems that are run on a broadly integrated group of the processors of a network [24, 25], many authors [26,27] have achieved research to test distributed systems that involve issues such as security, concurrency, timing and, controllability. Others [28, 29] have concentrated their

research on improving forward, the interpretation of the testing is prepared in order to make it adaptive and faster. The following results were obtained from the model In average 10 requests in HTTP take 25 ms and in Socket.io take 19 ms, while 100 requests in HTTP need 168 ms and in Socket.io take 30 ms, as well, 500 requests in HTTP take 779 ms and in Socket.io take 102 ms, in addition, 1000 requests in HTTP take 1520 ms and in Socket.io need 172 ms.

1.2 Related Works:

Several researchers have expressed interest in the intelligent agent, as it has an important role in all aspects of life, and here are some published works related to the current works:

- Sharples *et al.,* 1999 [30]: They discussed the learning in building govern systems, and contrast this process with existing intelligent building (**IB**) solutions. The authors clarified the importance of acquiring information from sensors to specific user needs. There is a new approach to the systems of **IB** that utilizes an intelligent agent process to autonomously controlling the building environment. They describe how their architecture, consisting of distributed agents and they show how these agents, employing a behavior-based process derivative from robotics research, are capable to learn and adapt to persons within a building. Finally, they show that such a system can be used to provides support for older people and allowing them greater quality and independence of life.

- El Yamany *et al.,* 2006 [31]: They proposed three –tire distributed system in software testing including server, middleware, and clients. The agent software represents a general agent and a mobile agent. The general agent applied in a framework that

consists of three-level agents. The first agent is a Database Repository Agent (**DRA**) within the server-side which response to monitoring data in the distributed application. Second, the middleware controller agent (**MCA**) in the middleware section which is the core stage of the framework proposed. **MCA** agent made the investigation process and create an integrated report by collecting the feedback from clients to conclude the process. The last agent located on the client-side. It's a client checker agent (**CCA**) and unit testing. Further testing is done by using Mobile Urgent Agent (**MUA**).

- Bai *et al.*, 2006 [32]: The authors developed an approach based on [25] to apply web service testing in a distributed system. The main idea is forced on classifying the test agent in different roles and the communication process is done by Extensible Markup Language (**XML**) based agent protocol.

  The Testing phase includes different tasks such as web testing creation, compact test planning, etc. in other words, every agent is responsible for one task. However, the tested agents are adaptive services taken by defining the tools which are used to communicate and generate each agent. While the rule-based system is proposed for test planning and agent communication. The three parallel and iterative stages are done in the testing process including test script. In summary, the Multi-Agent-based Service Testing (**MAST**) approach is concerned to support the universal testing and agent's classification process.

- Ma *et al.*, 2007 [33]: The researchers proposed an approach based on serving the communication between autonomous service agents and cross-enterprise applications by using a fabric agent. The fundamental autonomous system design is applying in the

fabric agent building process and is applied as message routing communication, highlighting the communication trust between agents in this work.

- Samanidou *et al.*, 2007 [34]: They gave a summary of the Donangelo- Sneppen model of the monetary exchange comparing it with related models in finance and economics literature. Their work dealing with many microscopic (agent-based) models of financial markets that have been studied by physicists and economists over the last decade. Their first aim is to reproduce thereby, and, provide explanations for the crashes and stunning bubbles seen in a historical episode, but they lack an estimation in terms of the global statistical lineaments of financial time series. This subject pursued by a number of contributions appearing in both the economics and physics literature since the late nineties decades. From the abundance of different multi-agent models that have manifested by now Levy, Solomon, Lux- Marchesi, and Huang models. Research questions are discussed in their concluding section.

- Liu, 2011[35]: The author aimed in his work to provide a comprehensive literature review on the use of intelligent agent technology in the library environment. The majority of the literature covers digital libraries (**DLs**) and there are fewer studies about services in traditional libraries. The application of agent technology in libraries is still at the experimentation and research stage. The survey has practical implications for libraries, librarians, and computer professionals in developing projects which employ intelligent agent technology to meet end-users' expectations as well as to improve information services within limited resources in library settings. This paper provides a comprehensive survey on the development and research of intelligent agents in libraries.

- Calvare *et al.*, 2018 [36]: The researchers present a systematic literature review of studies involving Multi-Agent Systems (**MAS**) and BlockChain Technologies (**BCT**) as solutions. The technology of MAS is widely used for the development of intelligent distributed systems (**IDS**) that manage sensitive data (e.g., healthcare, ambient assisted living, energy trading). Recent trends recommend to use **BCT** for **MAS**. Aim to provide a comprehensive overview of their application domains, they analyze assumptions, motivations, requirements, limitations and strengths presented in the current state. Moreover, discussing the future challenges, they introduce their vision on how **MAS** and **BCT** could be combined in different application scenarios.

- Khan and Bhatti, 2018 [37]: The aim of this work is to test the use of Semantic Web technologies for digital libraries. It also investigates the conceptions of university academicians and librarians in Pakistan about Semantic Web technologies and its use in digital libraries. Analysis of interview data was done to obtain results. The results of this paper showed that Semantic information, Dura Cloud, Onto Edit, and resource description framework (**RDF**) are the different Semantic Web applications that can be useful for digital libraries to develop semantic relationships among the digital contents and increase their accessibility in the web environment. The obtained results revealed that Semantic Web gave us precise results and meets the needs of user information in an effective way, also showed that next-generation of digital libraries use context-awareness technology, detecting sensors and software of intelligent agents to analyze user information needs and provide dynamic services. This paper conceives the future services of digital library and Semantic Web applications that can be used in a digital library.

- M¨uller *et al.*, 2019 [38]: The authors proposed an individual logic-based mechanism that amends reliability information to the data shared among the **MAS**. If multiple agents report the same event, their information is fused. In order to maintain high reliability, the machine detects and isolates misbehaving agents. Therefore, an attacker model is specified that includes faulty as well as malicious agents. The mechanism is applied to Intelligent Transportation Systems (**ITS**) and it is shown in a simulation that the approach scales well with the size of the **MAS** and that it is able to efficiently detected and isolated misbehaving agents.

- Bottino and Battegazzorre, 2019 [39]: The author focused to create the behavior of other non-human actors and it is a part of a larger project that worked on by multiple persons. The aim of the project was to make a virtual reality simulation to aid the therapists in studying and treating patients with apprehension disorders. The patient takes control of an avatar via a virtual reality (**VR**) headset and controllers and is free for moving in the store, communicating with other cashiers and customers, and also with different inanimate objects such as shopping carts or products on sale.
  The achieved results appear a good groundwork to improve upon. Especially due to the maximum modularity in both the behavioral aspect and the environment were of the most important in his project.

1.3 Problem Statement:

In electronic libraries, researchers and students are facing a problem in the process of exchanging books from electronic libraries as it is slow and the library also needs a large database to put electronic resources.

1.4 The aim of the thesis:

In this work, a small model was designed to be placed inside the electronic library in order to speed up the process of exchanging books from electronic libraries. Where were used agent technology depending on the WebSocket protocol, to obtain fast communication and high information, and any research and any user can access the model and it gets a quick result.

1.5 Motivation:

A recommendation is a web application that is so related to the consumer rather than the marketer, this is the challenge that is facing the recommended issue due to the wide spectrum of interests and demands of the cyber market. Different approaches and methodologies are deployed to cope with the rapid changes in market demands and interests. Expressiveness and interactions between the consumer and the recommendation are not the most important issue nowadays, the more important is the relation and the product, being advertising to the universe.

1.6 Thesis Organization:

The remaining parts of the present work include the following chapters:

Chapter Two: Theoretical Background

It contains an extensive overview to artificial intelligence, agent, and web socket technique. In addition, it presents the criteria utilize, background for the necessary techniques, and tools used in the present work.

Chapter Three: Design and Implementation of the Proposed Model

This chapter includes the steps of the proposed intelligent agent services system, describes the algorithms to perform that model.

Chapter Four: Experimental Results

This chapter shows the experimental work and the results which are acquired from the model running and the measures of the results of the test.

Chapter Five: Conclusions and Suggestions for Future Work

This chapter contains the conclusions which are obtained from the results of the present work and suggestions for future works.

Chapter Two

Theoretical Background