Research Article
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Design and Development in Intelligent Multi-Agent system in Software Engineering

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Abstract: Now-a-days, Multi-Agent is rapidly developing and fast growing area in computer science. Intelligent Multi-Agents are one of such upcoming technology which will have been evolutionary outcome on software engineering and all fields in computer science. The Intelligent-Multi-Agent (IMA) has object of special software that can work with integration and distributes information to accomplish task for achieving the goals. Multi-Agent takes decision on its behalf and assigns duty to agents which make (IMA- system) intelligently efficient. IMA- system in which multiple agent relate to develop their individual performance and to improve the system on the whole to make application more collaborative and interactive. We apply IMA technique in hospital system. For system IMA scenarios are designed and de-veloped. Developed system is then tested through testing technique on whole. The results proved prosperous for cost time and human resource after implementing IMA system rather using system without agents.

Keywords: Mobile Agent; IMA; Multi-Agent.

1. Introduction

In the field of Computer Science, the Mobile Agent is work of the art in the computer soft-ware engineering and data which is capable to roam from one computer to another individually and also sustain its execution to the objective system or computer. A Mobile-Agent particularly is a kind of Software-Agent and is with the attribute of independence, communal talent wisdom and the most significant mobility. More exclusively mobile agent is the method that will be able to convey its state from single circumstance to the other with its data vital and also proficient of performing suitably in the latest environment. Actually Mobile-Agent makes a decision when and where to shift or to move. Current concern in autonomous agent did not appear from blankness. Researchers and developers from a lot of unlike disciplines have been discussion about strongly correlated matter for various times.

The most important contributions are:
- Object orientation programming and concurrent object based system [9, 10, and 11]
- Human computer interfaces design [12]
- Artificial intelligence [13]

IMA recurrently interacts to distribute information and perform different tasks to achieve their goals. Multi agent cannot know each other without communication. Through cooperation and communication multi agent performs responsibilities intelligently and efficiently. Intelligent multi agent is a popular research object in the field such as Sociology, Psychology, and Computer Science. Intelligent multi agent has their root work in the field of software engineering. In Intelligent multi agent system the agents are of various kinds of size and intelligence and also Intelligence is directly proportionally to its size.

IMA used in experimental and ad hoc nature and in addition university and research centers and also a considerable numbers of companies research on agents. The technology of Intelligent-Multi-Agent seems set to fundamentally modify the way in which complex, distributed, open system are conceptualized and implemented [16, 19]. The main task of intelligent multi agent system is to perform active search for applicable information in non-local domain on behalf their user or customer or further agents [21]. IMA are reported such as more rapidly execution time, less bandwidth, and greater reliability [22].
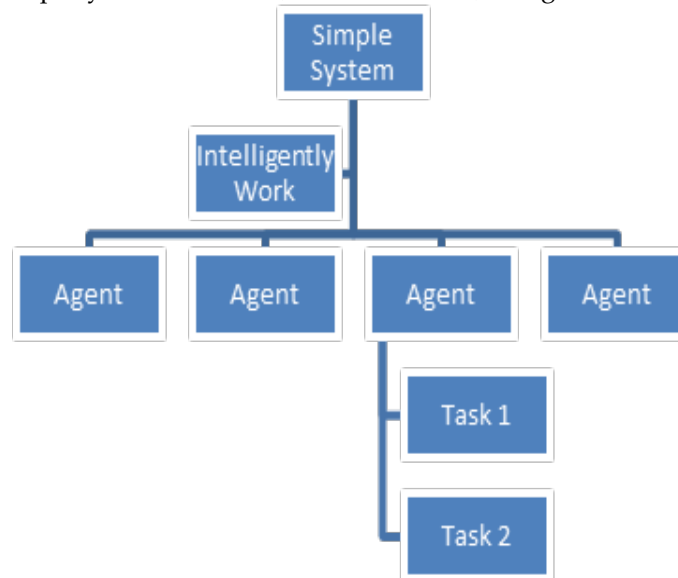

Figure 1. Intelligently work of Multi-agent in simple system

2. Literature Review

We review different types of literature like scenario in mobile agent or multi agent. There are some examples or applications that are used as mobile agent. Some application of multi agent is [8]:Mobile agent are used in dissimilar field but the idea of multi agent raise the functionality and provide acceptance to the customer or user and cooperation strategies resolving conflict between plans of a group of agent. Multi agent or cooperation relate on air traffic control field and the plan is to facilitate to all agent (aircraft) to make a sketch about flight that will sustain the secure distance with every aircraft in its locality and convince additional constraints (like as less fuel use and reach its objective and seat management).

Agents involved in potentially conflicting position and the one chosen agent is concerned to re-solve conflicting. The chosen agent is a centralized planner and expands Multi-Agent sketch that specifies the conflicts free of charge flight path that the agent will follow it. The conclusion which agent performs that what type of work that perform actively and perform job according to the criteria for example mainly Informed-Agent or more constrained agent [8].

Currently the electronic commerce is entirely determined by human interaction because only human know where to acquire and where to sale the things. There is no cause why some commerce is not mechanical because some profitable conclusion can be sited on the handover of agent. While prevalent of electronic commerce is possible to be positioned some distance in the future and a rising quantity of trade is undertaken by the agents. Different agents have special goals and implement special Strategies to achieve them and we predict agents embodying the communication of their creators, acting and also negotiating on their behalf [8, 18].

System along with network management is one of the initial application areas that exceed to improve using Intelligent-Agent technology. The movement is to client/server computing intensified and complicated to supervise mainly in the field of LANs and as network centric computing become further common this complication more escalates. The primary operator along with sys-tem management needs greatly basic management in these areas they look much difficulty. Architecture has existed in the system and network management region for some time although these agents are usually fixed function rather Intelligent-Agent. Intelligent-Agent can be used to improve system management software [16].

The system that describes and is designed to incorporate is the patient management process, which naturally involves many agents. For example, if a patient comes to health care center and performs his

treatment in different way like checking his sugar level and different test then diagnose disease. The surgical intensive care unit uses three types of agent which perform different types of duties [8].

Medical information is a main area in the computer science and latest application are being establish for computer in health industry and it is not surprise to use agent in this domain and two applications are used in this domain patient monitoring and health care [8].

3. Materials and Methods

It is essential for the hospital to keep tracks of its day by day performance like record of its patients, doctors, nurses, ward boys and other staff personal that run efficiently and effectively hospital system. We select hospital system scenario because of the data mobility. The agent whom we use in hospital system is data mobile agents. A Mobile-Agent particularly is a kind of Software Agent with the attribute of independence, communal talent wisdom and the most significant mobility.

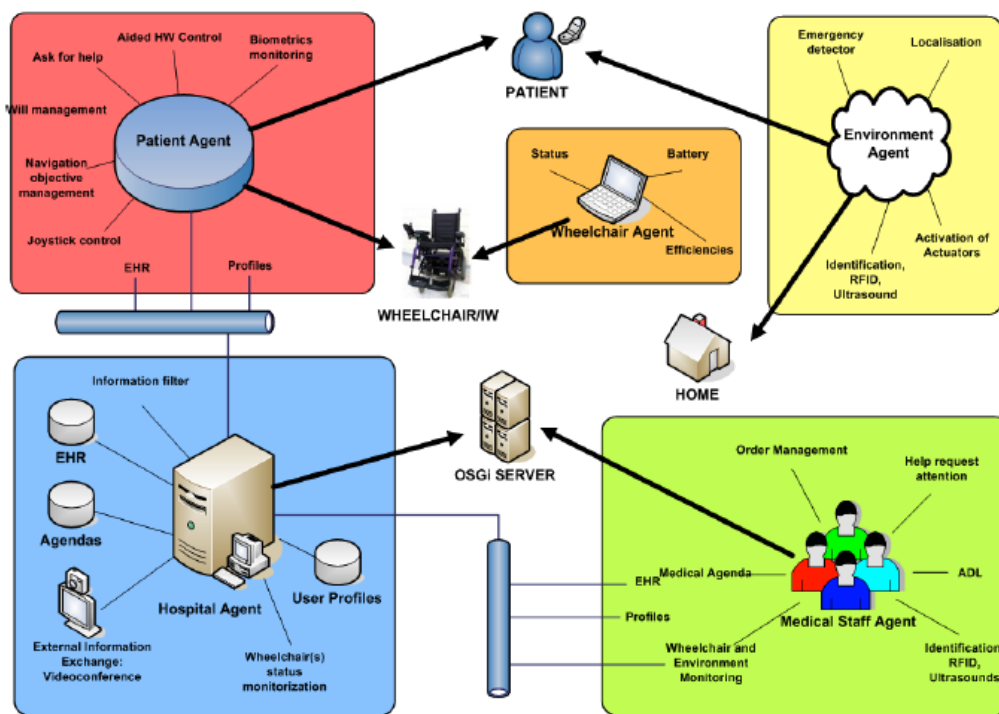3.1. Working of Multi-Agent in hospital system

Figure 2. Agent in hospital system in distributed environment [16]

3.2. Multi-Agent in hospital System

The hospital works on some module and some important function performs like relationship between different agents. So the patients come in hospital, login in the hospital, after registration, check, and allot agent for treatment. The responsibility of the admin for the checking the availability of Multi-Agent and allocate agents.

3.3. IMA Working

These all types of detail include in hospital system but we develop scenario in such a way to reduce time and cost.

The hospital system that we develop provide an effective solution   to hospital that plan to decrease the cost, time, less human resource of administrative and at the same time make available better services to the consumer. IMA include Multi-Agent like admin, patient and the patient include ward boy, doctor, staff, equipment. The equipment basically also an agent that provide equipment on time.
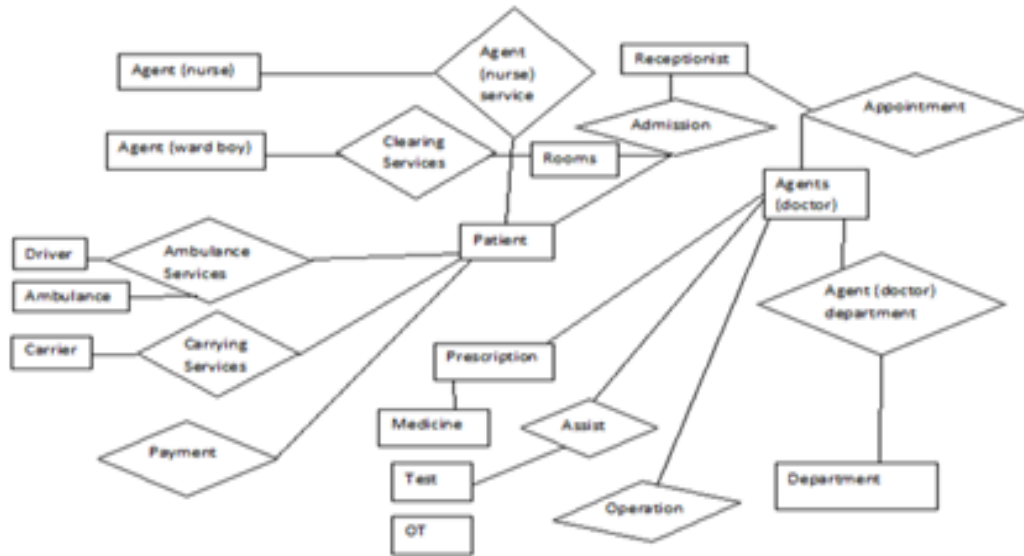
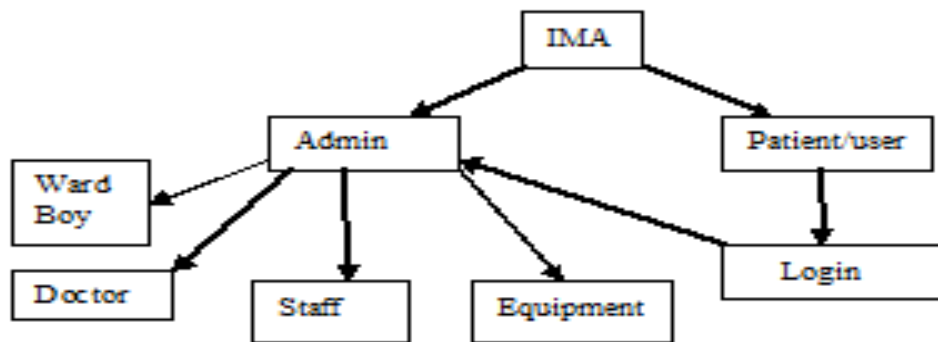**Figure 3.** Role of Multi-Agent in hospital system and agent cooperation
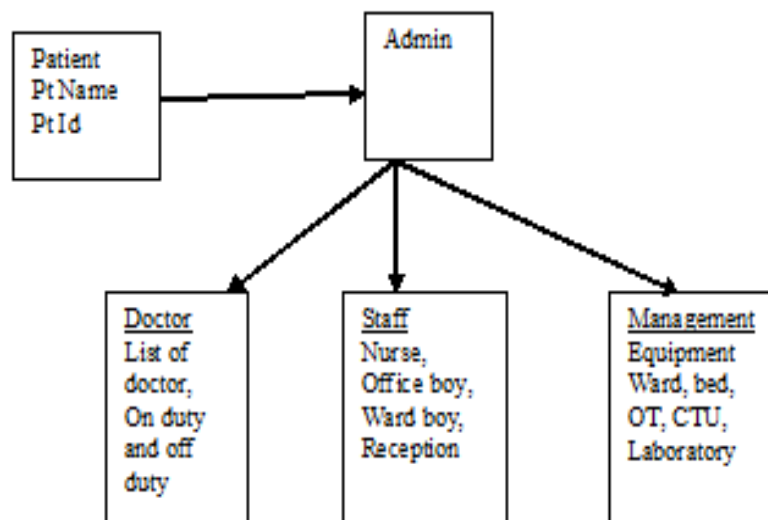

Figure 4. Working of IMA

Figure 5. Working of Admin

4. Implementation

Depending on the situation multi-agent implements in the hospital system and a hospital can implement the entire module in the single stage or in a phase manner. Specification is not end in software development and once given a specification so we develop a system that is correct with respect to its current specifications.

Hospital is very important place for the patient and doctor is also much important for patient. So many patients admit in hospital and when come in hospital then fulfill some condition. In the hospital different types of patient admit and different types of agents or multi agent look after him.
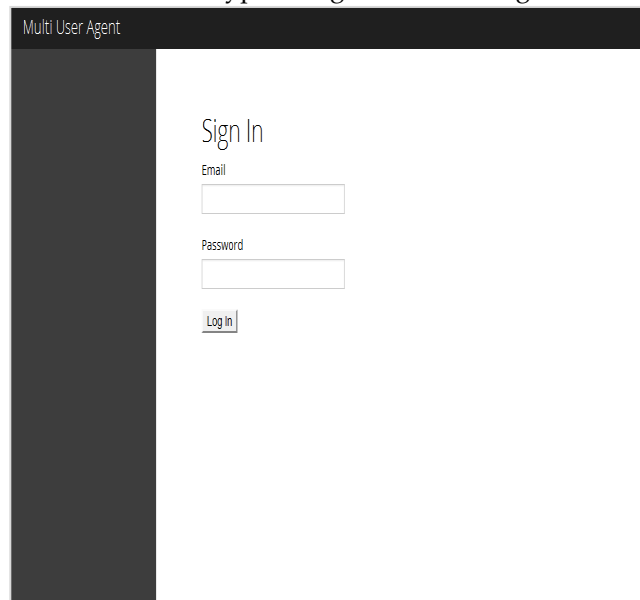
Figure 6. Multi User Agent Sign in Form

4.1. Home Page

This is the most important interface of our implementation and Doctor, Staff and taking under admin and patient work as user. Multi User visit hospital in daily routine for some purpose some are indoor patient, outdoor patient and some are emergency patient and if any patient visit hospital first register in hospital.

This interface used for the admin and the patient come in hospital and login and all detail going to the admin.

Sign in form include patient name and password and three types of patients come into hospital like

- In-Patient;
- Out-Patient;
- Emergency patient.

All types of patients when come in hospital then registration are necessary for every types of patient. Without login no patients registers or admit in hospital.

4.2. Patient registration form

When patient login or multi user login and enter its data and then patient agent create and its data provide it to admin. Different types of patients come in hospitals like

- Patient 01;
- Agent Pt (01);
- Patient 02;
- Agent Pt (02);
- Patient 03;
- Agent Pt (03)……………..so on.

After receiving data the admin creates agent for Pt (01) agent and the working module of multi agent is like such types. When matching done then admin agent create agent Pt (01) then it will create further agent to send message to concerned doctor staff and management.
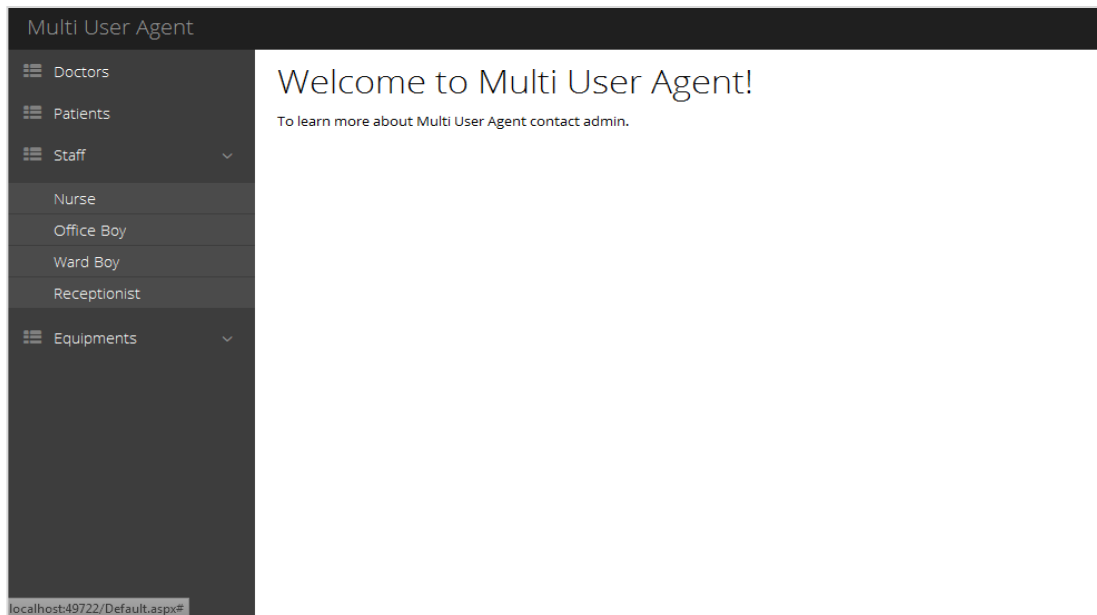
Figure 7. Multi User Agent Home Page

The agent checks the appropriate doctor and informs him and allots duty to the doctors and inform that the appropriate patient has allots bed number and room number. These types of information to the give doctor agent.

Patient detail include name, gender, Age, address….etc. So all detail necessary for registration in hospital system. Patient includes in Multi user in Hospital system and three types of information include in-patient, out-patient, and emergency patient. All types of patient need to login.

Different types of patient come in hospital and allot card no, name, gender, department and doctor allot to the patient. Different types of patient have suffered in different diseases.
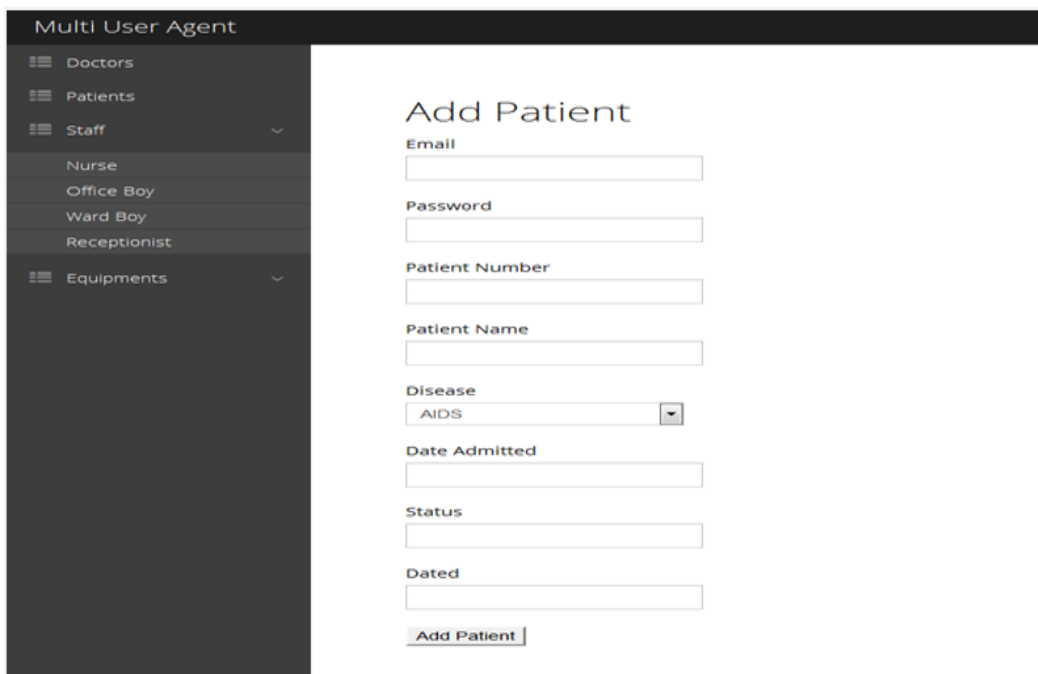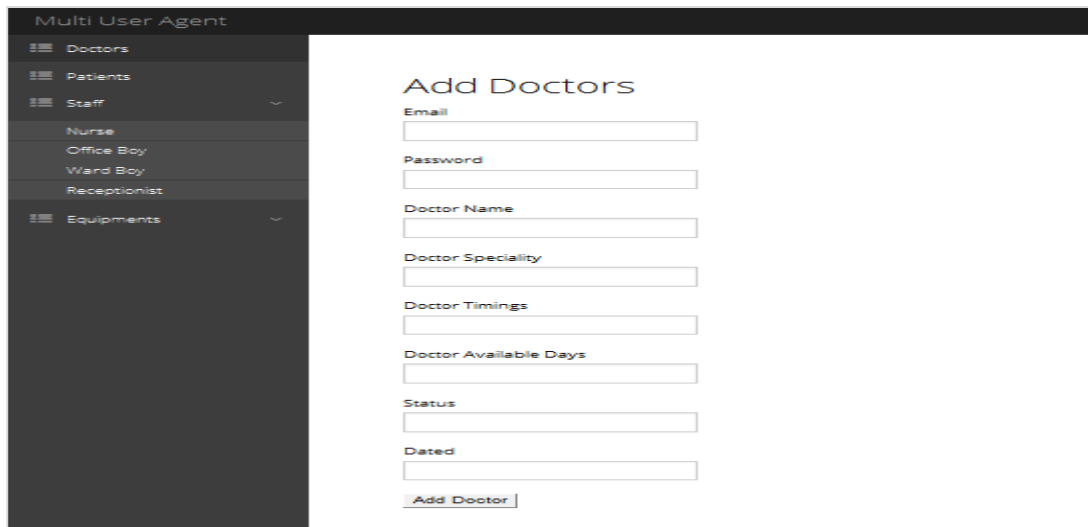

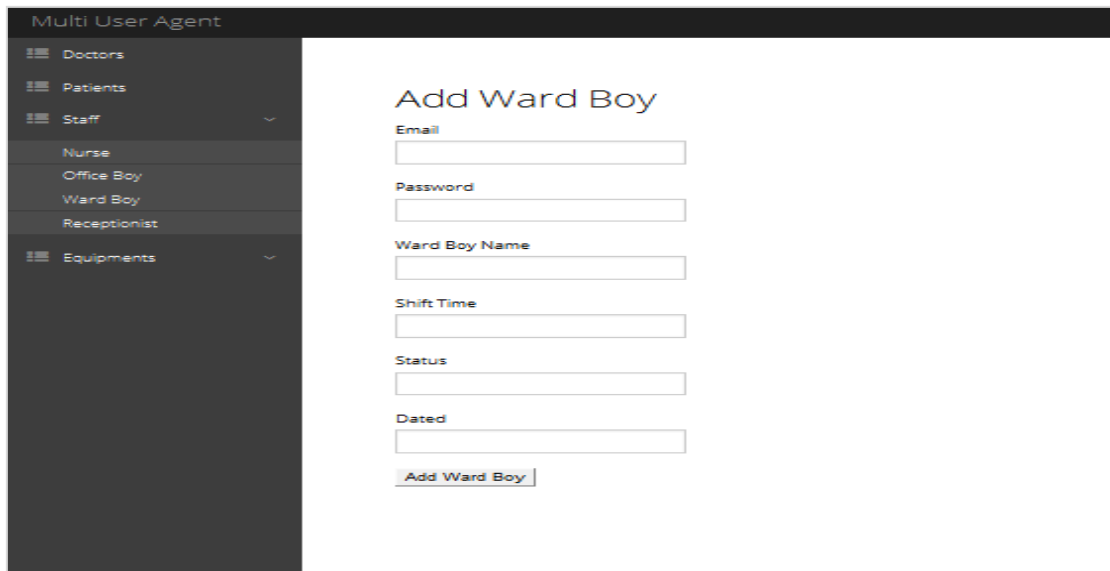**Figure 8.** Multi User Agent Add Patient

4.3. Add doctor

The doctors are very essential part of hospitals and without doctor the hospital not runs properly. All types of agents have its own importance but doctor and specialist are much necessary part of hospital so the functionality of doctor and availability of doctors are major need of the hospital system.
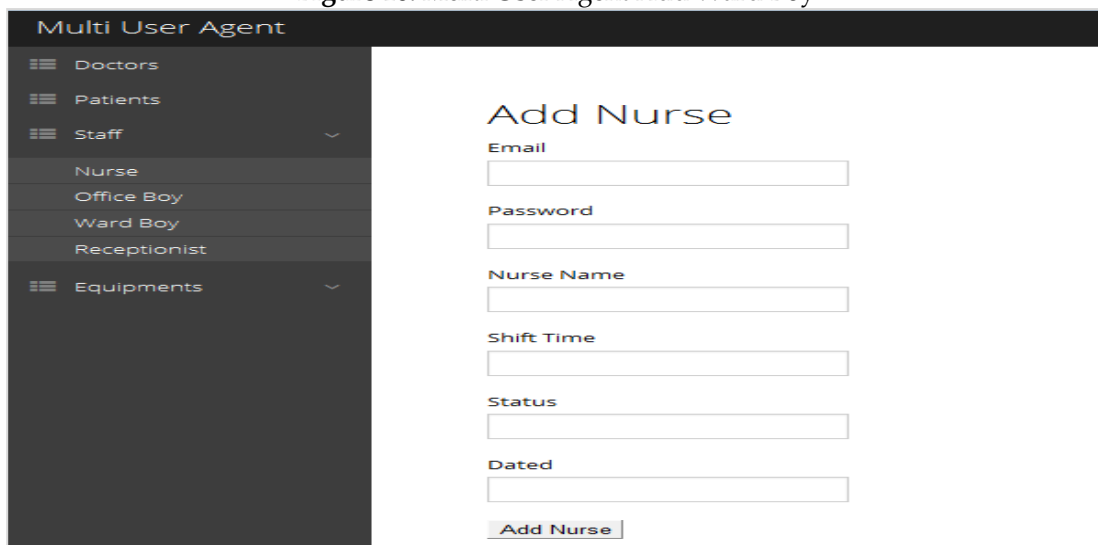
Figure 9. Multi User Agent Add Doctors

Figure 10. Multi User Agent Add Ward Boy

Figure 11. Multi User Agent Add Nurse

Figure 12. Multi User Agent Generated Page

The Agent generated page display the working in our Intelligent Multi-Agent system that works properly and efficiently. This is basically agent generated page or report. When patient registered in hospital then registered and allotment of doctor, nurse, and ward boy in hospital. The report generate contain such types of information

- Patient number
- Patient Name
- Patient Disease
- Allocated Doctor
- Allocated Nurse
- Allocated Room
- Date Admitted
- Status

Such types of detail generated after registration and allotment of all facility, agents.
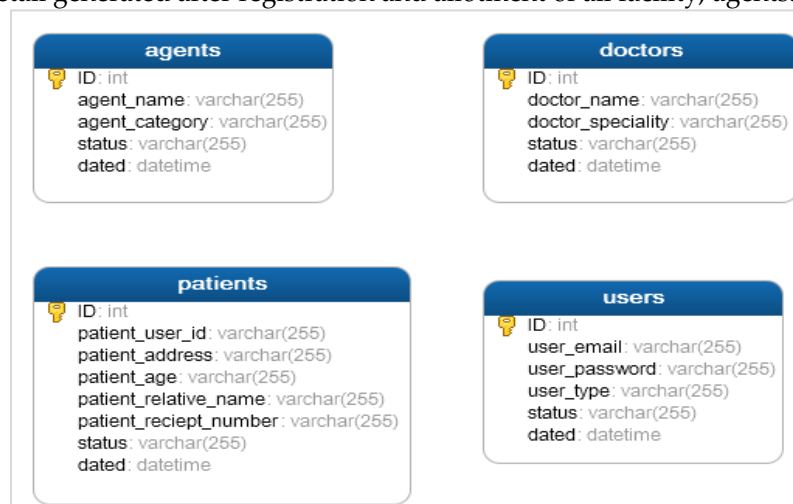
Figure 13. Current DB Schema

5. Testing Phase

The purpose of testing in our system is to validate and verify our development that relate to intelligent MAS. The communication among the multi-agents and the other agent some time not complete and clear and time is usually short. So result is not satisfactory. So the customer or patient feel unsatisfactory and trouble. That's why we used the technique of intelligent multi-agents and the intelligent multi agents fulfill the requirements of customers or patients intelligently and efficiently and take decisions according to situation on its behalf.

The purpose of system testing in intelligent multi-agent system is to consider all the variation to which it will be subjected and then push the system to its limit and if we implement the system without proper testing then it might cause the problems.

- Communication between the intelligent multi-agent and patients;

- Time frame of intelligent multi- agent clears to the attendant and other multi-agent in hospital system.
- The structure that's we plan should have the entire piece in the working order and work cooperatively.

5.1. Software testing lifecycle

Software testing apply some testing techniques on our development lifecycle such as

i.   Requirement study[30]

Testing cycle start through the study of patient requirement and understanding the requirement is very important for the test.

ii.   Test case design and development

The basic purpose of test case design plus development is section recognition and testing plan design and review.

iii.   Testing execution phase

The use of test execution is to code review, evolution, performance, and simulation.

iv.   Test process analysis

Test process Analysis complete on report and implementation.

Table 1. Software testing life cycle [29, 30].

Testing type	Specification	General scope	Opacity	Testing agent
Integration testing	Low and higher level design	Multiples classes	WB and BB	programmers
Unit testing	Low level designing and actual code	classes	White box	programmer
Acceptance testing	Requirements analysis	Whole manufactured in environment	BB	customer
System testing	Requirements testing	Whole result in environment	BB	Independent tester

5.2. Unit Testing

We apply unit testing to test the one module or one unit testing and test internal logic and also make sure inner design. After make up our application we are applying on unit testing and use method white box testing and test coverage technique and apply tool, debugger, and code analyzer.
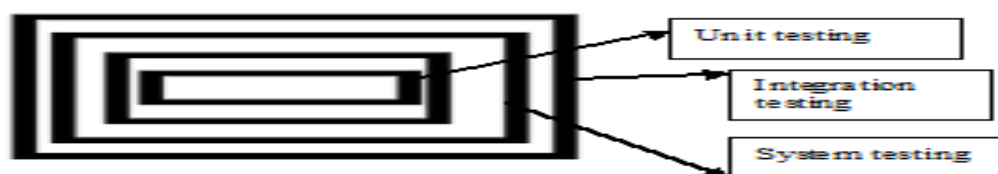
Figure 14. Level of testing applies on system

5.3. Integration testing

Integration testing involve build a system from its component and we use it for testing and solve problem that arise that during system interaction. Two types of integration testing involve such as:

1) Top down integration

2) Bottom up integration

We use integration testing to prove proper interacting between modules contained by subsystem. After unit testing we apply integration testing and the tool is used for debug, re structure and code analyzer. White box and black box testing technique apply on it in integration testing.

5.4. System testing

We apply system testing to test internal system. System test is used test functionally and operationally as specified. After integration testing we use system testing.

5.5. Acceptance testing

After apply system testing we use acceptance testing apply on our development and acceptance testing use the technique of black box testing.

Figure 15. Testing technique apply on all phase of our Proposed Work.

5.6. Testing technique

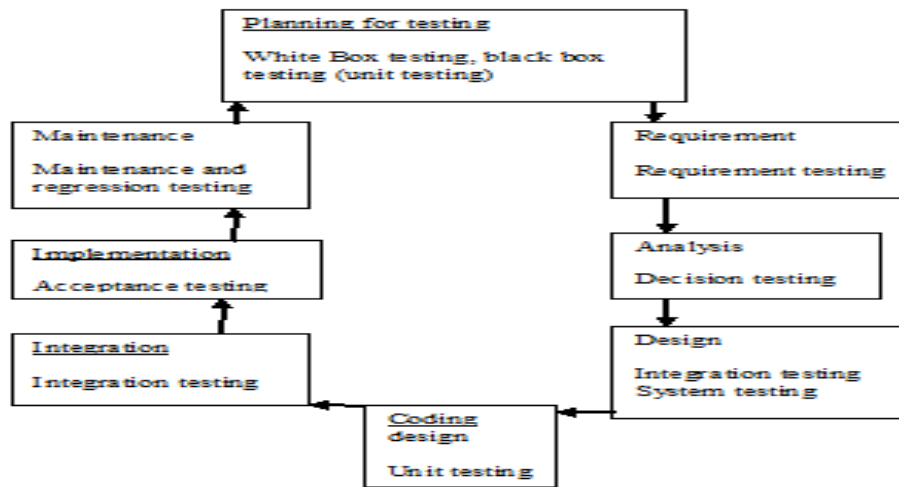Two types of testing technique apply more on our research and the technique includes white box testing and black box testing and we apply and then conclude result which is the best work of testing technique.
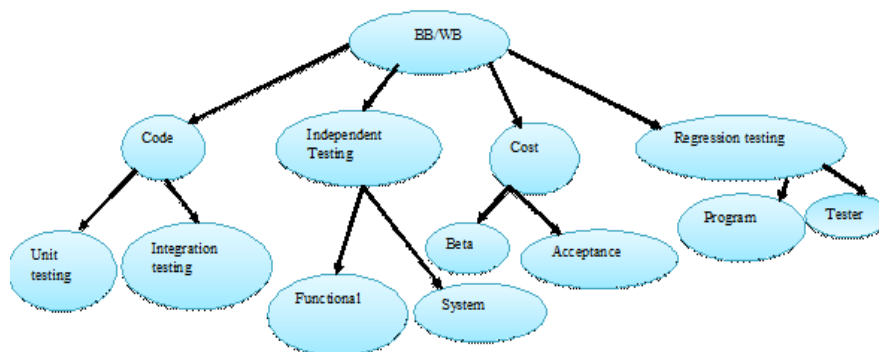

Figure 16. Testing spectrum of black box

In WB/BB testing we test code through unit testing and then apply on integration testing. Then in independent testing we apply functional testing and system testing and then apply regression testing and the beta and acceptance testing we will apply on it. Unit testing in black box is best applying on our research because unit testing apply on every phase of model. In this way our development works better because every phase depends on its previous phase. If every phase is tested already then it will save much time and the system that we develop will work in an efficient way. The testing technique include white box testing and black box testing if we use both then works best and result much better.

5.7. Testing technique apply on IMA System

Different testing techniques apply on our scenario. Unit testing apply on each interface individually like Add Doctor, Add Nurse, Add Ward Boy and Add patient. The result is No Error. After apply unit testing on each interface then apply integration testing on all interfaces collectively. The result is No Error occurred. Then check the whole system then apply system testing on our scenario. The result is Sorry No Error Found. We apply four testing technique apply on every phase of our system then our system working efficiently.

5.8. Result

The result we have got in our research is the scenarios that we develop give better result than existing system of hospital that's work without agents. Because in hospital the doctor sitting in hospital in fix time and if that type of doctors are not available if patients come to hospital then such types face problems that

occur and the patients refer in some other hospital and if emergency called that types of doctor was not available. So many types of problems occur. That's why we use the way of Intelligent Multi-Agent system to avoid such type of problems.

Table 2. Time table of doctor in hospital System

Name of doctor	Specialization	Timing first time	Timing second time
Adeel Rasool	Dental surgeon	11.00 to 2.00	Nill
Akhtar Rasool	Physiotherapist	Nill	4.00 to 8.00
Abdul Rehman	Dental surgeon	Nill	4.00 to 6.00
M. Waseem Sadiq	Laparoscopic surgeon	Nill	2.00 to 8.00
Tayyab hussnain awan	Medical specialist	9.00 to 2.00	6.00 to 8.00
Shoib Ahmad	Orthpedic Surgeon	10.00 to 2.00	5.00 to 8.00
M. Arif karim	Heart specialist	11.00 to 6.00	Nill
Khwaja Muhammad Arshad	Child specialist	12.00 to 8.00	Nill
Adnan Hameed Gull	Neuro Physian	Saturday7.00 to 10.00 Sunday 10.00 to 4.00	Nill
Lateef ur rehman	Ultra sound specialist	Nill	1.00 to 8.00

The doctor available in appropriate time and if doctor not available then problem create so Intelligent Multi-Agent technology solve such types of problems. So Intelligent Multi-Agent give better result than existing system because all time actively and intelligently. Intelligent multi-Agent reduces cost, effort, less human resource.

5.9. IMA Agents classification

Our system of Intelligent Multi-Agent is such types of agent that's including the functionality of different types of agents like as:

• Collaborative Agent

Our system provide agent collaborate with other agent and carry out intended task. So that we save time, cost.

• Interfaces Agent

Our system works as an interface agent and has characteristics like responsive, competence and accessibility. Each agent works on its platform and performs duties according it.

• Information Agent

Information agent is basically Intelligent Software-Agent and our system work intelligently. In this way we save time, cost and human resource.

• Intelligent Agent

Our system work intelligently and exhibit amount which saves time and cost.

• Cognitive Agent

Cognitive Agent works same as an intelligent agent.   In which our system works with its intuition in absence of human resource which is huge savior in software systems. Our system has the functionality of five types of agent. Our agents carry out intended task and provide interfaces, information, working as intelligently and cognitive.

6. Discussion

In our research we focus on agent and then mobile agent. The first approach that used is mobile agent. With the passage of time a new technology introduces multi agent and multi agent works better then mobile agent. In our research we first focus in mobile agent and their working then multi agent and main focus on design and develop of intelligent Multi-agent in software engineering. In our research we choose hospital system and doctors and nurses use as agents and administrator use as intelligent Multi-Agent. The intelligent Multi-Agent works efficiently and intelligently.

In our research we focus on Multi agent and the working of agents that work cooperatively and intelligently. The working criteria of agents are implemented in hospital system. In hospital three types of patient come in hospital in-patient, out-patient and emergency patient and the patient admit in hospital then the administrator heir an agent that work very actively and check the availability of the doctor that rooms. After checking availability then take action and give responsibility to the other doctor according to the patient. In this way Intelligent Multi-Agents work efficiently and intelligently. If a system that work without agent that not give better response as compared to multi agent. The Intelligent Multi-Agent gives much better response as compared multi agents.

When any Patient admit in hospital and login in hospital and the patient create its agent and the agent carry its data to the admin and the admin create its agent. Agent checks the availability of doctor, staff and checks the resources and will create further agents to send message to concerned doctor staff and management and then doctor receive message by the agent created by admin and will be the in time. Staff member like nurse, ward boy office boy allocate room, bed to the patient. The Agent performs duty intelligently and actively. So the result of such technique or way adopting give better result than the existing systems that work without intelligent Multi-Agent system. Intelligent Multi-Agent design and then develop and prove that the Intelligent Multi-Agent work proper and better.

The testing technique applies on our research and the unit testing is working best in code testing because we test each part of our development one by one and then integration testing apply on whole development. Intelligent Multi-Agent will be much famous technology and work best in future and people or developer realize the need of Intelligent Multi-Agent technology and will be used in every field with the passage of time. We compare our system with existing system of hospital and our system working better than existing system.

7. Conclusions

An important conclusion is drawn from this study that the cost of quality of software product and introduce a new way of approach intelligent Multi-Agent System and these are fast growing techniques. Intelligent Multi-Agent is the essential building block for the expansion of new creation triggered approximate computer science the research aim is to develop feature for the utilize in the upcoming technology. It's much problem the needs to overcome of ISA (intelligent software agent) in future progress. In future intelligent Multi-Agent has great contact in our communication medium.

Intelligent Multi-agent technology if succeed then it will provide solution many problems related to software engineering. In our thesis we set out design and development of intelligent Multi-Agent in software engineering like hospital system. We include examined the basic problems of requirement, implementation and then apply testing technique on them. Throughout we are careful about the research design and development in software engineering. We are hopeful about our research that gives better result and are much helpful for new researcher.

Basically Intelligent Multi-agent is a fast growing future technology and the researcher also aware about it. There create a revolutionized in the all field especially in the field of computer science. The new researcher adopts such technology that has much progress seen before the coming of few years. The system that's we develop reduce cost, human resource and time. Each agent works on its behalf and performs duties intelligently.

8. Future work

In future we develop such a system that can take major change in the field of software engineering. We properly develop scenario of Intelligent Multi-Agent system that can be used in different field of computer science in future. Every user or researcher can easily access. The technique that's we develop will create major change for the researchers in computer science. We develop such system in future that work like a network and reduce effort.

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