Mobile Agent Service Model for Smart Ambulance

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Abstract. In a highly connected world, widespread networking has imposed new needs that require new paradigms and new technologies. The mobile agent is an emerging technology that is gaining ground in the field of distributed computing for the processing and transfer of information on the network. In our previous article we study the mobile agent model which thanks to its autonomy, mobility and adaptability, can send and retrieve data in real time using a local and or distant interaction with other agents on the network. In this paper, we will discuss the case of the use of mobile agent model in a connected ambulance. This paper aims to give a brief description of the mobile agents model and illustrates some existing systems that use this model in telemedecine. Then we present the new concept of the ambulance of the future and our proposal of mobile agent model service in smart ambulance able to diagnose the patients condition and the appropriate service and data transmission to get an accurate response in real time.

Keywords: Mobile agent · Smart environment · Smart ambulance · Lightweight agent · Heavy agent

1 Introduction

Mobile agent technology is an emerging concept that is gaining momentum in several fields of applications, like mobile computing, e-commerce, Internet applications, user modeling, etc. The power of these agents in solving complex problems is due to their autonomy and mobility, they can achieve their goals in a flexible way by using interaction with other agents on the network.

Indeed, there are several reasons for using mobile agents, like: reduce the network load, overcome network latency, encapsulate protocols, execute asynchronously and autonomously, adapt dynamically, naturally heterogeneous and robust, and fault-tolerant [1].

Mobile agents are used in different domains like:

– Smart environment to follow the users as they move through different smart spaces [2].

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– In a wide variety of healthcare applications such as medical data management, medical information retrieval, health data integration, decision-making support, telemedicine, securing medical information and coordination of distinct medical activities [3].

In this paper, we aim first to give a flashback of the use of mobile agents in telemedecine and then the use of mobile agents in smart environment. We will focus on the use of mobile agent in the connected ambulance.

The paper is organized as follows: Sect. 2 describes the concept of smart ambulance, what this new ambulance is going to bring and using mobile agent in telemedecine. Section 3 presents our proposed model of smart ambulance using mobile agents. Finally, the paper is concluded in Sect. 4.

2 Telemedecine in Smart Environment

2.1 The Ambulance of the Future: A Conceptual Proposal

Ambulance concept is seeing a big shift, it passes an ambulance designed to transport patients to hospital, to an ambulance able to diagnose the patient's condition and the appropriate service. The ambulance of the future is a connected ambulance, intelligent, able to act quickly to save more lives. The most crucial aspect of the smart ambulance is its ability to send and receive data by contacting the hospital's doctors in real time. From here, we had the idea of using the mobile agent model to propose an efficient communication model based on Mobile Agents.

Related Works: Here we will talk about the different existing projects and ideas on the ambulance of the future:

Project SAEPP: brings together a group of European Emergency Medical Services and other healthcare organisations to form a consortium with the objective of designing and building a 21st century prototype of ambulance which will allow frontline clinicians to provide enhanced patient care on scene [4].

Smart Pods: the objectives of Smarts Pods are to understand current models of emergency care and provide the equipment and space they need to carry out more affective assesment and treatment on scene, thus minimising the number of patients admitted to hospital [5].

2.2 Use of Mobile Agents in Telemedicine

Recent studies have shown that mobile agents model facilitate medical and telemedecine applications. Its efficiency is due to its autonomy, capacity for adaptation and ability to communicate with other agents.

Mobile Agent: There are several types of mobile agent. In our case, we will use the following types of Mobile Agents:

- lightweight agents: small agents that have the ability of a very short displacement due to a very short transmission times because of their low cost bandwidth. These lightweight agents can migrate to any accessible item before it disappears.
- heavy agents: These agents are called heavy because of the size of the executable code and that of the transported data. They perform a task requiring lengthy periods of local treatments.

Related Works: In this part, we will provide examples of work that links mobile agents to telemedicine:

Secure Mobile Agent for Telemedicine Based on P2P Networks: to be able to communicate with patients remotely, telemedicine has opted to use mobile agents which operate in networks and have the ability to move from one server to another to find the right result. In this article, they talked about the construction of a secure telemedicine based on the P2P network architecture implementing 2 types of service model [6].

Mobile Agent based Ubiquitous Health Care (UHC) monitoring platform: is a mobile agent based ubiquitous healthcare platform so that patients could benefit from an automatic and real-time follow-up on their health without moving each time to the hospital(for patients who require medical follow-up) [7].

3 Proposed Model Based on Mobile Agents in Smart Ambulance

3.1 Using Mobile Agent in Smart Ambulance

Improvements made in the ambulance service focus on managing information and documentation aspects of medical incidents and patient care. The session is not interactive. Our objectives are divided into 2 parts: immediate objectives and objectives once arrived at the hospital.

Immediate objectives(along the way to hospital)

- Knowing the hospital to which the patient is associated thanks to the name of the patient.
- knowing the urgent care (current state) to be administered to the patient in the ambulance before arriving to hospital, according to his previous conditions and the information in his medical file.

Objectives once arrived at the hospital

- Prepare in advance the resuscitation room and the staff at the appropriate department of the hospital to which the patient is attached.
- Adequate device according to the declared state of the patient.

We will present a service model (Figs. 1 and 2) concern the case where the patient is attached to one hospital where he has his medical history.

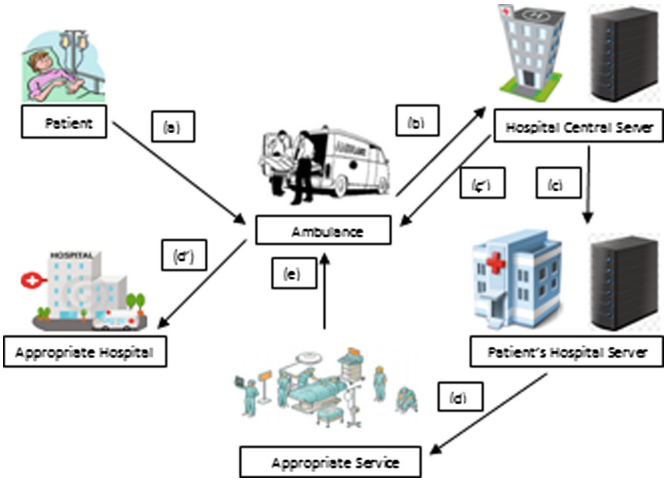

Fig. 1. Proposed Architecture for the first service model

(a) Once the patient is taken by the ambulance, the nurse identifies the patient and take his health parameters such as heartrate, body temperature, blood pressure, level of blood.
(b) This data are sent to the Hospital Central Server to see if the patient is attached to a hospital or not.
(c') Hospital Central Server sends to the ambulance the name of the hospital of the patient.
(c) Hospital Central Server sends to the appropriate hospital the name of the patient.
(d) The appropriate service looks for the patient's medical record to prepare the staff and sends to the ambulance the recommendations of patient.
(d') The ambulance takes the patient to the appropriate hospital.
(e) Appropriate service sends to the nurse of the ambulance the first care to make while awaiting the arrival of the patient.

3.2 Proposed Models Description

The diagram (Fig. 2) explains the role of the mobile agent model for data transmission to get an accurate response in real time.

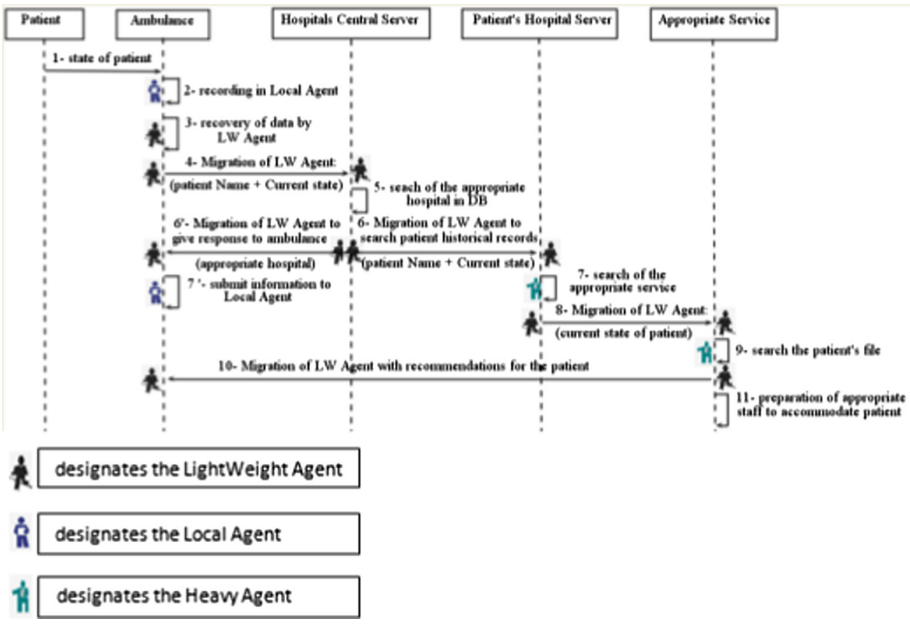

Fig. 2. Data transmission diagram for the first model sevice

1- When the patient is in the ambulance, the nurse takes the patient's name and current state (health parameters such as heart rate, body temperature, blood pressure, level of blood).
2- This data is recorded in the Local Agent in the ambulance.
3- The LightWeight Agent retrieves this data(patient Name + current data).
4- and thanks to its migration capacity, the LightWeight Agent migrates to the Hospitals Central Server, where is stocked which contain for each patient, the name and the hospital to which it is attached.
5- The LightWeight Agent looks in the database if the patient's name is already registered with its appropriate hospital.

Once found and thanks to the capacity of mobile agent to clone, the agent will clone to be able to do 2 tasks at the same time:

6'- Send to the ambulance the name of the hospital to which the patient is attached,
7'- and record the name of the appropriate hospital in the local agent to take the patient directly to it.

6- Migration of the LightWeight Agent to the patient's hospital to seek the appropriate service to have his medical record.
7- The LightWeight Agent will charge the Heavy Agents to search where each patient is registered with his identifier and the appropriate service.
8- Migration of the agent to the appropriate service with the current state of the patient.
9- Lightweight Agent searchs the medical record of the patient.
10- Migration of the LightWeight Agent to ambulance with recommendations for immediate care for the patient, waiting his arrival at the hospital.
11- Preparation of appropriate staff to accomodate patient when the ambulance arrives to hospital.

4 Conclusion and Discussion

Nowadays, everyone talks about the concept of Smart Cities and Smart Environment. For a city to become smart, it must begin by improving various areas that are part of the city like the health sector that is experiencing several problems. In this article we studied the case of Smart Ambulance, since the current ambulance knows many problems of design, problem of safety, etc.

Smart Ambulance is an ambulance that must be connected and able to respond quickly to emergencies and must be loaded with the latest healthcare technologies. The major challenges of the Smart Ambulance is to be able to diagnose the patient's condition in the ambulance and be able to communicate his condition to the hospital and have his medical record in a real time.

Our proposal is to send the data in real time and to set up an architecture that allows this using Mobile Agents which thanks to their autonomy and their ability to migrate and to clone allow to face these challenges.

We opted to work with the Mobile Agent model because of its ability to move, it allows to reduce as far as possible the remote communications to mobile agent transfers only and during the collection of Information in distributed databases and in the management of networks, it reduces the consumption of bandwidth.

There are several types of mobile agents and in this article we have choosen 3 types: local agent, light agent and heavy agent.

- The lightweight agents ensure the exploratory part, i.e. the agent migrates from one server to another to fetch the information and then retrieve it and each time it repeats the same behavior.
- The local agent ensures the reconstruction part, this part to which the light agent addresses when depositing his information.
- The heavy agent has the same principle of the light agent except that, as the name indicates, it carries several tasks.

In our future work, we will focus on the security aspects of our proposed service models.

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