Intelligent Home-Hospital System Based on Context-Aware Technology

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Abstract*—with the deep prevalence of the wireless network and sensor technology, the real time monitoring system with some application environment comes true gradually. This article designs a feasible Intelligent Home-Hospital System (IHHS) to a certain extent through the pivotal context-aware technology which plays an important role in the area of the pervasive computing and the Wireless Sensor Network (WSN). The system provides the patient who needs to be professionally nursed by doctors anytime with real-time, household and convenient monitoring conditions. With using the XML language in the system modeling design, this article implements some context conflict-solving technologies. According to the design, the IHHS would bring the innovation for the remote intelligent medical service.

***Keywords*- pervasive computing, context, WSN, Intelligent Home-Hospital System**

I. INTRODUCTION

With the rapid progress of the whole computer technology, our social life and production have been already changed by the computer science dramatically. Between the late 1980s and 1990, the significant concept of the ubiquitous computing (also called pervasive computing) was addressed by the chief scientist of the Xerox PARC: Mark Weiser [1], then the developing direction of the global computer application technology marches along this trend rapidly. The thought of the pervasive computing is that the computing and the environment will mix as unique and the computer itself would disappear from people's visual field. In the pervasive computing environment, people could get the information and deal with it at any time, any where and by any ways. Pervasive computing will greatly debase the difficulty of the equipments and make the life of individuals easier and more efficient [2]. Whereas the key technology needs to be solved is the technology of context-aware in its realization. The concept of the context presented to 1991 and many scholars have defined it. It's defined usually as the whole information which could be used to describe the situation of an entity. And so called "entity" are those people, positions and objects which related to the users and applications intercourse, including the users and the applications themselves. As the most important research aspect of the pervasive computing, the study on it will bring the strong promoting to the development of the pervasive computing.

Generally, pervasive computing combines context-aware technology which can handle, capture and analyze the context information [3], including 4 sub-technologies mostly: (1) context-getting; (2) context-modeling; (3) context-reasoning; (4) context-conflict-solving.

This paper will describe the idiographic application scene in section 2 [4]. The section 3 carries out the IHHS's context reasoning and conflicts solution. The last part concludes the paper.

II. DESIGN OF THE IHHS

The sensors' deploying manner usually includes two deploying environment: the deploying of the target area and the body of the target person in the IHHS.

The core equipment of this system is the context management server. The equipment will be in charge of the task for storage, reasoning and management of any kinds of the context data and provide the man-machine interface as shown in Figure 1.

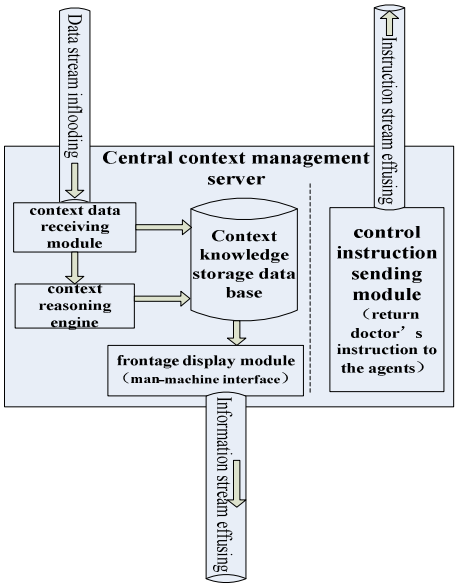

Figure 1 the structure of the context management server

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A. *Application scene*

A patient named Bill who suffers from hypertension, cardiopathy, etc, such geriatric diseases. He always stays at home and necessarily needs the real-time medical monitoring service. Hence, his house should be deployed as the target monitoring area. When Bill walks into a room, the RFID reader [5] "knows" his entrance by obtaining the information of the label chip embedded in his cell phone or other wearable apparatus [6]. And then it will send this context information to the context agent server at home. At last, the information will be sent to the central context management server and this "fact" will be the foundation for the reasoning after it is processed by the context data storage and aggregation in the context agent server. Some small intelligent sensors are carried with paraphernalia, e.g. the pocket of his bedgown, strap or wrist [7]. So when Bill rests in the bedroom, the sensors fixed on the wall will collect the room temperature, humidity, light brightness, noise intensity and other physical environment information uninterruptedly. Meanwhile, the wearable sensors collect his physical data. For example, Bill's heartbeat information will be collected by the sensor bound on his wrist; Bill's activity status information will be collected by the sensor wore on the strap. This information and the environment context information will provide the doctor who is in charge of monitoring with the important referenced evidences for remote nursing. Then the doctors make determination and send the instructions back to the agents deployed in the relative electric equipments with central context management server. At last, the agents will manipulate the equipments to accomplish adjustment immediately. For instance, today Bill's body heat is a little lower or the temperature sensor deployed outside feed back that the temperature descends and then the doctor will dictate the agent deployed in the air-condition in Bill's house opening the equipment to a proper operating degree to make sure that Bill will not be taken badly for the low temperature inside. Consequently, we achieve the goal: "Defer to the doctor at any moment". The logical structure of the application scene is as the figure 2 shows. According to the design, the old patient Bill will get the circumspective care at any time. One day, if the feedback data from Bill shows that his heart beat information abnormal or inactive suddenly and the intelligent activity status information shows that Bill's posture information deviant, such as too low — maybe Bill is lying on the ground; still — maybe he is shocked. Then the central management server will alarm intelligently and inform the doctor for requesting the ambulance (Bill's home address is recorded). If Bill is not at home but takes a walk outside and the disease outbreaks then the intelligent sensors providing the GPS localization to the hospital or ambulance and starting the agents embedded in the telephone informing Bill's family members and calling the police. The whole deployment design on the concept of the sensors as the Figure 3 shows.

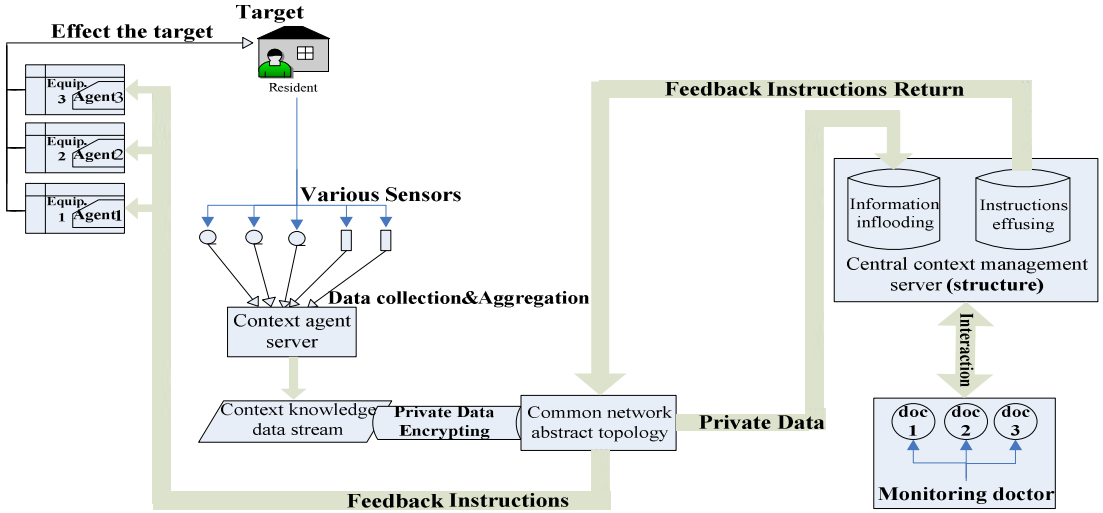

Figure 2 the working logic of the application scene

B. *System modeling*

Presently, the design for the context-modeling adopts the application technology in the semantic web mostly [8]. The modeling for Bill in the medical monitoring environment designed above at some time will be given here.

<!--use the name as the top label-->
<Bill>
<!--the label below describes the time information-->
<time>
<time_instant> TI 2008-12-04-07:00
</time_instant>
</time>
<!--the label below describes the space information-->
<geo>
<longitude>120°2'</longitude >
<latitude>53°</latitude >
<location>Bill's Home</location>
</geo>
<!--the label below describes the human heat data-->

<humanheat>36.5℃</humanheat>
<!--the label below describes the heartbeat data-->
<heartbeat>75beats/min</heartbeat>
<!--the label below describes the temperature data-->
<temperature>20℃</temperature>
<!--the label below describes the blood pressure data-->
<bloodpressure>130mmHg</bloodpressure>
<!--the label below describes the breath frequency data-->
<breath>17times/min</breath>
<!--the label below describes the locomotory/static status information-->
<status>static</status>
<!--the top label ends-->
</Bill>

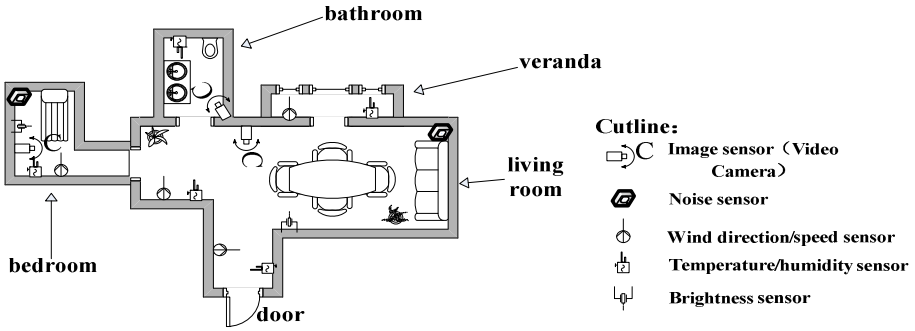

Figure 3 the ichnography of the sensors' deployment concept

The above case uses the XML modeling technology to model elementarily for the patient Bill in some key information of his.

After completing the modeling, the context data need to be wrapped in some format, for example, wrapped as n-members array with some semantics. The XML segment mentioned above could be wrapped further as the defined n-members array with the format: (source, status, location, time, humanheat, heartbeat…), importing the name, status, position and other information in turn [9]. The system will use these data structures to provide higher layers application services with this context information. The guarantee for the requirement for the context information of the different services across the fields in the different systems will be provided through the universal encapsulation. The logical structure of a context-aware system is shown in Figure 4, which context-aware system has five layers architecture as an OSI network model [10].

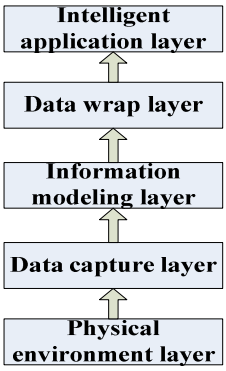

Figure 4 the logical architecture of the context-aware system

III. CONTEXT REASONING AND CONFLICT SOLUTION

A. Reasoning technology

The reasoning technology is the significant part of the context-aware technology. It is the key method of collecting more context information for the higher layer application and service [11]. It includes time reasoning, space reasoning and affair reasoning mostly [12].

B. Conflicts solution

Because of the distortion of the data gathered by the sensors or the bug of the logical rules, the conflicting context information will appear. Solving conflicts and disaccord before the context information is put into the context knowledge storage is a very important indispensable process.

A check-up policy will be constituted in this article. Bill leaves his watch-heartbeat sensor home and walks in the park with his PDA only. So the heartbeat sensor gets the heartbeat data 0 beats/min. But the context information feeds back from his PDA indicates that Bill is in continuous movement. And there will be a conflict in the reasoning engine of the central context management.

So the context reasoning engine will carry out the primary processing course automatically according to the policy established:

(1) Firstly, it instructs the heartbeat sensor communicating with Bill's PDA with the sensor-node-level communication to confirm the distance between them (the communications scope is about the human body). The result indicates that they are not in the efficient space (the space of the human body) at the same time.

(2) After receiving the feedback of the heartbeat sensor, the reasoning engine locates the position of the heartbeat sensor by the RFID sensors deployed in every room and starts the image sensor (video camera). Then it is assured that no one comes in by the personal image identification program.

(3) The reasoning engine instructs telephone system dialing Bill's PDA and Bill answers the hospital-system's automatic telephone. Then the reasoning engine receives the context information with the voice signal feedback. So the judgment that heartbeat data collected by the sensor is unreliable concluded through these. After that, an established label field of the context information will be set "UNRELIABLE". At last, the result will be outputted to the human-computer interface uniformly for the further judgment of the doctor in charge.

C. Contrasting analysis

This article brings forward a new and efficient conflicts checking policy. This section will contrast them in several aspects. Then the sufficient feasibility and unique advantage of the policy this article gives will be found.

There are 3 steps to define the policy designed in this paper: (1) Communication checking; (2) Position searching; (3) Feedback validation.

By the first step, the context-aware system can get a correct cognition for the present situation in macro situation. Whether the space relation between them is efficient can be confirmed through instructing the two sensors which are incompatible communicating with each other. And then the policy switches to the second step — position searching. The reasoning engine gives the conclusion by confirming the "iffy" sensors' concrete positions with position searching further after understanding the deployment situation of the conflicting sensors primarily. Finally, in the step of "feedback validation", the reasoning engine will use telephone inquiring, short message, video camera monitoring and other methods for actual validation completing validating the reasoning conclusion and send the results to the doctor in charge. And then it goes into the artificial reasoning phase. As a result of the main reason for the happening of the conflicts is contrived reason, for example, the untaken sensors or the incorrect operating, the policy designed in this article can make the engine find the reason for the conflicts in macro situation in the first phase. The Reference [12] brings forward a concept of the "Trust Degree" in its checking policy and that represents considerable checking projects. It defines different "Trust Degree" for the data collected by the different sensors and decides the tendency of the reasoning conclusion according to the values of the "Trust Degree". And it finishes the final conclusion by depending on the voice, existence or other environment parameters mostly. Although that policy can implement the conflicts checking to some extent, the checking project brought forward in this article has the incomparable advantage. This article adopts communication checking as the foundation of the project with the position searching aiming at conflicting sensors as supplement to accomplish the part of the machine reasoning but not carry out the reasoning depending on the subjective, constant and inflexible "Trust Degree" or other environment parameters. In the end, the artificial checking will be the end of the entire reasoning process for implementing the sufficient combination of human-computer and high reliability. That's very meaningful for avoiding fatal medical accident and saving monitoring resource. Furthermore, because of the special dependency for the other environment data, and if the data depended on is also anamorphic or wrong, the serious errors will happen to the reasoning results. Into the bargain, if the project does not adopt the checking thought — checking the conflicts aiming at the conflicting sensors and then the illogical dependency for other data will be inevitable. And that tendency will be the hidden trouble of the reasoning work.

IV. CONCLUSION

This paper finishes the design for the remote Home-Hospital system with some intelligence based on the context-aware technology in the architecture of the collectivity model, logical framework and inside modeling by using some key technologies of the context. And a new efficient conflicts solution policy is carried out. According to the design, the system will complete the design target in the application scene in the macro point of view. Some details of the programming work need to be put into effect in the concrete implementation in the underway. It is credible that the intelligent Home-Hospital integrated the WSN technology will bring the innovation for the remote intelligent Home-Hospital in the future.

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