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ITJ

ISSN 1812-5638

INFORMATION TECHNOLOGY JOURNAL

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Information Technology Journal 12 (20): 5616-5620, 2013
ISSN 1812-5638 / DOI: 10.3923/itj.2013.5616.5620

Design of Smart Space Context-aware System Framework

Wang Xiao-chi, Xu Jie and Fang Zhi-gang
Zhejiang University City College, 310015, Hangzhou, Zhejiang Province, China

Abstract: The emergence of Context-Aware Computing (CAC) environment makes context based Human-Computer Interaction (HCI) possible. The main problems faced CAC is the lack of a unified, general support for CAC system framework. This paper proposed a smart space oriented context-aware system called S2CAS in order to provide an idea to handle contextual information processing and services. We also designed and implemented ThinkMeeting prototype system based on S2CAS. We have established multi-modal sensors, embedded in a variety of information equipment and a variety of wireless network coverage of the smart meeting room environment. In this particular scenario, we describe and verify that S2CAS workflow.

Key words: Context-aware computing, smart space, human-computer interaction

INTRODUCTION

The major content of pervasive computing is to establish the interactive interface between physical space and information space and access to contextual information in order to achieve context-aware computing (Shi *et al*., 2003). The emergence of context-aware computing (CAC) environment makes full use of environment contextual information to perform Human-computer Interaction (HCI) possible. It is an important sub-area of pervasive computing. Context reflects the integration characteristic of information system and physical space (Antelopoulos and Bourbakis, 2010; Copetti *et al*., 2009). Users in the so-called ubiquitous environment are able to interact naturally with multimedia devices (PDA, PC, GPS, etc.), according to their position (at home, in the office or in public situation), their preference and another context information, so that they could finish their routine work. Researchers defined context-aware computing as make use of context information to provide the information and services which related to the user's work (Prekop and Burnett, 2003; Want *et al*., 1992). Specifically, it is divided into three aspects: Show information and services appropriately, implement services automatically, mark the context information (Dey, 2001). This paper discusses design principles of smart space oriented context-aware system framework and design a system framework based on them. Compared with common frameworks, analyze the functions of each module should have. We will analyze the structural properties of the framework which we designed from two perspectives of context-aware computing and smart space.

DESIGN PRINCIPLES OF SMART SPACE ORIENTED CONTEXT-AWARE SYSTEM FRAMEWORK

In the light of available functions, services the smart space provides and many kinds of existing context-aware system frameworks, we propose some design principles for smart space oriented context-aware system:

- The system must have a distributed and loosed structure. A distributed and loosed structure reflects the "anytime, anywhere" concept of Pervasive Computing. It enables user to enjoy the services provided by the context-aware system in a broader space and time
- The system should have property in expansibility. The expansibility involves two aspects of meanings. One pointed to device's expansibility, including the support of mobile devices entering into the intelligent atmosphere and basic devices in different intelligent environments. The other point is that different kinds of contextual information are extensible. The contextual information in intelligent environment has a dynamic and isomeric feature, so context-aware system must have a good support for this dynamic property that requires the system uses a context model of versatility
- The system needs to use a kind of hierarchical structure. Normally, the contextual information has been divided into two types: Low level and high level. The low level contextual information usually means that it can be directly acquired by many kinds of sensors from the intelligent space. And the high

Corresponding Author: Wang Xiao-chi, Zhejiang University City College, 310015, Hangzhou, Zhejiang Province, China

level contextual information means the information of human behavior, status, intention and so on. The high level contextual information usually comes from the low level contextual information by deductive inference. This deductive inference process needs to be completed by a context inference machine, but the services and applications directly related to user always be built on high level contextual information

- The system needs to have the ability of storage and processing the historical context information. There has a continuity property between the actions of human beings and facilities in the time domain of intelligent space. In most case, the historical context information is also an important context clue
- The system needs to apply user management interface. The system let users define the high level contextual information, for example user's preference, by themselves (Schilit *et al*., 1994). These context can be acquired through the self-study way provided by Bayesian network, it also could be implemented through the direct definition and prearrange made by users

A SORT OF SMART SPACE ORIENTED CONTEXT-AWARE SYSTEM FRAMEWORK--S2CAS

According to the several principles given above, this paper put forward a context-aware system framework orienting to the smart space-S2CAS (Smart Space Oriented Context-Aware System Framework). The framework is shown in Fig. 1 and overall S2CAS is mainly divided into three major layers: Primitive context-aware layer, S2CAS core layer as well as Application and Service layer.

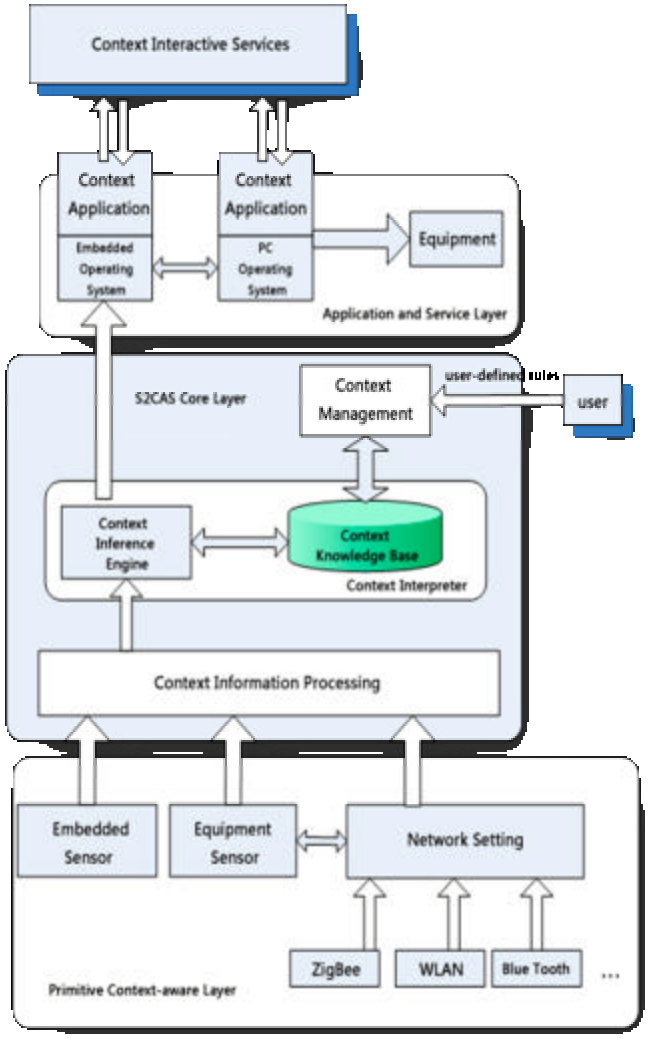

Fig. 1: S2CAS framework

The Primitive context-aware layer, which is situated in the bottom of the system, has its major function that is to obtain the primitive context information and data and then, make them available to deal with the core layer of S2CAS. In view of the application of intelligent space, the context information which we will need to gain should be divided into two categories. One is the physical context information, such as temperature, humidity, luminous intensity etc. Another one is the virtual context information. For instance, via the linking information of blue tooth or the Wi-Fi to discover the portable equipment such as PDA , mobile, notebook and so on, or through the RFID label to recognize the user's status and permissions, or gaining user's schedule information by the given software interface and so on. Moreover, this layer also has the certain function of information pretreatment. The intermediate layer of the entire S2CAS is the core function layer, which including the context information processing, the context explanation and the context manager these three main modules. The major function of the context information processing module is to transform the context information, which is obtained by the primitive context information sensation layer, into a kind of normative and formal context data. This process, is essentially a process of modeling the context, simultaneously, the acquirement and the processing of context information is foundation of the context-aware computation, while a good definition of context model turns into the key to realize a context-aware system. The context interpreter has two major function, the first one is to record the historical context information and user-defined context information rules and the second function is to transform the low-layer context information into high-layer. These two parts of functions are, respectively completed by the context knowledge basement and the context inference engine (Chen and Kotz, 2000). The module is primarily charge of the management of the context information and system, the reception of the user-predefined information (for example, inference rule, preference, etc.) and to standardize these inference rule and the clues as the form of rules and to save the them in context knowledge base, so the user may through the management interface to revise or extend the inference rules to make it applicable to the different situation of intelligent space and to be enable for the whole function of system to have certain extendibility. Furthermore, the context manager module can do the whole setting and the management of the system, simultaneously, can also do the direct operation and the management of the intelligent space equipment.
What located at system top layer is the application and the service layer, which provides the interface of the man-machine interaction and gains the high-layer context information from the context interpreter and provides the specific context-aware service for the users according to results of the context rule inference.

STRUCTURAL PROPERTIES OF S2CAS

According to the above description of the system structure, Table 1 summarized the principal characteristic of S2CAS.

Essentially, S2CAS is a kind of system structure which to process context information, it was just in some given applied situation (such as smart space) that can it be developed with clear purpose. Accordingly, it has common context awareness system layered structure.

S2CAS aim at achieve the auto-management among various routines, for example, meeting, agenda, document transmission, entertainment etc, in smart space. And this also implements the implied interaction between smart space and human being.

PROTOTYPE SYSTEM THINKMEETING BASED ON S2CAS FRAMEWORK

Smart meeting room is the application scene model of the prototype system, all applicationmainly occursin asmart meetingroom, the smart meeting room has the general characteristicsof intelligent space, whose equipment andresources mainlyincludethe followings:

- Various of informationequipment and terminal units, including PDA, server, notebookPC,printer, projector etc
- Abundantnetworkresources, with wireorwireless LAN, broadband internet access, Bluetooth connection between devices and so on
- Multimodalsensing device, including sensors of RFID, GPS receiving module on handsets, Bluetooth module, the embedded physical environmentsensors etc.
- Virtualinformation resources, including personal information of users, the schedule etc, which storedin a distributed database

In the following, we will take the conceptual model sceneas a basis, on which we combine and classify the resources and equipment, abstract classify variouscontext information as well astheconference scenecontext functions and services and finally to realize a prototypeof smart meeting roomwith a certaincontext-aware capabilities. Thinking of the heterogeneity of smart meeting room and diversity of the equipment and context

Table 1: Major characteristics of S2CAS

Item name	Characteristic	Illustration
Overall structure	Layered structure	including the original context Information awareness layer, S2CAS core, application and service layer
Sensor Level structure	Distributed sensing node	Sensor node has some information on pre-processing and control, linking by sensor networks, to provide the original context data for the system
Whether related to multi-operation system	Yes	Application and service layer, the system contains multiple devices and multiple operating systems, mainly embedded operating systems and computer operating system
Context modeling method	Based on Ontology modeling	Use of Ontology to standardize and formalize context information and describe the relationship between context information
Context inferential method	Use of the predefined context event sets and context clues to deduce fusion	According to the spatial characteristics of intelligent space to definite possible events set, fuse multi-context-time to obtain a variety of high-level semantic knowledge
Whether support historical context	Yes	Historical context information and inference rules stored in the distributed database, these constitute a context knowledge base
Whether provide user management interface	Yes	Through handheld devices, PC and other equipment, users could do event planning and inference rules changes
Whether support to expand mobile device	Yes	Can find and offer services to devices, including PDA and laptops etc., which are entered into the smart

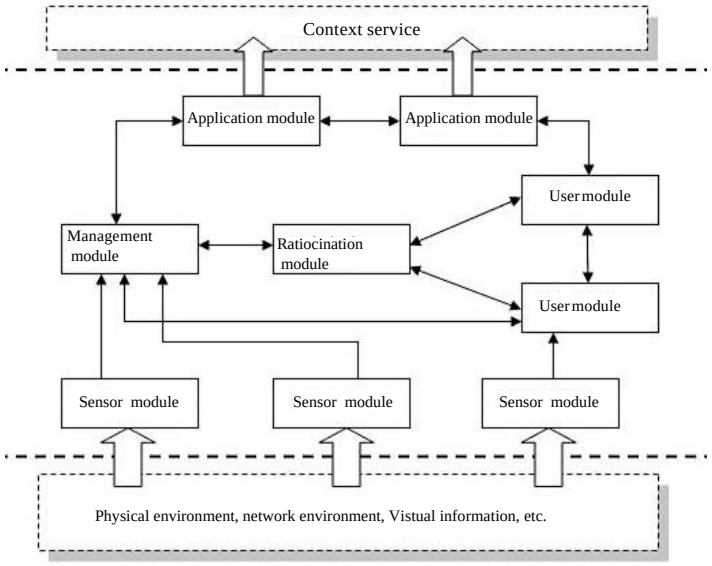

Fig. 2: Structural modules of think meeting

service, we decompose the ThinkMeeting system toseveralmodules according to the description of S2CAS framework, which are Management module, Inference module, perception module, user module and application module. The system structureandthe relationship between the parts as shown in Fig. 2.

CONCLUSION

In order to explain the structure, module function, data transfer process of the S2CAS framework in practical application, we designed and developed the ThinkMeeting prototype system based on S2CAS (published by another article), to implement some representative and smart space oriented context aware services in smart meeting room. The natural interaction between human being and intelligent space is realized by this scheme. The distributed frame proposed by this scheme has good expansibility and compatibility. This scheme is easy to put into practical and also have a good support for the updating of the technique. Its costs will be controlled at an acceptable area for normal users. At the same time, features and tendency of future human-computer interaction can be shown. And it will have a well development and research foreground.

ACKNOWLEDGMENTS

Our Research Project was fully sponsored by Bureau of Hangzhou city science and technology project, Hall of Zhejiang province science and technology public welfare project and Zhejiang University City College cross research foundation project with grant number 20120633B32, 2012C21038 and J-13027. Thanks for the sponsorships.

REFERENCES

Antelopoulos, A. and N.G. Bourbakis, 2010. A survey on wearable sensor-based systems for health monitoring and prognosis. IEEE Trans. Syst. Man Cybernetics, Part C: Appl. Rev., 40: 1-12.

Chen, G. and D. Kotz, 2000. A survey of context-aware mobile computing research: Technical report TR2000-381. Departement of Computer Science, Darmouth College, USA.

Copetti, A., O. Loques, J.C.B. Leite, T.P.C. Barbosa and A.C.L. da Nobrega, 2009. Intelligent context-aware monitoring of hypertensive patients. Proceedings of the 3rd International Conference on Pervasive Computing Technologies for Healthcare, Pervasive Health, April 1-3, 2009, London, pp: 1-6.

Dey, A.K., 2001. Understanding and using context. Personal Ubiquitous Comput., 5: 4-7.

Prekop, P. and M. Burnett, 2003. Activities, context and ubiquitous computing. Comput. Communi., 26: 1168-1176.

Schilit, B., N. Adams and R. Want, 1994. Context-aware computing aplications. Proceedings of the Workshop on Mobile Computing Systems and Applications, December 8-9, 1994, Santa Cruz, California, USA., pp: 85-90.

Shi, Y.C., W.K. Xie, G.Y. Xu, R. Shi, E. Chen, Y. Mao and F. Liu, 2003. The smart classroom: Merging technologies for seamless tele-education. IEEE Pervasive Comput., 2: 47-55.

Want, R., A. Hopper, V. Falcao and J. Gibbons, 1992. The active badge location system. ACM Trans. Inform. Syst., 10: 91-102.