

Design of the Middleware Enabling Context Awareness and Energy Optimizing for Smart Environment*

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Abstract. Context-aware computing is a class of new conceptual pervasive computing system, which spring up and develop rapidly recently. In order to screen heterogeneity of ubiquitous networks and support rapid development of applications in context-awareness, the idea of middleware is widely adopted. In this paper, the middleware is proposed to support the application development of context-awareness under the wireless sensor networks environment. It applies the updated service-oriented and light-weight structure with excellent expansibility and efficiency in the running process. The runtime structure of the middleware is presented. During the process of context-awareness, the new method of awareness synchronization is designed to ensure the sensitivity to context switch. The algorithm of the energy efficiency during the context-awareness process is designed and evaluated. At the end of the paper, a healthcare scenario is used to validate the design methodology and demonstrate the supporting function of middleware.

Keywords: Context Awareness, Energy Efficiency, Middleware, Smart Environment, Pervasive Computing.

1 Introduction

Context-aware computing is a class of new conceptual pervasive computing system, which spring up and develop rapidly recently. context-aware applications are more and more widely used.[1, 2]. Recent research on context-awareness mainly focuses on two aspects: the methodology of modeling and the mechanism of awareness process. Since context-awareness applications are usually characterized by “one scenario, one development”, the tools which support context-awareness application development are extensively studied and implemented. Dey [1] put forward a collection of context-awareness tools, some of which are reusable so as to support rapid development of context-awareness prototype. Also, Dey leveraged idea of middleware [3, 4, 5, 6, 7] is also employed. By defining the runtime architecture to co-support the development of

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application, it usually turns the common process into an abstract one and encapsulates all kinds of operation into interfaces.

In this paper, we initially propose middleware enabling context awareness and energy optimizing for smart environment, with the purpose to give a service-oriented middleware to bridge the gap between the programmable application layer consisting of different scenarios and the hardware layer consisting of extremely heterogeneity devices. In this process, the middleware utilizes a service-oriented, distributed-extensible architecture to achieve the service in each awareness service domain, and the aware process is achieved by applying rule-based reasoning. In context-awareness, how to perceive scenario switching remains to be an open issue. An agent-based method could solve this problem.

The rest of the paper is organized as follows: section 2 describes the design principles of the middleware. Section 3 analyzes its runtime mechanism, especially the context-awareness process and energy optimizing approach. The application of the middleware in healthcare scenario and energy efficient evaluation is demonstrated in section 4. Section 5 summarizes the paper.

2 Design Principles of the Middleware

The middleware plays the supporting role in smart environment and its application development. On one hand, it could make bottom hardware transparent. On the other hand, it supports kinds of scenarios to release the expenses, which is achieved by supplying reusable application programming interface or criteria in development. Main design considerations include as following.

A. *Service Oriented Approach in Middleware*

Most of the context-awareness application system works under certain type of phenomenon and flows in a certain limited region. Actually, context-awareness usually is a process in which many factors interact with each other. It is common that one process depends on the status feature of another one. The traditional context-awareness system could not deal with this situation for lack of communication when obtaining contexts. The service oriented methodology in the paper aims to resolve the problem.

The service receives, manages, stores, and distributes context information. It is designed as a light-weight multi-thread running model, and only includes the necessary resources for a context-awareness process, such as the related awareness facts and rules. This model represents the customize process.

B. *Smart Context-awareness*

As a branch of expert system, rule based reasoning has its certain requirements. Firstly, in context-awareness, rule based reasoning is an event stimulated execution based on enough condition rather than a fixed logical workflow. The rule based reasoning in context-awareness shields the change of logical workflow efficiently and reduces the expenses of development. Furthermore, as the rules of runtime are customized, the programmer could load many rules into rule engine dynamically to carry out the process of customized awareness and reasoning.