Context Modeling and Inference System for Heterogeneous Context Aware Service

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Abstract. Context can be utilized as an effective source of information for supporting the user system interface under the ubiquitous environments. The context awareness function forms the basis of the studies regarding the ubiquitous computing environment for creating numerous smart spaces, and a context awareness service is usually based on the context awareness system or middleware. However, conventional context modeling approaches based on ontology bear several problems. First, a context awareness service must share the context information with other context awareness services in the designing phase. Second problem is a context uncertainty, which can arise in the process of deducing the data acquired from the sensor into the context information based on the dynamic modification of the context ontology, must be resolved. This study proposes the context management system based on the dynamic context ontology management method, which involves the hierarchical context management method using common context and the paper proposes a method for resolving the context uncertainty problem of interpreting the data acquired from the sensors as two or more types of context information.

Keywords: Context Aware, Context Modeling, Ubiquitous Computing.

1 Introduction

The context awareness function forms the basis of the studies regarding the ubiquitous computing environment for creating numerous smart spaces, and there are several studies under way in universities and research institutes[1,2,3,4]. A context awareness service is usually based on the context awareness system or middleware. A context awareness system has a structure for generating the context information using the data acquired from the sensors and forwarding the data to the context awareness service. The context awareness services provide specific services to the user according to the context information received from the context awareness system. Therefore, the context awareness service must be able to clearly understand the significance of the context information conveyed from the context awareness system. There have been various studies on the techniques of context modeling, and the ontology modeling approach is receiving much attention, thanks to its capability to enable significance modeling exchange among systems.
However, conventional context modeling approaches based on ontology bear several problems. First, a context awareness service must share the context ontology with the context awareness system in the designing phase[5]. In turn, when a context awareness service is dynamically added to or deleted from the system, the new context awareness service cannot share the context ontology with the system under the circumstances where other context awareness services are not affected. In addition, the problem of context uncertainty, which can arise in the process of deducing the data acquired from the sensor into the context information based on the dynamic modification of the context ontology, must be resolved[6,7,8].

This study proposes the context awareness middleware based on the hierarchical context ontology management method, which involves designing of the common ontology hierarchy for the context ontology to be dynamically shared between the context awareness service and the middleware. The context awareness service dynamically defines the context ontology that it needs using the common ontology, which is forwarded to the middleware. The middleware integrates the context ontology received from the context awareness service with the domain ontology that is managed by the middleware for management. The context awareness middleware does not transfer all the deduced context information to all context awareness services, and only the context information that the context awareness services take interests is forwarded. Furthermore, the paper proposes a method for resolving the context uncertainty problem of interpreting the data acquired from the sensors as two or more types of context information. The context awareness middleware is designed using the proposed hierarchical context ontology management approach. The designed middleware uses the data acquired from the sensors to deduce the context information, which is delivered to the requesting context awareness service using the event delivery method. Compared to the existing studies, the designed context awareness system allows dynamic management of the context ontology according to service addition and deletion, and also has the advantage of resolving the context uncertainty issue.

2 Hierarchical Context Management Model

A context awareness service must be able to exchange context information based on identical understanding of the content among the user, devices and services. This chapter presents a method for dynamically modifying the context information required by the context awareness services operated from the context awareness middleware, as well as the hierarchical context ontology management and context uncertainty resolution methods in order to deliver the changes in the middleware so that the corresponding context information can be received from the middleware.

2.1 Hierarchical Context Ontology Structure

The context information managed by the middleware is constructed into the domain context information that is delivered to all services in the middleware and the individual context information defined for each service. All of the context information is defined by ontology. If a service is newly allocated in the middleware, the