Dynamic Service Composition in Semantic Internet of Things Based on QoS

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Abstract: There are some problems in the semantic internet of things, such as the limited resources of atomic services provided by physical devices and the dynamic changes of their environment. Based on this, this paper proposes a dynamic service composition method based on QoS in the semantic Internet of things. According to the QoS ontology of adding context, this method dynamically annotates the services in the semantic Internet of things, and dynamically selects and combines the service set to be selected. It can dynamically provide accurate services for service requesters according to service objects and service environment.

1. Introduction
The semantic Internet of things (IOT) constructs a global collaborative service ecosystem based on the semantic network, IOT, IOT and social network from the perspective of the basic elements of the information ecosystem, namely "people, machine, things", and their interaction. It integrates resources, settings, entities, tie-ups and other different objects to construct things and intelligent objects. Through Semantic Collaboration technology, it finally realizes the intelligent information exchange among people, machines, events and objects. Semantic Internet of Things is not a simple superposition of Semantic Web, Internet of Things, Internet of Machines and Social Networks, but a reverse extension to the above areas to achieve the whole process of semantic computing.

2. QoS ontology with context in semantic internet of things
The connection of semantic Internet of things and "things" makes the QoS parameters used to describe static virtual services no longer suitable for describing dynamic services embedded in physical entities. To solve this problem, the context factor and its association with the QoS factor are introduced into the QoS ontology. The context-added QoS ontology is formed. The dynamic nature of semantic Internet of things makes the QoS evaluation factors used to describe virtual static services no longer meet the dynamic services embedded in physical entities. In view of this feature, the context factor and its relationship with QoS factor are introduced into QoS ontology to form a QoS ontology with context added. The service description file is semantically annotated by using the relevant concepts and the relationship between concepts in the context added QoS ontology, and whether each QoS factor is a dynamic factor and the degree of user preference is annotated.

In order to describe all kinds of contextual parameters and their attributes in the context-added QoS ontology, a contextual parameter model in the context-added QoS ontology is presented. As shown in Figure 1, the related attributes of contextual parameters are defined.
In view of the new features of semantic Internet of things services, a service model in semantic Internet of things is proposed, as shown in Figure 2. It consists of three parts: service interaction, service function and service status. At the same time, service models, service resources and input/output information are provided with semantic annotation by related ontologies.

3. Dynamic composition of semantic Internet of things services based on QoS

3.1 Dynamic combination pre-processing process of semantic internet of things services based on QoS

In order to select and collaborate services in service library more efficiently according to user perceived context information and QoS constraints, it is necessary to preliminarily screen services in advance and get candidate service sets. The service filtering model in the pre-treatment phase of dynamic service composition is shown in Figure 3 below. The service filtering process in the pre-processing stage of service composition includes application domain matching, service description matching and service function matching.
3.2 Dynamic composition process of semantic internet of things services based on QoS

According to the different measurement methods and values of QoS parameters, it can be divided into numerical type, text type, hierarchical type and Boolean type. Among them, the numerical type can be divided into the exact type and the interval type, which uses specific numerical values to represent the value of the QoS parameters. Text type uses ordered and finite clauses to describe the values of the QoS parameters.

Because of the different dimension of each parameter, in order to make the mathematical modeling more reasonable and the calculation process simpler, it is necessary to deal with the QoS parameters dimensionless. The non-numerical parameters are treated numerically. Other types of parameters are represented by numerical values or sets of numerical values, so as to facilitate the subsequent standardization of various types of QoS parameters. The candidate service set C is represented by a matrix. If there are m QoS parameter values, then n x m order matrix:

\[
QoS = \begin{bmatrix}
Q_{R1} & f_{i1} & f_{i2} & \cdots & f_{in} \\
Q_{R2} & f_{i1} & f_{i2} & \cdots & f_{in} \\
\vdots & \vdots & \vdots & \ddots & \vdots \\
Q_{Rm} & f_{i1} & f_{i2} & \cdots & f_{in} \\
\vdots & \vdots & \vdots & \ddots & \vdots
\end{bmatrix}
\] (1)

The list represents the QoS parameters of the candidate service set, and the row represents the corresponding QoS values of each candidate service. The value of each service's QoS parameter is standardized. After numerical processing, there are only three types of QoS parameters: precise, interval and discrete. Next, we will standardize them.

The dynamic service composition algorithm based on QoS uses the combination of Breadth-First_Search and Depth-First_Search to find the optimal solution. In the process of dynamic service composition, the depth first algorithm is used to calculate the optimal QoS of services and data. When all the output data are satisfied, but the result of service composition is not unique, the breadth first algorithm is used to get the optimal solution. Based on the above analysis results, the dynamic service composition process based on graph search is shown in Figure 4 below.
4. Conclusions
Services in the semantic Internet of things are not only dependent on the physical devices with limited resources in reality, but also their environment and related information are constantly changing. In view of this feature, a QoS ontology with context added is constructed, and on this basis, the service description file of semantic Internet of things service is semantically annotated, forming a semantic Internet of things service description file with QoS restriction, which provides semantic support for further screening and composition of semantic Internet of things service. A dynamic composition method of Semantic Internet of Things services based on QoS is proposed. Based on the scenario-added QoS ontology, the system can dynamically provide more accurate services for service requesters according to different service objects and different service environments by perceiving the context of service requesters and physical devices and their impact on the quality of service information.

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