A mobile collaboration knowledge framework based on mobile ontology

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Summary
In order to depict the knowledge in mobile collaboration and effectively express mobile collaboration, a novel model MCKF — a mobile collaboration knowledge framework based mobile ontology — was proposed. At first, we give a description language been fitted to mobile application based on investigating to the application actuality of mobile ontology. Then, the basic concepts have been extracted from mobile collaboration and described them and their relations with MODL. Follow that, we created a visualization platform of MCKF that can provide powerful foundation for deeply comprehending mobile collaboration and more directly validate validity and rationality of knowledge framework and mobile collaboration rules. At last, we still give a specific instance of mobile collaboration game of mobile collaboration platform supported collaboration service. The MCKF and MODL have triumphantly applied to Mobile Collaboration Platform Supporting Collaboration Services (MCPSCS). The practice indicates that the MCKF and MODL provide a powerful means for advancing cooperation intelligence.

Key words:
Mobile Computing, Mobile Collaboration, Mobile Ontology, Knowledge Framework

Introduction

Along with the continuously consummation of mobile infrastructure as well as daily popularization of mobile termination equipment, the people can access any resources and services of network through each kind of terminal device in any time, any place. But along with the rapidly developing of information socialization, the people also realized mobile computation[1,2] should not only provide to the people the ability of data accessing, but provide more supports ability to carry on the cooperation. At the same time, CSCW[3,4] (Computer Support Collaboration Work) had the rapid development, since CSCW [5]as a discipline was founded in the first international conference of CSCW on September in 1986 which convened in the American Texas state, such as it has widely applied to the distance learning, distance medical, the video conference system et al. The people had the important research results on some issue of CSCW[6,7], for example HCI (Human-Computer Interaction) and HHI (Human-Human Interaction), SIS (Sharing Information Space) and CWS (Collaboration Work Space), conflict and coordination control, and so on. So, the people hope for supporting to collaboration with no spatial and temporal restriction and more drawn close to the natural way. Therefore, syncretizing the supports for mobility of mobile computing and the supports for cooperation of mobile collaboration becomes a new research hot spot of many domains overlapping. Because the inherent characteristic of mobile computing, such that terminal resource are limited and the wireless link is waved and the network connections are broken frequently, and so on, bring an obvious conflict question between it and the demands of CSCW, which CSCW demand the connection is continues and stable and the computing lies in terminal et al. So, the collaboration in mobile computing environment is facing many new challenges.

Follow above research about mobile collaboration, this paper proposed mobile collaboration knowledge framework based on mobile ontology—MCKF. At first, we give a description language being fit to mobile application based on investigating to the application actuality of mobile ontology. Then, we extracted the basic concepts from mobile collaboration and described them and relations among them with MODL. Follow that, we created a visualization platform of MCKF that can provide powerful foundation for deeply comprehending mobile collaboration and more directly validate validity and rationality of knowledge framework and mobile collaboration rules. At last, we still give a specific instance of mobile collaboration game of mobile collaboration platform supported collaboration service.

The second section in this paper summarizes the theoretic research. The third section describes the definitions and theorems about MODL (Description Language for Mobile Ontology). The fourth section presents the MCKF. The fifth section gives the instance of mobile collaboration platform supported collaboration service. And the sixth is the final summary of the whole paper.

2. Relation Work

2.1 Study of Mobile Collaboration

At present regardless of the academic and industries like IBM, Microsoft, CMU, Brunel, Cambredge, as well as domestic Tsinghua University, Zhejiang University,

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Shanghai Jiaotong University and so on have done a lots work in this domain. Among them, some research organization like IBM, Microsoft mainly focus on applying traditional CSCW to enterprise level application in mobile computation environment; And like CMU, Brunel, Cambridge mainly focus on cooperation processing aspect of wireless network video and audio conference and cooperation data transmission, and so on. Therefore, they are more the research about application and technology aspect, and few regarding the mobile collaboration theoretical model. Although also some scholars proposes some collaboration model, framework and application system architecture under mobile computation environment, for example literature [8-12], but they emphasize particularly on the technical realization that similarly lacks model from the theory description.

2.2 Study of Mobile Ontology

The near years, the ontology theory has gained tremendous development in many domains [13,14] . But the successful applied cases about it still have not been seen in the mobile communication and the mobile service domain from concerned literature at present. Regard of this we have carried on study deeply about it and got hold of some valuable conclusion about producing this situation. We think the reasons for the status have concluded the factors of not only ontology itself, but also mobile communication aspect and other economy aspect. They are some of such as: ①The factors on Ontology itself. The knowledge in ontology applied domain generally is quite standardized content, and few changing. In traditional domains, some criterion and rule were formed by a long time evolvement, and they facilitated expression and application, also standardization of domain knowledge. But the knowledge of mobile domain is highly dynamic changeable, or non-standardization, this lead to the difficulty to unification describing it;②The factors on Mobile communication. The patterns of mobile communication have the characteristic of mobility, multiplicity, and so on. Although W3C and some developer business developed some mobile communication standards and protocols, the patterns of mobile communication is still fairly complex because the communication technology on all kinds of communication devices was irregular and advantage among operation business is difference. For example, mobile communication service relies on the actual application value at very great degree, all kinds of factors such as the actual benefit, the service type, the type of communication, even user community always impact research and development for ontology of mobile communication domain.

Although the ontology theory has many restrictions in the motion domain application, but it still has beautiful progress prospect. At mobile communication, many mobile communication organizations and producers all need the unified standard fit to widely application very much for promoting each kind of new technology and the application the broader scope; At ontology, the superiority of ontology theory gradually has been embodied in other domain, it has been expanded in the mobile domain is inevitable trend.

Whereas above, we proposed a mobile ontology description language, shortening as MODL

3. Mobile Ontology Description Language

3.1 Component of MODL

MODL (Mobile Ontology Description Language) refers and profits from a lots research achievements of predecessors in ontology interactive language aspect, mainly includes below 3 parts, such as: ① Formalized semantics and effective inference support in description logic; ②The frame system provides basically modeling primitive; ③ Based-XML standard grammar symbolism DAML (DARPA Agent Markup Language).

Fig.1 shows.

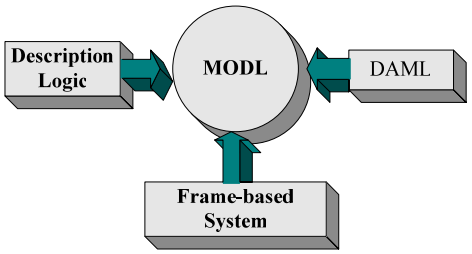

Fig. 1 The component of MODL

3.2 Layered Model of Knowledge Description

Here, the layered model of knowledge description is suitable for the dynamic knowledge description. Any previous ontology language is unable simultaneously to satisfy the user in all domains and request of the application system to the knowledge description. In order to strengthen extension of MODL and make it gradually to enrich the modeling primitive and the description method, following the application domain unceasing expansion, we extract the idea of layered model from the software architecture (SA). We take MODL as a set of multistage sub-language level combination. It is said that the layered model of MODL completely satisfies in the definition of layered model in SA, each sub- language level can

strengthen the MODL function and the complexity. Low level sub-language provides supporting service for the upper, for example statement grammar symbol, modeling primitive and semantics and so on. Upper level sub-language calls the function which the underlying level provided to realize the new service. Under not changing interface, each sub-language level may update independently, provide new modeling primitive and grammar symbol. Thus make the design, the development, the promotion and the application of MODL has a stronger distributional characteristic.

At present, there are mainly include 3 levels in the MODL layered model. Just like each sub-language level may expand, the level of the MODL layered model also will be able continuous add and modify following the further research. This presents superiority of the layered model.

The MODL layered model like Fig 2 shows.

①Core MODL level. As the layered model foundation structure, the core level only contains the most basic standardization modeling primitive and the grammar express, here uses a primitive conforms to defines the standard and the communication mechanism of the general FIPA[15] organization, provides general and facility grammar symbol, succinct semantic description and the simple feasible communication mechanism for application. Because it is a general, the most foundation primitive, the expansion based on it may regard as the ontology defined by user based on the foundation primitive, and the expansion also can transform the form described by other ontology like OWL, RDF, XML, with HTML and so on.

②Extended MODL level. Because the core level provides the basic general modeling primitive and the grammar symbol, the main function of this level mainly has two aspects, One is the expansion and richly modeling primitive. It is said that add some primitive defined by user over the core level to support formidable modeling function. Another is to optimize grammar symbol and rich grammar symbol expression or distort to original grammar symbol.

③Complex level MODL level: Based on the foundation and expansion primitive, rich and substantial description and the restraint about primitive, tries hard to contain covers all domain knowledge and provides more complex and appropriate description language for domain application.

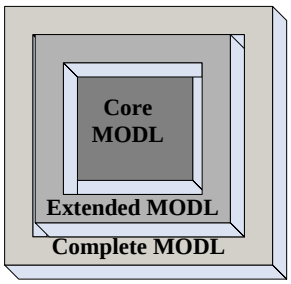

Fig. 2 Layered model

3.3 Modeling Primitives of MODL

In mobile ontology, it is through kind, the slot and the slot restrains that portrays the concept and the concept mutual relations. Among them, class completes a class name and the corresponding description mapping, namely, it defines a class name, and make the corresponding definition description; The slot completes one slot name and the corresponding description mapping, namely, it defines a slot, and make the corresponding description; The slot restraint in the essence is a anonymous class (same as expression of class), contains instance of all class satisfying the restraint condition. The restraint condition defined aims at some slot and it limits some function components in the dual relation (for example, the slot value territory or scope attribute).

Based on above, we began to construct the mobile collaboration the knowledge frame description.

4. Mobile Collaboration Knowledge Framework

4.1 Concept extraction and Expresses

The essential factors that we depict the mobile collaboration are group, member, task, role and act. Therefore, we extract five basic concepts from mobile collaboration like Group, Member, Task, Role and Act. They have been described as follow.

Def. 1: Group

Let Group as G, then

$$G ::= (Gid, Mid, T, E, R) \quad (1)$$

In expression (1), Gid is unique identifier of Group; Mid is unique identifier of Member in a group; T is the task of group

E is a set of environment information surrounding group; R is a set of all role in a group.

Def.2: Member

Let Member is M, then

$$M::=(Mid,Content,State,IsEngaged,R,\ EngagedTask,Executing,Environment) \quad (2)$$

In expression (2), *Mid* is unique identifier of Member in a group; *Content* is basic information of member; *State* is task content of member; *IsEngaged* indicates if the member is vacancy; *R* is the role acted as in a task; *Executing* indicates the carrying task at present; *Environment* is environment of member.

Def.3: Task

Let Task is T, then

$$T::=(Tid,PRI,Useful\text{-}life,Rating,Content,\ Partion,Granulatity,Mode) \quad (3)$$

In expression (3), *Tid* is unique identifier of a task; *PRI* is the PRI of a task; *Useful-life* is the useful life of a task; *Rating* is grade of a task; *Content* is the context of a task; *Partion* is the rule of a task partition; *Granulatity* is partition granularity of a task; *Mode* is partition mode of a task.

Def.4: Role

Let Role is R, then

$$R::=(Rid,Ab,Ac) \quad (4)$$

In expression (4), *Rid* is unique identifier of role; *Ab* is ability possessed by role; *Ac* is a set of action in a role.

Def.5: Action

Let Action is Act, then

$$Act::=(ActId,Subject,Object,Content) \quad (5)$$

In expression (5), *ActId* is unique identifier of action; *Subject* is a provenance of an action; *Object* is receiver of an action; *Content* is the content of an action.

Let action sequence as *Act-Seq*, then

$$Act\text{-}Seq::=(ActId \mid ActId \in Act) \quad (6)$$

4.2 Construct MCKF

Therefore, the mobile collaboration knowledge framework, MCKF, has been defined as follow.

Let MCKF as ψ, then

$$\psi::=(G,M,T,R,Act) \quad (7)$$

In expression (7), G, M, T, R, Act is same to expression (1), (2), (3), (4), (5).

5. An Instance of MCKF

Now, we give an instance about it for illuminating the MCKF. In order to be simple, only give the description for Member, Task, Action and their relations. The sketch map is as Fig. 3

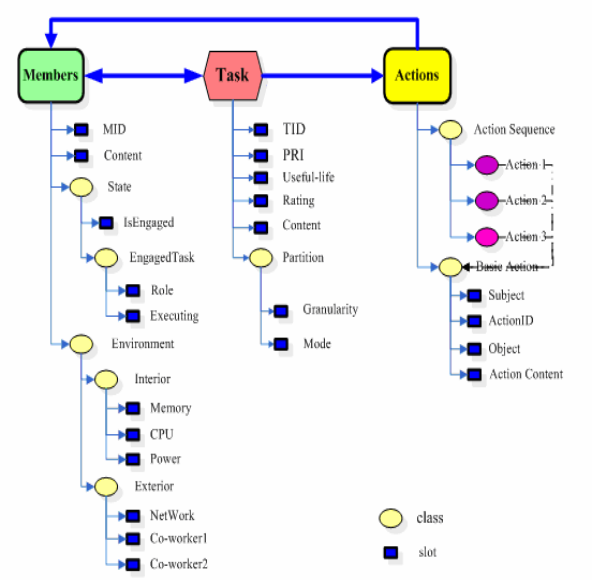

Fig. 3 MCKF described by MODL

In instance, the concepts and their relations have been defined by restriction class and slot in MODL.

5.1 Format of MODL

① General class and its restrains expression form is as follow.

$$class:classID((slotname1:slotvalue1)\ (slotname2:slotvalue2)\cdots) \quad (8)$$

In expression (8), *class* indicates what described is a class, *classID* is identifier name of the class, symbol ":" is separates prompt symbol, linking *class* and *classID*.The content inside the first layer " (" and ") " is restraint explanation for to *class* ; The second multi " (...) " is restraint item for the *class* at the compound level, *slotname1* is the slot name of the first restraint slot, *slotvalue1* is its value, similarly *slotname2* is the slot name of the second restraint, *slotvalue2* is its value.

② Layer class relations expression form is as follow.

$$class:\ classID1((class:classID2(slotname1:\ slotvalue1))\ (slotname2:slotvalue2)\cdots) \quad (9)$$

In expression (9), *classID1* is identifier name of father-class, *(class:classID2(slotname1:slotvalue1))* is the subclass system taken as a restraint item to explain the father-class, its internal form also obeys the definition form of general class, *classID2* is the subclass identifier name, *slotname1* and *slotvalue1* separately is the slot name of restraint slot and its value of subclass.

③ The Most Top Layer Class expression form is as follow.

ontology:mobileontology
(task:(…)members:(…)actions:(…)…) (10)

In expression (9), mobile ontology illuminating the description domain of ontology is mobile computing.

5.1 A Specific Instance in Mobile Collaboration Platform Supported Collaboration Services

The instance given based on the hypothesis that *Tid* is "task110", *PRI* is 1, *Useful-life* is 4, *Rating* is 2, *Granulatity* is 2 and *Mode* is "in turn". The task "invest" was assigned to member *Jack*, and *Jack* transmit the result to vacancy state member *Tom* by wireless network, then *Tom* execute the work. Thus, the MCKF can be expressed by MODL as follow.

```
ontology:mobileontology(
  task:((tid:task110)(pri:1)(useful-life:4)(rating:2)
      (class:partition((granularity:2)(mode:in
turn))))
        members:(((mid:jack)(content:investor)
                (class:state(isengaged:task110)
                (class:engegedtask(role:investor
)(executing:30/80)))
                (class:environment

(class:interior((memory:40)(cpu:100)(power:50))
              (class:exterior(network:45)(co-
worker1:tom)))
                )// Member1
                ((mid:tom)(content:executor)
                  (class:state
                  (isengaged:task110)
                  (class:engegedtask(role:exe
cutor)(executing:30/80)))
                  (class:environment

(class:interior((memory:35)(cpu:90)(power:45))
                (class:exterior(network:45)(co-
worker1:jack)))
                )//Member2


  actions:(
   (class:action sequence
  (class:invest(subject:jack)(actionid:invest)(action
content: "invest")) //Action1
  (class:transmit(subject:jack)(actionid:transmit)(o
bject:tom)(action content: "result")) //Action2
  (class:execute(subject:tom)(actionid:execute)(act
ion content: "execute work")) //Action3)))
```

The MCKF and MODL had been successfully used to Mobile Collaboration Platform Supporting Collaboration Services (MCPSCS), which is expansibility study of the Key Technologies Research and Development Program of Shaanxi Province during the 10th Five-Year Plan Period (No. 2000K08-G12). At present, the MCPSCS had been passed the expert appraisal. The practice indicates that the MCKF and MODL can provide a powerful means for advancing cooperation intelligence.

6. Conclusion

As a new and important research embranchment of mobile computing, mobile cooperation can provide user more function supporting especially cooperative work capability. In this paper, we proposed a mobile ontology description which fit to mobile computing, and a mobile collaboration knowledge framework. They had been successfully used to MCPSCS. The practice shows they can effective supporting mobile cooperation and provide a powerful means for advancing cooperation intelligence. Our future research work is: ①To improve the MODL and MCKF; ②To farther validate the them.

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