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A Study on Efficiency Improvement of Situation Data Deduction using Semantic Web Rule Language and JESS based on PaaS Cloud

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Abstract

We propose a conduct mobile cloud situation service with using Google App Engine based on PaaS in order to get situation service in various mobile devices without any subordination to any specific platform. At the same time, it is intended to shorten the situation service reasoning time with mapping the regular reasoning of SWRL to JESS reasoning engine by connecting the values such as Class, Property and Individual which are regular information in the form of SWRL to Jess reasoning engine via JESSTab plug-in in order to overcome the demerit of queries reasoning method of SparQL in semantic search which is a previous reasoning method.

Keywords: *Situation Awareness, Cloud, Web Ontology, Semantic Web Rule Language, PaaS*

1. Introduction

Situation Awareness Service provides users with the function of situation prediction based on situation information recognized by computer itself, not with external pressures physically[1]. Situation Awareness System is one part of Ubiquitous Computing. The purpose of Ubiquitous Computing is to unite computers with one-dimensional space, two-dimensional space, environment. Things are recognized as terminals of networks through united computers. AR(Augmented Reality), the space embodiment technique which can recognize situations more sensitively and take stronger control of them, and CA(Situation Awareness), the enhanced awareness technique of space shape alteration, are used in this computing system to make users prove their own computing abilities. Recently there have been a lot of studies regarding Ubiquitous Computing, specially situation Awareness System[2-4].

However, situation awareness system only provides specific prediction service subject to specific platforms by researching inference technique for determining situations based on situation information recognized by the system. There are not enough studies so far regarding systemic extension of Tablet Personal Computers produced with various platforms or service flexibility of data transmission/reception between different platforms. Most of studies introducing situation Awareness System shows the weak point of small-scale situation awareness processing capacity due to restricted mobile function under the current mobile environment, memory space, and data processing capacity. Also, situation information inference methods are turned out to be in restricted shapes due to partially developed inference engines.

This paper is made up of three parts. First, system risk factors, which is likely to occur afterwards through object-oriented modeling design considering "reusability and extendability of the system", were minimized. Secondly, situation awareness design and its implementation utilizing "Cloud", which is the virtual space utilization technique of

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Ubiquitous Computing in issue recently, will be researched. Finally, the time required for situation pattern analysis and interference through "Situation Resource Interference technique" are reduced when providing situation awareness system service.

2. Related Works

Soong-Sil University[5] invented the information recommendation system utilizing inference engine on the basis of preliminary predication in order to collect and process primitive data for situation information analysis in the restricted mobile environment. It loads recommendable information in the memory through the subordinate inference of primitive data. It adds situation information data to be shown at real user GUI(Graphic User Interface) through the potentials inference. In Singapore National University[6], SOCAM(Service-Oriented Situation Awareness Middleware) as a situation awareness system utilizing ontology based on OSGi was invented. This research provides an efficient middleware to collect various situations, analyze patterns. SOCAM is dealing with the issue regarding situation expression based on semantic methods utilizing 2 leveled situation ontology based on OWL, situation interference, knowledge sharing, situation classification and situation inter-reliance. Gaia system invented in Urbaba Champaign of University[7], IL, USA converts the location, situation, event existing in physical space and behavioral space into electronic space. Also, it focuses on studying how ontology for situation awareness and interference is applicable to PC environment. Gaia system[7] consists of Gaia kernel for the situation awareness framework, application framework and behavioral space application functioning in real behavioral space.

3. Design of the Proposed Situation Awareness System

In this paper, we propose the process which makes high-capacity situation resource process possible and various clients access simultaneously to overcome security problems by disposing situation awareness software in the virtual server equivalent to the cloud. Figure 1 is the overall overflow chart of situation awareness system proposed in this paper.

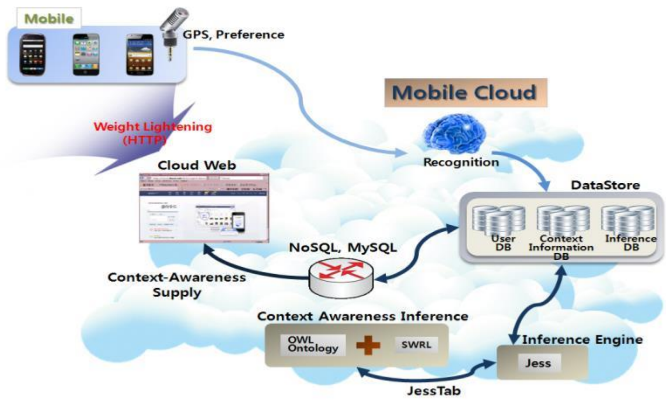

Figure 1. It is the System Overflow Chart. It Provides Situation Awareness Service through Jess Inference Engine and NoSQL by Receiving Situation Inference Data from Mobile Devices

The situation awareness process introduced in this paper exists at clouding and uploads users' GPS values and preference degrees automatically in the situation awareness process to get situation awareness service served. Cloud processes situation information inference with JESS inference engine based on situation information resources saved in datastore for the situation awareness inference. It executes semantic search of RDF/OWL pre-defined for inference. Semantic search infers situation awareness based on rule inference of SWRL. The result of the inference is stored at datastore and executes the situation awareness process based on the mobile could through NoSQL inquiries.

3.1. Object-Oriented Modeling

Figure 2 shows the Class Diagram displaying UseCase statically. It is proceeded to display initialization receiving situation information through *onCreate()* method by summoning intro class, in order to verify inference information from mobile cloud. *onTouchEvent()* method inherits the Map information from Situation Awareness class and an URL address from the mobile cloud. Design class development transmitting situation information is executed through *Webservice* class. It is sent to *DataConvert* class to parse the received data after being connected to situation information such as users' GPS through *request()* method of *Webservice* class. Situation information resource, received from DataConvert class after the first and second situation information data parsing, proceeds to the step of situation awareness information inference through *getSWRLProcess()* of *SWRLRule* class. *SituationInformation Inference* class summons *getSWRLRuleid()* method and brings inferred data by ID on the basis of the inferred data completed by inference process with ontology.

Also, *InferenceDataMerge* class unites inferred data according to requirements, which are defined by ID after summoning *InferencetoMerge()* method. The united data is saved in database through *getStoregedatasave()* method of *HBaseFuntion* class.

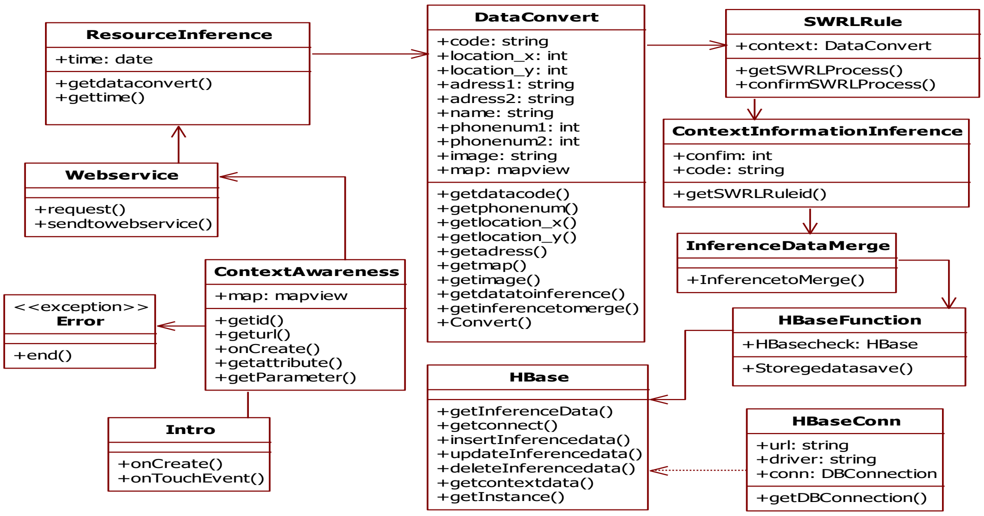

Figure 2. It Shows the Class Diagram Displaying UseCase Statically

Figure 2 is the Login table showing user verification process performed at devices. Users access the cloud from clients through this process. *Input_Resource* table to provide clients with users' situation information through log-in has the relationships of N to 1. Thus, it makes multiple data transmission possible. In *Output_Resource* table providing users with inferred information, there are 3 tables related each other as super types containing common *Output_id*. They will be output to users. *Input_Resource* table and *SWRL_Infer* table can provide multiple situation inference information with one situation information data through the relationships of N to 1. Furthermore, *SWRL_Infer* table of situation inference information saves situation information data including High Class and Low Class table classified by preprocessing.

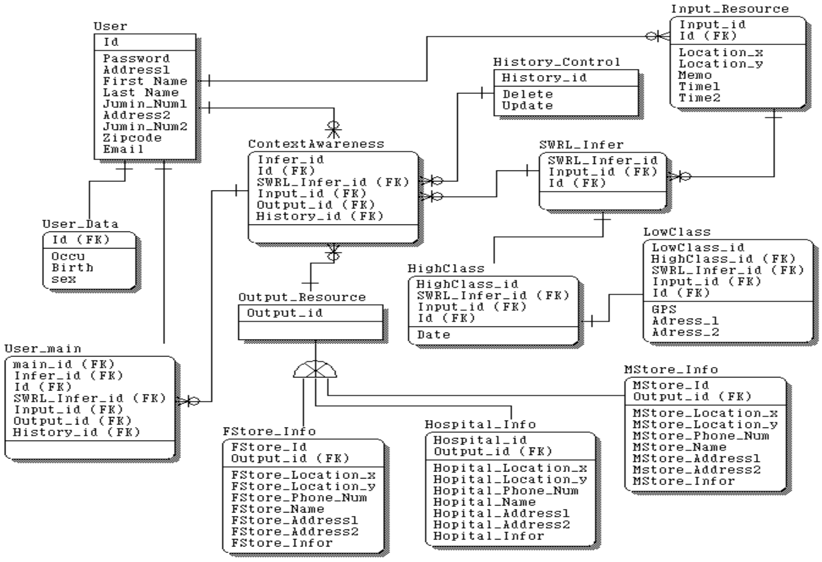

Figure 3. Database used in Situation Awareness Process Consists of 13 Tables

3.2. Design of Situation Awareness Process Inference

3.2.1. Design of situation awareness inference based on the object-oriented: Figure 4 is the functional diagram between multiple Phone classes. Sub-classes inherit all features of root classes. All sub-classes belonged to Phone class inherit all phone numbers which are the slots of Phone class. This is the reason why the slot is designed at the most generally featured class. Collection, Month, Location class as sub-classes of Phone class inherit all slots from their root classes.

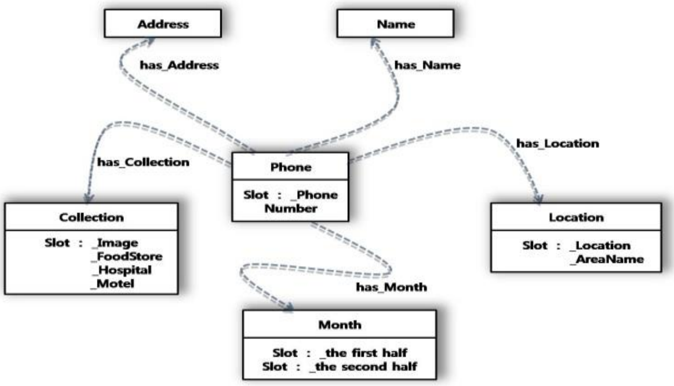

Figure 4. It is the Class Slot Structure Defining Functional Diagram between Classes, Inheritance Relations Model and Domain Relation Lists

Figure 5 shows the design of ontology object utilizing protégé tools on the basis of knowledge and rules.

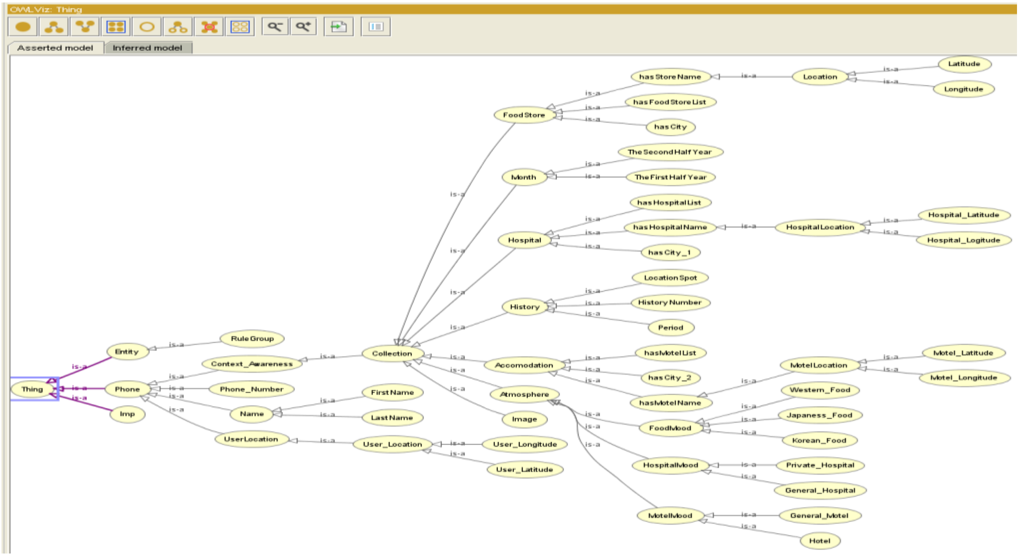

Figure 5. It Shows the Relationships and Processing Structure between Instances by Implementing the Situation Awareness Inference Class with Protégé

3.2.2. Design of SWRL Rule: SparQL inquiry, used for previous studies expressing semantic searching way, requires a lot of time costs to extract Subject, Object, and Predicate. Thus, syntax rule inference in the shape of SWRL is used in this thesis. Syntax rule inference is the process of inferring new facts with the structure rule named by inventers. SWRL is the language expressing the rule theory. SWRL is a total rule-expressing language uniting OWL DL, sub-language of OWL with Unary&Binary Datalog RuleML, sub-language of RuleML. SWRL rule is to infer the shape of semantic shape included in between the consequent equivalent to the head part and the antecedent equivalent to the body part. Figure 6 shows a part of rule inference.

antecedent :(Pre-Condition)
Phone(?x1) ^(?x1 UserLocation ?s1,?s2,?s3) ^(?s1 User_Location?s2,s3) ^(?s2 User_Longitude ?x2) ^(?s3 User_Latitude ?x3) ^(?y1 Situation_Awareness ?x1) ^(?y2 Collection) ^(?y4 Atmosphere ?p1) ^(?p2 FoodMood p3) ^(?p4 Westen_Food ?p4) ^(?1f FoodStore ?m1) ^(?m1 hasCity) ^(?1f hasFoodStoreList?db) ^(?db hasStoreName ?i) ^(?i Location ?z1) ^(?z1 Longitude ?cs1) ^(?z1 Latitude ?cs2)
⇒ *consequent :(Condition Result)*
(?x1Phone ?lf) ^(?lf :FoodStore ?sf1) ^(?sf1 :Locaton ?sm1) ^(?sm1 :Latitude ?df1)^(?sm1 :Longitude ?df2)

Figure 6. It Shows the Relationships and Processing Structure between Instances by Implementing the Situation Awareness Inference Class with Protégé

Figure 7 shows the mapping of SWRL rule with protégé, the production tool of situation awareness process. The consequent values of situation awareness are returned to the inference engine by comparing definition expressions of each rule.

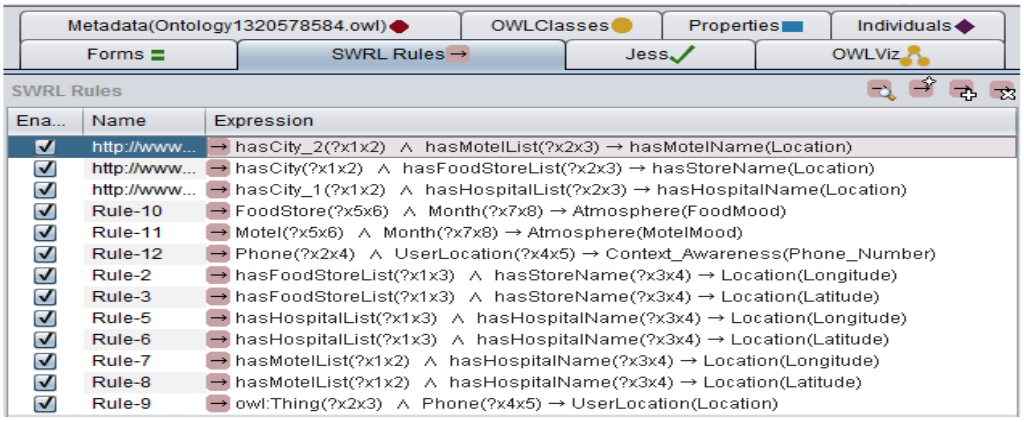

Figure 7. Definition of Situation Awareness System Inference SWRL Rule(using protégé)

3.2.3. Design of JESS Rule: JESS inference engine is made up of execution engine, information base and rule base. Execution engine analyzes the fact information saved in information base through rule base. Rules create new information and save it in information base or execute JAVA function. Situation awareness information as the element of inference rule consists of basic base element. The basic base element exists in the shape of Rule Base and Fact Base. Rule Base of Jess is mapping the instance based on knowledge utilizing JESSTab through parsed rules from SWRL and pattern matching. Instances mapped in Rule Base is named the group of rules. Figure 8 shows the codes regarding rule creation of deftemplate, defrule for the information inference of current users' areas through situation awareness service location values. The rule creation code mapped to infer situation information is made up on the basis of JESS.

```
(deftemplate FoodStore
"Situation-Awareness Recomendation"
(declare (slot Latitude(INTEGER))
          (slot Longitude(INTEGER))
          (slot hasCity(STRING))
          (slot DetailAddress(STRING))
         ..........)

(defrule find-UserLocation
;; User of Locatoion(Latitude, Longitude) is Maegokdong in
  suncheon(FoodStoreName).
  hasRecomLatitude(of User)(is ? a1)
  hasRecomLongitude(of User)(is ? a1)
  ............)
```

Figure 8. Definition of JESS Rule to Search for Food Store Location

3.2.4. Design of Mobile Cloud: Situation Awareness System process of this paper is designed to provide the service at the situation awareness application, without installing additional programs on the mobile device utilizing PaaS. In order to make it possible, situation awareness cloud utilizing Google App Engine(GAE) is established for mobile cloud design. Moreover, instead of client-based applications, web application server based system is installed for users and situation awareness service processing through various kinds of platform access. It makes users enable to use the service freely and process data as long as they are allowed to access internet. Figure 9 is the code saving log-in data with key values of database, which is the Bigtable datastore of NoSQL. Log-in ID is designated as key values in case of user log-in and the rest of data identified as property values is creating and uploading User map. Phone number is set as a key value so as to save user's location values and provide situation information inference. It creates *Input_Resource* map identifying latitude and longitude as property values. When using put syntax, it proceeds to the situation awareness data interface.

```
rom google.appengine.ext import dbclassUser(db.Model):
   Id = db.StringProperty()
   phonenumber = db.IntegerProperty()
   password = db.StringProperty()
   address1 = db.StringProperty()
   jumin_num1= db.IntegerProperty()
   jumin_num2 = db.IntegerProperty()
   email = db.StringProperty()

User(key_Id='sehoon', phonenumber=01011111111).put()
User(key_Id='kyungjong', phonenumber=010112344789).put()
User(key_Id='minjoo', phonenumber=01011111114).put()
User(key_Id='hyungjin',phonenumber=01011111115,  email=iam1710@nate.com).put()
```

Figure 9. Save Code of Login Data Bigtable using NoSQL

4. Implementation and Performance Evaluation

4.1. Implementation of User Interface

The scenario of situation awareness system is as follows(Users take pictures with their mobile devices; Users' location values and pictures are saved in the cloud server; Users can set up favorite locations and input preferred food stores in advance; User Recommendation service should provide the list of information regarding the facilities such as hospitals, restaurants and lodging places; When users start to move, it should provide the image previously taken by mobile devices with GPS censor). Figure 10 show the implemented consequence GUI by uniting implemented scenario with the system.

Figure 10. System Result GUI. ((a)Transmitting Recognized GPS Information to Virtual Servers. (b)Providing Situation Information Map through Recognized GPS. (c)Transmitting previously Taken Images through user Recommendation Images. (d)User Situation Awareness Service Log-in window based on the Cloud. (e)Providing Recommended Restaurant List through Situation Inference. (f)Verifying Location Grids of Recommended Restaurants based on User's Preference.)

4.2. Performance Evaluation

4.2.1. Verification of Suitability of Situation Information Recommendation Service: The verification of suitability of situation awareness recommendation service is performed by evaluating the system macroscopically how much the information of restaurants, hospitals and lodging places through resource inference is provided properly to users based on given conditions. As shown in Table 1, recall Ratio for the completeness of inference service and Precision Ratio for the accuracy of inference service are given as the criteria of searching the effectiveness of situation awareness recommendation service.

Table 1. It Explains the Constitutive Equations of Recall Ratio and Precision Ratio

Section	Formation
Recall ratio	*(The number of food store to meet the conditions in recommendation food store) / (The number of food store recommended by the system)*
Precision ratio	*(The number of food store to meet the conditions in recommendation food store) / (The total number of food store to meet the conditions)*

Situation measurement conditions are determined for performance evaluation as follows. Users evaluate restaurants nearby the current point (front gate of Suncheon University, Maegok-dong, Suncheon-si, Jeonnam, Rep. of Korea) as moving to a particular place selecting the category of preferred restaurants (limited to delis and family restaurants). The process was measured 300 times repeatedly at the same place. The reason why Recall Ratio turned out to be lower relatively than Precision Ratio was because the number of recommended restaurant list on user's mobile devices was limited to 5. Precision Ratio was turned out to be higher overall because the ratio of 5 places on the list over user's actual preferred restaurants was calculated. The average Recall Ratio of Situation Awareness System process calculated from 1000 times(1 time in graph: average of 100times) of measurement was 36.12%, while the average Precision Ratio was 93%. It is concluded that 4 preferred places out of 5 restaurants were selected on average by situation awareness system of mobile devices. It is regarded as the high level of service performance.

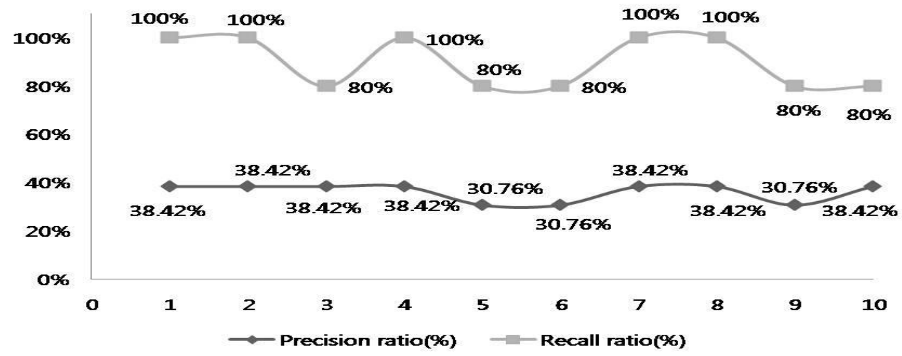

Figure 11. Performance Evaluation Result of Recall Ratio and Precision Ratio

4.2.2. Evaluation of inference speed to infer situation information resource: Figure 12 shows the estimated cost when situation inference resources utilizing SWRL is loaded in Working Memory of JESS.

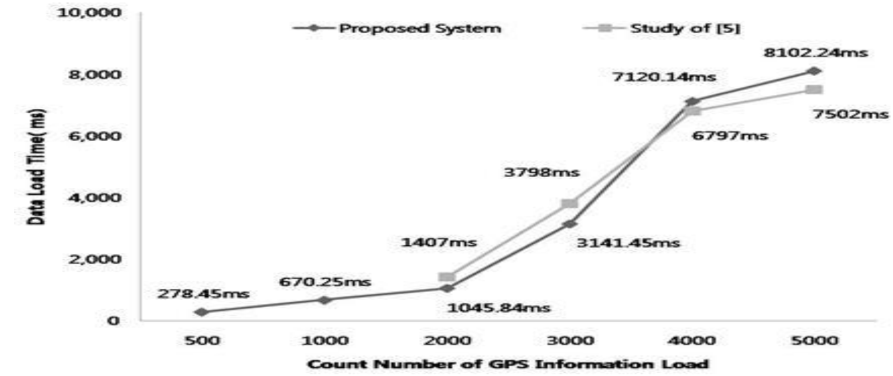

Figure 12. Performance Evaluation of the Memory Loading Cost of Situational Information Resources

The memory loading cost of potentials inference measured at the research [5] ranges from 2000ms to 5000ms. However, the memory loading coast of each sectional data is measured considering the range from 500ms to 5000ms. It turned out that the memory loading cost of inference resource responding to 2000~3000 GPS values was higher than the one of the research [5]. Meanwhile, the memory loading cost of the range over 4000 GPS values and massive GPS information analysis on the move turned out to be lower than the research [5].

5. Conclusion

In this paper, situation awareness process based on mobile cloud utilizing object-oriented design modeling was introduced. The process provides users with optimized situation awareness service at the current location on the basis of user's GPS values and pre-defined user's preference. Firstly, each functions were converted into modules based on the object-oriented design for the implementation of the situation awareness process, in order to maximize reusability and maintenance. Also, the extendibility of the process was maximized by classifying output from each process according to codes. Secondly, situation awareness process was implemented utilizing PaaS which is the virtual server based on cloud, in order to prevent it from being subordinate to a specific platform. It made situation awareness process available at various shapes of platforms. Thirdly, DL+RuleML of SWRL, which is semantic search for ontology of RDF/OWL, was used to accelerate the inference speed. Also, the expressions of Rule and Fact were used as they are, by linking Jess inference engine and mapped SWRL Class, Property, Individual values to OWL syntax utilizing JESSTab plug-in. Moreover, the reduced inference speed resulted from the connection to exterior inference engines was verified through the performance evaluation.

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