A REVIEW ON CONTEXT MODELLING TECHNIQUES IN CONTEXT AWARECOMPUTING

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*Abstract--***A system is context-aware if it uses context to provide relevant information or services to the user, where relevancy depends on the user's task. Context-awareness is offering services to users with react of proactively to user environment and service conditions.The main goal of context-aware system is to track and identify the users. There exist many approaches for modeling contextinformation and each model brings along some reasoning techniques. Many researchers are concentrated the context aware computing and pervasive computing and has developed different context modeling and reasoning techniques. This paper mainly addresses keyperformance issues, challenges and differentmodeling techniques for Context aware computing and summarizes them.**

Keywords: Context, Context aware computing, Modeling Techniques

I.   Introduction

The term "Context" is some information which can be used to describe the situation of the entity". An entity is a person, place or object that is considered relevant to the user or an application [16]. In a real time scenario, Context are might be location, time, temperature, noise and bandwidth of communication etc. A context-aware system is described as a system which usescontext to provide adequate and proper information and/or services to the user, where relevancy depends on the user's task [17]. As Schilit, Adams, & Want[18] definition, "A Context aware computing is a software that examines and reacts to an individual's changing context". The objective of most current research is to develop uniform context models, representation and query languages as well as reasoning algorithmsthat facilitate context sharing and interoperability of applications. In this paper we want to make a survey of the most relevant current approaches for modeling context for context aware computing.

We start in section 2 with some specific requirementsarising from context modeling techniques. Section 3 summarizes various context modeling techniques in context aware computing. Section 4 discusses various contexts frameworks which are used various context modeling technique.Section 5 presents with conclusion and discussion on context modeling techniques.

II.   Requirements of Context Modeling Approaches

It is important for any modeling of context information closely with several requirements. In this section, will give a short overview to the requirements defined by Strang and Linnhoff-Popien [19]:

1.Distributed composition: Strang and Linnhoff-Popien defineubiquitous or pervasive computing is a specializedarea of distributed and mobile computing. Anycontext modeling approach for pervasive computinghas a lack of a central instance. It is responsible forcreation, deployment and maintenance of data and services.

2.Partial validation: Context modeling techniques has the ability to partially validate the contextual knowledge on structure as well as on instance level against context model.This very important requirements because of the complexity of contextual interrelationships.

3.Richness and quality of information: The quality of informationdelivered by sensors varies over time, as well as therichness of information provided by different sensors. So the context modeling techniques has this requirement.

4.Incompleteness and ambiguity: These existing contextinformation at any time is usually incomplete and/orinexplicit. Therefore a contextmodeling approach should be capable with this possibility.

5.Level of formality: Sharing of contextual factsneeds the realization of an adequate specification of thecontextual information. This requirement describes theability of a context modeling techniques.

6.Applicability to existing environments: Every contextmodeling approach should be realizable. Every modelingapproach should be implemented and realized withinthe existing infrastructure.

The above mentioned requirements are important for any contextmodeling approach which has to be realized in apervasive computing environment [19].

III. Modeling Approches

This section will survey the most used context modeling techniques. These techniques are classified by the schema of data structures which are used to exchange contextual information in the system.

A. Key Value Models

The model of key-value pairs is the most simple and frequently used data structurefor modeling contextual information. Already Schilit et al. [20] used key-value pairs to model the context by providing the value of context information in the context aware computing. This model list the attributes as key value manner.

B. Markup Scheme Models

All markup scheme modelingapproaches is a hierarchical data structure consisting of markup tags with attributes and content. Representatives of this kind of Mark up scheme approachare profiles.Typical examples for such profiles are the Composite Capabilities/Preference Profile (CC/PP) (W3C, 2004a) and User Agent Profile (UAProf) (Wapforum, 2001), which are encoded in RDF/S.

C. Graphical Models

A very well known general purpose modeling instrument is the Unified Modeling Language (UML) which has a strong graphical component (UML diagrams). Due to its generic structure,UML is also appropriate to model the context. Another example is the nicely designed graphics oriented extension to the Object-Role Modeling (ORM) approach context model.

D. Object Oriented Models

Object oriented context modeling approaches is the intention to employ the main benefits of objects oriented approach. This is namely encapsulation and reusability isto cover parts of the problems arising from the dynamics of the context in context aware environments. All details of the objects are encapsulated within the active objects and hidden to other components of the system.

E. Logic Based Models

The context is defined with facts, predictions or roles; a goal is to form new expressions or facts from previous ones.A logic defines the conditions which are a concluding expression or fact may be derived. First logic based context modeling approaches has been published by McCarthy and his group at Stanford [21, 22]. McCarthy introduced contexts as abstract mathematical entities in artificial intelligence.

F. Ontology Based Models

This model represents a concept group in a given domain and the relationship between the different concepts; depicts a domain with a graph of concepts; contextual relationships may be hierarchical or semantic. Most context modeling approaches are realized for a special application scenario and on that account many context information models are limited from the view of interoperability.Ontologybased approaches represents knowledge, concepts andrelationships about a domain and describes specific situationsin a domain. For example, given two atomic classes Person and Female, the class Male can be defined as: Male $\equiv$ Person $\neg$Female

G.Spatial context model

Space is an most important context in many context-aware applications.Context is defined as ―Where you are, who you are with and what resources are nearby. Some of the context modeling approaches gives space and location. Most spatial context models are fact-based models. This model organizes their context information by physical location.

IV. Literature review and related works

Matthias Baldauf [1] proposed a review of common architecture principles ofcontext-aware systems, context modeling techniques and derive a layered conceptual design framework to explain the differentelements common to most context-aware architectures. It is the survey paper about existing context aware system focusing on context aware middleware and frameworks which is used to develop the context aware applications based on various modeling techniques. The author summarized the main aspects such as Sensing,Context model, context processing, Resource discovery, historical context data and security and privacy policies of the various context aware architectures which is used various context modeling techniques. The goal of this discussed architecture is to separate of concerns between the context acquisition and the user components.

Muhammad Ashad Kabir[2] proposed a model, manage and reason about social contexts toaid the development of socially-aware applications. The author investigates the existing context modeling andreasoning techniques of socially aware applications. This development of socially aware application manages for the middleware platform. The author defines the social context as a representation of user's relationship. It further categorizes in to Interaction oriented relationships and connection oriented relationship. And also discuss about the challenges of social context poses.

Johnson Fong[3], gives a semi automatic and forward engineering context modeling tool which is used to provide design support for developing context models designed using the CML(Context Modeling Language). This tool uses the existing context information and automatically generates code for mapping context models. The proposed context modeling tool is to support Software Engineering of context applications and to check the typical errors including omitting constraints.

Hatim Guermah[4], presents an architecture for the development of context aware services based on ontologies and also discuss about context meta data model and about reasoning process for e-health systems.The author discusses the reasons about why ontology based model is suitable for representing and reasoning on context information.The author highlights the challenges of context awareness. Existing ontology based context aware application is discussed in this paper.As a future work the author plans to provide an applicative layerfor context management and reasoning and evaluate more reasoning mechanisms.

Karen Henricksen[5], investigate the reasons about the shortfall, to evaluate the uses of ontology languages and tools in context aware systems.The author integrating the two modeling techniques to form a hybrid solution that combines interoperability support and ontology based reasoning. These context model is based on Object Role Modelling(ORM).the author briefly review the previously developed approach to context modeling and three types of reasoning like Reasoning about context, Reasoning for model checking, Reasoning about interoperation.

Dejene Ejigu[6],aimed at to develop a collaborative context aware service platform based on hybrid context management model. Context Data is organized in to a hybrid context management model (HCoM) which is a combination of ontology and relational approach. The main advantage of the HCoM is, it has a heuristic component which has the problem solving techniques.The author presents an enhanced CoCA(collaborative context aware model), which is based on hybrid and collaborative context aware service platform. The proposed hybrid model is to separate the context data management and context knowledge management, process these two separately and given the results together for better reasoning and decision support in a context aware environment. As a future work, the author will concentrate on the security and privacy issues.

Bo Hu[7], proposed the context model framework based on ontology, dividing the model intoMeta Ontology level and Domain-specific Ontology level according to the abstraction hierarchy.The author designed an algorithm to convert the context model to the knowledge described in OWL(Web Ontology Language) and used the reasoning tool to complete the context reasoning. The author reviewed the related work done for context models and classified the existing models in to three categories as Application based method, Model based method and ontology based method. By using this proposed context model, when application domain has been changed need to change the Domain-Specific ontology not to change the reasoning method itself. The author mainly focus on how to raise the model reusability and reason automatization.

Samyr Vale[8], proposed Model Driven Development(MDA) in ubiquitous computing to promote reuse, adaptability and interoperability incontext-aware applications development and context metamodel proposition based on ontology conceptsand the parameterized transformation technique applied to context-aware development. The author discusses about the state of the art in context-aware applications development and gives a brief discussion of related works. Most important concepts in MDA are mapping and transformation techniques. The author identifies important benefits of MDA as concerns separation, reuse of models and interoperability and also proposes for context information definition ontologies concepts represented by RDF and RDFSchemas.

Imad Afyouni[9], proposed a survey of spatial models for context aware indoor navigation systems. The author discussed not only the properties of those spatial models, and also to which degreethe notion of context can be taken into account when delivering services in indoor environments. Spatial model requirements are also discussed in this paper and have been classified in to two categories as service-oriented and efficiency-related requirements. The strengths and weaknesses of both symbolic and geometric spatial models are assessed by describing and evaluating different spatial representations. A hybrid spatial model is a combination of a hierarchical, set-based representation of space and a geometric representation of places, sensor ranges, and objectsof interest. This hybrid model achieves a good trade-off between geometrical and symbolic approachesby combining the benefits from both sides.

Jianchao Luo[10], proposed an ontology-based framework for developing NFC-based context-aware applications. This ontology based framework can perceive user context and offer appropriate context-aware

services to the user by combining the NFC technology with context-aware technology. NFC-based context-aware applications are using this ontology based framework. The authorpresents the framework's design, implementation and a real use case scenario that shows the validation of the approach. Related work for context aware architectures and framework also been discussed in this paper. With the proposed framework, development overheads of acquiring, aggregating, inferring and storing context information are greatly reduced. The author provides security service for ensuring data integrity of the NFC context.

Hayashi et al. [11] introduced context-aware scalable authentication using multiple passive factors by modulating active factors to authenticate users. To select active authentication factors, the author proposed a generic probabilistic framework. This framework given a set of passive authentication factors. The author developed a prototypes and investigated the feasibility and effectiveness of their proposed framework.

Hu and Weaver [12] proposed a dynamic and context-aware security infrastructure for healthcare applications. This model extends the role based access control mechanism. It is associated with access permissions with context related constraints. The author described the capability of their model by showing decisions approach.

Badram et al. [13] presented context-aware user authentication, supporting proximity-based login in pervasive computing environment which uses for a javacard for identification and cryptographic calculation, context awareness system for verifying use's location and implements security fall back strategy. The authors introduced a concept of proximity-based user authentication in a pervasive computing environment. The author designed and implemented a proof of concept of a proximity based user authentication mechanism by combine the context aware subsystem with a personal smart card.

Maw et al. [14], designed and developed an adaptive access control model for medical data in body and wireless area network. The author evaluated the framework using medical scenario in which they included a user behavior trust module along with the access control module. The author concluded with the overriding policy whichis useful to handle unanticipated situations and showed that by incorporating user behavior into access control model, one can make better security decisions.

Feng et al. [15] incorporated contextual application information to improve user authentication by presenting a touch based identity protection service. The author proposed the system and evaluate with real time data which is collected from 23 phone owners and deployed it to 13 of themwith 100 guest users. The proposed system can achieve 90% of accuracy in real life naturalistic conditions. In touch screen data feature, the author considers two new sets behavioral and contextual features. The proposed system has 90% accuracy for both security and usability concerns. Real time data can be used in the proposed system.

V. Conclusion and discussion

In this paper we described the context modelingwhich supports gathering, evaluationand dissemination of context information in pervasive computing. Existing approaches to context information modeling differ in the expressive power of the context information models.In the paper we presented a set of requirements thatcontext modelingtechniques should meet and the list of context modeling techniques.Most of the people used smart phones, personal assistant devices to access the services through the internet. So need to model the context which is accessed by the internet and sensors. Many frameworks have been proposed and discussed about Context modeling techniques. In this paper, context modeling techniques in context aware computing has been considered and discussed a possible architecture, as well as some research issues to be investigated We concluded our survey with most of the context aware frame work are used ontology based and hybrid based context modeling techniques.

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