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Context Awareness and Natural Interaction in Ubiquitous Computing

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***Abstract*— Ubiquitous Computing means how we can interact with Heterogeneous devices like computer, mobile, Personal Digital Assistants (PDAs), tabs, small sensors without the use of it and such gadgets are invisible to of the user. It provides more facilities which make people life easy and more comfortable due to intelligent sensor environment. Ubiquitous Computing includes two main concepts, context awareness and natural interaction. In context awareness a computer will be able to understand the need of people according to all given or required condition. It helps in providing all types of services and resources and provides the related information to given context too. In natural interaction, computer acts as a human being to perform task and instead of being a part of the task itself, the computer focuses on learning or doing in order to achieve a desired result. In this paper we emphasis on exploring the ubiquitous computing architecture and the two major fundamental concepts of ubiquitous computing, context awareness and natural interaction.**

***Keywords*— Ubiquitous Computing, Context Awareness, Natural Interaction, RFID, Agile Process Agent.**

I. INTRODUCTION

Ubiquitous Computing means how we can interact with heterogeneous devices like computer, mobile, Personal Digital Assistants (PDA), tabs, small sensors without the use of it and such gadgets are invisible in front of the user. So ultimately, ubiquitous computing makes people life more easy and comfortable. Ubiquitous computing is all about to make a computer so implanted, so appropriate and so natural which fulfil every requirement of the user what he/she is desired of.

II. ARCHITECTURE OF UBIQUITOUS COMPUTING

The Architecture of Ubiquitous Computing is basically a combination of four below listed revolutionary concepts:

1) *Context Awareness*
2) *Natural Interaction*
3) *Nanotechnology*
4) *Wireless Technology*

As we can see in Fig. 1 that how ubiquitous computing comes into shape with the above listed concepts. Nano-Technology deals with the shrinking process of computer parts way down to an atomic scale while the Wireless Technology is in great demand because it allows one to access the network and communication services from anywhere within reach of a wireless network, without the troubles caused by a network cable [1].

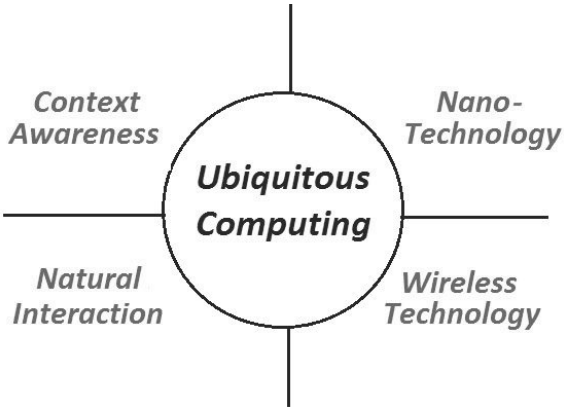

Fig.1 Typical Ubiquitous Computing Architecture

The other two concepts, Context Awareness and Natural Interaction are thoroughly discussed in this paper, but with the help of Fig. 2, we can have a better glimpse of how these two concepts work together to implement Ubiquitous Computing.

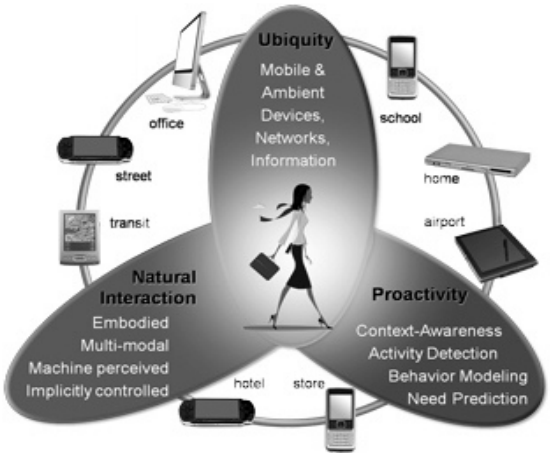

Fig. 2 Role of Context Awareness and Natural Interaction in the Architecture of Ubiquitous Computing

III. APPLICATIONS OF UBIQUITOUS COMPUTING

Ubiquitous Computing will enable diverse wireless application including business scheduler in which Ubiquitous Computing is able to manage and plan business meetings, presentations and many more, monitoring pets and houseplants and other operations of appliances to keeping track of books and bicycle, and much more. Ubiquitous Computing will be able to handle smart devices without to instruct them. In the same manner it will be helpful for doing smart wear, smart marketing as well as home networking also [2]. Ubiquitous Computing is also

helpful in managing home activities like monitoring on home appliances and it provides home security solutions. Now-a-days a new term called U-Learning (abbreviation for Ubiquitous Learning) is getting buzz in the market. It provides many applications in the business arena like managing business meetings, arrange appointments.

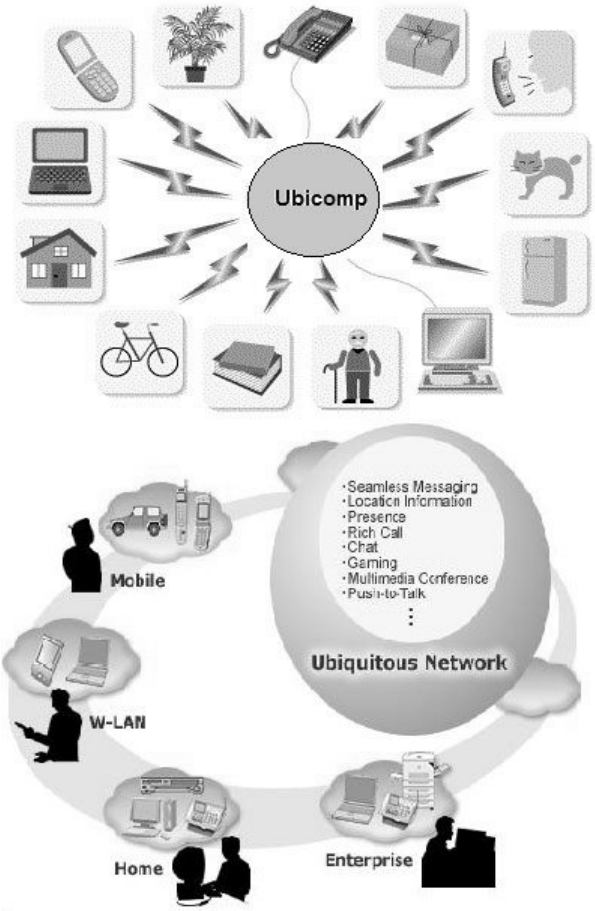

Fig. 3 Applications of Ubiquitous Computing

IV. Context-Awareness

Context awareness, in aspect to ubiquitous computing, is a kind of concept in which the computer will be able to understand the need of people according to all given or required condition. It helps in providing all types of services and resources and provides the related information to given context too. This context can be related to any kind of object like father, son, manager and any type of location in which the user wants to work, and also the external or internal stimuli. For the better understanding of context awareness let's take an example, suppose a user is far away from his/her home around 7:00 pm and is not having enough time to go home for dinner, so in this situation the context aware map will work on it and will suggest some nearby hotel for dinner.

Ubiquitous Computing is quite important for the definition of models for wide contextual information coming out of external stimuli. It helps in understanding of how to frame a technique to filter and collect necessary chunks of contextual information and is being processes in intelligent manner to provide intelligent services. As we know, Ubiquitous Computing allows computing among objects, people and the information which is being collected via the communication among different devices occupied in the external stimuli [1].

V. Architecture of Context-Awareness

Earlier context-aware systems used to provide different roles as per the position based information. The framework for Context-awareness computing provides various types of context awareness development platforms [3]. As shown in Fig. 4, the context-aware framework is depicted into five layers.

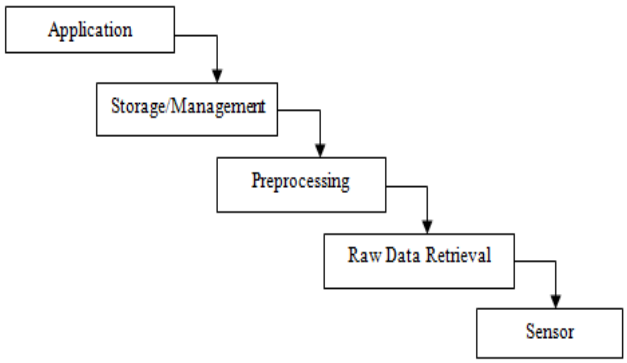

Fig. 4 Framework for Context-awareness Computing

The first layer is sensor layer, which contains different types of sensors. It not only captures the hardware but also it captures all reliable information from various sources. The sensors further categorized into three categories: Logic Sensor, Virtual Sensor and Entity Sensor. The second layer is retrieval layer in which the raw data can be captured from the sensor. The third layer is preprocessing layer which is generally useful only in the case when the very rough raw data is provided, as this layer is not well armed. The fourth layer is Storage/Management in which all the collected data is organized and the user is offered an open interface to use. The data can be accessed with or without synchronization as per the choice of the user. Application Layer is the last layer of context-awareness architecture, which offers an adjustable and friendly approach to manage and program as per the requirement of different contexts. It also offers the tools with which the user will be able to understand the state of the sensors.

In Fig. 5, depicts the architecture of context-awareness based on the framework in Fig. 4.

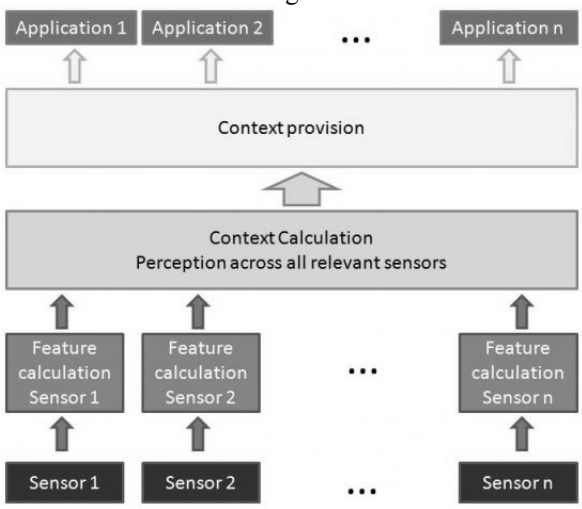

Fig. 5 Architecture of Context-Awareness

VI. CONTEXT-AWARE LEARNING

Context is defined in terms of any kind of information related to objects, time, location, person, and all other objects [4]. The composition of these above entities with user, program and external stimuli is applied on the basics of context-awareness. The power of a category of systems to utilize contextual information for better service delivery to the client in a smooth and easy to manage way can be basically called as Context awareness [6]. In 1994 Schilit and Theimer first proposed the concept of context-awareness or context-aware computing [5]. Many definitions for the concept of context have been proposed, Dey's being the most well-known and quoted, context is any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between the user and the application, including the user and the applications itself [7]. Later this definition has been extended to include computational objects as well; Context is typically the location, identity and state of people, groups, and computational and physical objects. A very powerful operational definition that allows a natural understanding of this concept to users and developers of context-aware applications is provided by Zimmerman et al. As far as the consideration of above mentioned definitions the context of an object is part of the below mention categories: (a) Uniqueness, (b) Place, (c) Action, (d) Period, and (e) Associations.

Context is important for context-aware learning because the best instruction is highly contextualized [8] and may contain learner's individual profile like characteristics, specific requirements, current situation(s) on learning topic, learning method choice, record of earlier accomplishments, present location, present interface selections, audio, video and virtual reality proficiencies etc. For the selection and generation of suitable learning services for a specific learner at a specific time the contextual information is crucial.

A. Learning Architecture with Agile Process Agent

The agile agent offers the core agile agent development process and is responsible for the implementation of an Integrated Development Process. The Integrated Development Process comprises of 4 vital and two iterative stages. The four vital stages, as shown in Fig. 6, are: (i) Design, (ii) Test-Driven Implementation, (iii) Release and (iv) Review, while two iterative stages are (i) Re-factoring and (ii) Enhancement, that are performed repeatedly till a final state is arrived.

The Agile agent follows bottom-up approach, which raises smoothness and empowers the focus of development team on the rapid delivery of model in action. It also enables the same to react fast to modifications in chucks. iterative stages are Re-factoring and Enhancement are not considered as stages rather these are characterized as non-stop process which include applying changes and improvements to the completed model.

Basically, refactoring involves making modifications to the inner structure of the application software without changing the external behavior, so that it can be more easy and effective to understand. This process of refactoring might impose removal of replicated code, to simplify difficult logic, and to clarify uncertain model. The design and employment of the application is improved by such continuous analysis. Enhancements stage involves new or updated functionality that improve the applications

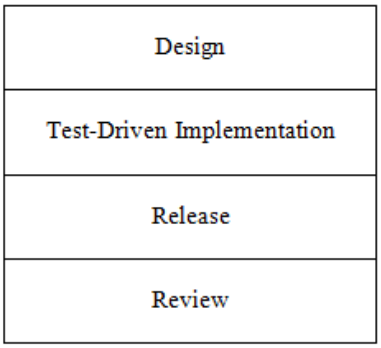

Fig. 6 IDP Phases Implemented by Agile Agent

Agile Process Agent brings together the adoptability in the process of obtaining context data and reacting to the applications in real time [9]. The agile process agent concentrates on repetitive and refactoring topographies. Agile Process agent works on all stages of agile structure. In the analysis of sensor data collection, it also demonstrates requirement analysis and feasibility study processes. The central block of agile agent contains context driven design and modeling to enhance refactoring features [10].

B. Agile Security

We can see Agility as a set of collective quality properties and it is very sensitive to changing resources and to variations in contexts. Beznosov offered a theoretical study of the appropriateness of Extreme Programming for building secure systems and presented the concept of good enough security too[13]. Due to regular iterations in agile processes, the cost of involving the third party at all iterations is considerably increased, and the development also should continue, while the security assurance efforts proceed [12]. The methods like rule based systems can be considered, while taking security decisions. But for the applications of dynamic nature, these rule based systems cannot provide security alone. The model might visit unknown contexts quite often, and at that time the agile agent will assign a new name to the new context. Then refactor the new context using the predefined context information and metadata [14].

Context aware security policies will comprise the information related to the authenticity user, place and other relevant contextual information need to be processed further. If agent gains genuine contextual information then it will incorporate with server to finalize that given data is correct or not with the help of encrypted protocols. When the similarity is being done then further security policy agent has to take appropriate actions. For example it might approve and forward if and only if the given contextual information is match or reject if it does not match with defined security policy. Next phase of the process is the agent will decide where the information is partially sufficient to satisfy the policy constraints. The probabilistic

approach is to determine which policy it might be satisfy, it is decided by the agent, next the information will sent to the context modeling module [12]. The client would be assured that only services equivalent to his/her preferences would be received, at the client side. From client's point of view he wants the simple authentication service to accomplish the process. At the server end, it might be confused that the user is trusted or not to gain access to its service. They are only access the service when the client will prove his authenticity. This is done by only the confirmation of the authorized agent and the agent is provided his own space to work the user so he will be able to get his desirable result.

VII. NATURAL INTERACTION

Natural Interaction is one of the major concepts of ubiquitous computing in which computer acts as a human being to perform task where instead of being a part of the task itself, the computer focuses on something like, learn, or do in order to achieve a desired result. The basic concept of Natural Interaction is to provide the services, resources and other relevant information to the client without let the client thinking how to use the computer and get the desired outcome.

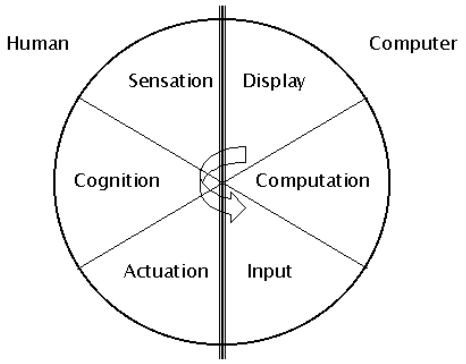

Fig. 7 Human Computer Interaction

As we can see in Fig. 7 which depicts human computer interaction where there are six components. All are divided into two parts, first part includes display, computation and input in the computer side, and in the second part it includes sensation, cognition, and actuation in human side. In such manner the user need not to think about how the computer will provide the information without asking for any instruction and how the computer will get to know, what the client will need in a particular situation. According to the Donald Norman, a well-known researcher in human–computer interaction, once said that he doesn't want a word processor; he wants a letter writer—something that will allow him to get the job done of writing a letter, without the instrument getting in the way [1].

In Ubiquitous Computing, Natural Interaction is a paradigm which is based most recently on Ambient Intelligence. In this the technology becomes invisible, unseen, hidden, embedded, and available whenever we require it. It provides simple interaction with user and all our senses and given context too. The definition of Ambient Intelligence is an exciting new paradigm of information technology, in which people are empowered through a digital environment that is aware of their presence and it is also context sensitive, adaptive and responsive to their needs, habits, gestures and emotions. These ideas endorse the aim of embedded technology into daily or routine objects, without much work effort and with simple interaction. Its final aim is to provide needful information to the user anytime, at any place and in any situation. In this scenario we create intelligent environments which require modest hardware, wireless sensor networks, wireless communications, enormously dispersed devices, natural interfaces and security.

A. Technology Related to Identification

With the notions of context and its cited features, we have considered some awareness features through a technology called RFID (Radiofrequency Identification). This approach is being proposed by the identification process and it is a specific input to by means of identification process. Hence, we can say that one will be having the information related to the client profile, the context knowledge and the task.

1) RFID (Radiofrequency Identification): To develop context-aware applications, it is compulsory to adapt sensor related proficiencies to offer implicit inputs to the system for the accomplishment of natural interfaces closer to the clients. The proactive characteristic of the system is guaranteed due to this. Generally there are two basic components in an RFID system, (i) Tags or Transponders and (ii) Readers or Interrogators. The tags in general contain a microchip to store data and an antenna, which work as coupling agent. Both of these, microchip and antenna, are wrapped in such a way that they might be installed in an object. There is also a provision for a unique series number for all of them. The other component, readers or interrogators might have one or many antennas, which release radio waves and receive signals back from the tag. The interrogation signal initiates all the tags that are within its range.

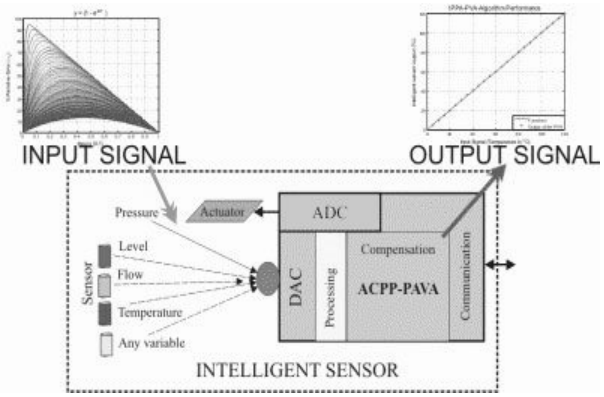

Fig. 8 Intelligent Sensor

Basically Reading a RFID tag is equivalent of a barcode scan, as it is also a sensor input. In the process of writing on a tag first the tag is read, then new contents are written and then the tag is read again to confirm tag write operation, so in this way this process is a sensor input and an output both. Although on the application of RFID many people say that there must be a layer that rests between RFID and everything else, otherwise all the data will choke business systems. In the manufacturing industries or distribution center, they don't have RFID technology and sensors.

Although the implementations incorporate the technology into their present infrastructures, that actually originate value from RFID.

RFID readers are choreographed with other devices using corporate logic to develop an Intelligent Sensor Network. It is quite significant that the platform supports a distributed architecture that offers corporate logic to be accomplished where it is most effective and works in the network restrictions. Several facilities can be joined together, while centralized management, asynchronous communication, and secure integration is being maintained. It permits companies to create an Intelligent Network Sensor Infrastructure (ISNI).

VIII. Related Works

Context awareness or Context-aware learning is quite promising, and in the last 10 years, it's been a great demand of context-aware learning projects all over the world. Instead of the problems related to the ubiquitous technologies, which is the educational aspects of context-aware learning, quite recently, various works have advanced. We emphasis here on the works which are related to ours. In [11], the focus is on the development of a conceptual model for the learning context within e-learning environments, which captures various aspects of learning situations like subject domain, technological (hardware, software, networking), pedagogical (learning theory, instructional strategy), psychological (motivation, preferred senses and learning methodology (delivery models with respect to time, main figure, dependence on content). The context parameters taken into account for learning support correspond to the operational definition of context from individuality, time, locations, environment, and relations [15]. The information flow categorizes applications according to the number of entities that are involved in information flows and information distribution: one-to-one, one-to-many, many-to-one, and many-to-many. The pedagogical models that are taken into account are: behaviorist, cognitive, constructivist, and social constructivist. The purpose describes applications with respect to their goals and methods directed for enabling learning: sharing content and knowledge facilitate discussion and brainstorming, guide communication, social awareness, and engagement and immersion. The context for communities and collaborative learning is approached in [19], where authors review the challenges that context modeling has to face in order to provide for mobile learning scenarios, and exemplify those issues in the case of a mobile collaborative language learner in the city. IBM developed the Blueboard experiment with a display and RFID tag for the user's collaboration [16]. A similar project is IntelliBadge [17] developed for the academic conference context. There are several works on interaction with public displays by mobile devices [18] [19]. However, mobile devices have limitations in their input and output capabilities [20].

IX. Conclusions

The Ubiquitous Computing is having an extraordinary growth nowadays because of its huge number of intelligent sensor network applications in various fields. Both context-awareness and natural interaction, provides an intelligent environment in which user can easily avail desired services in an intelligent manner such as identification of user, likings, place, time etc. These technologies offer lifetime and permanent learning, which might provide advantage from a great level of personalization, as it supplies the client with the appropriate learning material, at a suitable location, and at the correct time. Among the evolving environments of natural interaction, context-aware computing, communication, and sensor-centered instruments are must be embedded and flawlessly combined into client's daily life resulting in immersive service experiences. In this paper, we highlighted the two major concepts of Ubiquitous Computing.

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