Available online at www.sciencedirect.com

ScienceDirect

Procedia Computer Science 132 (2018) 477–485

Procedia Computer Science

www.elsevier.com/locate/procedia

International Conference on Computational Intelligence and Data Science (ICCIDS 2018)

Contexts enabled Decision Making using sensors to perceive pervasive environment

Prabakaran.N[1] and *R.Kannadasan[2]

[1,2]*School of Computer Science and Engineering,*
VIT University, Vellore, India.

Abstract

Context aware applications are seeking for the technologies that provides regularly available data between internal and external environments. Wireless access infrastructure is integrating real time data and heterogeneous devices to establish ubiquitous communication. A wireless sensor network (WSN) is primarily undertaking remote monitoring of any task in any sensing field further to extend for context fetching and refining to collect essential context information for pervasive environment. The applications are well utilized on context observation and interpretation for mobile users. The proposed method assists to combine various basic low level contexts to provide reliable decision making in the pervasive environment using sensor networks and context aware computing. Pervasive computing has powerful and influencing factors to establish dynamic and smart environment with its dominant features in the backend. Pervasiveness provides the regulated smart interactions and interfaces together to avail the information for various applications. Using rich context for event notification than simple position and time, aim to bring automated decision along with accuracy information. The proposed model also facilitate users and group members to create and submit an event. It provides ability to submit an event using a various mode of input.

Keywords: Context Aware Computing, Pervasive Environment, Automated Decision Making, Wireless Sensor Networks.

*Corresponding Author: kannadasan.r@vit.ac.in

10.1016/j.procs.2018.05.145

1. Introduction

The data centric autonomous sensor nodes are organized for pervasive environment pre-configured to be an attribute centric than address centric. Homogenous or heterogeneous devices (Few examples are given in Table 1) observe the phenomena and communicate together to route the meaningful data to the destination. Practicing readiness and improved access control data with available resources are perceiving results of pervasive computing anytime and anywhere. Using current simple contexts in the varied environment is easier to interact the smart devices typically used in dynamic environment [1]. It is harder to accept each dynamic environment because devices are unaware of backgrounds and contexts. When integrating sensing technology into ad-hoc and handheld devices, it demands usage of multiple sensors of the similar type placed at dissimilar points of a device. Wide range and categories of sensors available as shown in Table 2 but few of these sensors are definite to certain applications for their operation in a pervasive Computing environment is not useful [2,3].

Table 1. Examples of homogenous and heterogeneous

	All Sensors at Same Position	**Sensors Distributed**
Homogeneous system	*Instance:* orientation aware PDA	*Instance:* load sensing system
Heterogeneous system	*Instance:* context-aware mobile phone	*Instance:* distributed sensing boards

Context aware computing establishes the local interaction between user and computational services based on available user, physical, location, computational and environmental contexts. Smart devices behave on varying input that are identified and observed using contexts that are sensed habitually in the pervasive environment.

Table 2. Summary of technologies used for context acquisition
Sensing technologies

S.No	**Technologies used for context acquisition**
1.	Light and Visualisation
2.	Hearing
3.	Motion and Acceleration
4.	Location and Locus
5.	Zero-Power Sensors
6.	General Magnetic Field and Orientation
7.	Proximity
8.	User Interaction
9.	Touch
10.	Pressure
11.	Humidity
12.	Temperature
13.	Weightiness
14.	Movement Detection
15.	Electronic Noses
16.	Gas-Sensors
17.	Bio-Sensors

The devices share context information to enhance the interaction between each other's in the smart surroundings. Examples for relevant context information are:

- Verbal context
- Roles of communication partners
- Goals of the communication, goals of individuals
- Local environment
- Social environment
- Physical and chemical environment

The context devices are sensor based, data centred and reusable. Dense distributed heterogeneous devices or nodes intend to recognize large scale pervasive environment using contexts evolve in and around. The rest of the paper is organized with related works, evaluation of contexts, context perception, Flow of contexts and conclusion.

2. Related Works

2.1 Understanding the Context

What is meant for context and in what way it associated to situations in the real time? There is quiet a central lack of understanding on how contexts associates with situations and how common context information can be utilized to assist the applications. This is also a question on what is the universal representation of context [4].

2.2 Using Contexts

Assuming the available contexts in a system and identifying what are contexts useful when contexts are beyond the location. The questionevolve around what kind of applications can be enriched? When allowing the contexts as supplementary input, the issues raise about ambiguity and reliability and ambiguity are essential. Further the association between context and others in the system and how they impact on each other, are to be addressed [5]. Ultimate requirement is smartness of the system to recognize the context it deals with. Basic architecture for context-aware systems is shown in Figure 1.

2.3 Acquire Contexts

Gathering simple context as prerequisite for any kind of context-aware system. Commonly context acquisition known as the process of observing real fact in the Environment, the major features are considered, an abstract illustration is depicted then to provide it to the components of the system to proceed further. Various approaches are involved to acquire context including sensor systems, computer vision, location tracking, modelling users and their behaviour.

2.4 Relating Context Acquisition to Context Usage

In a location-based system, close relationship exists between context use and context acquisition, location sensor often attached to the devices through position as context. Context representation is arranged between the components. Context use and context acquisition are distributed in most of the general environments. It is supposed to offer dynamic configured contexts for various applications mostly. This creates noticeable mechanisms to relate context acquisition and context use as important. Few real time interpreters are shown in the Figure 2.

2.5 Understanding Impact on Human Computer Interaction

If a system is context-aware, then its behaviour depends upon the context use or the common situation use. The ultimate aim is to create a system that react in a way as expected by the user. In real-time this makes complex difficulties, specifically if the system reacts contrarily from the user's expectations [6]. Two serious issues are raised such as how users understand the system behaviour and how to provide the user control over the system behaviour .

Table 3. Human Computer Interaction

- Demo Recommender
- Group to URL
- iButton ID to Group
- iButton ID to Group URL
- iButton ID to Name
- Conference Recommender
- Name to Presenter
- PinPoint Zone to Location
- PinPoint ID to Name
- Motion to Names
- Words to Valid Words

2.7 Supports for Enabling Context-Aware Pervasive Computing

Context-awareness is one of enabling technology for Pervasive Computing systems and commonly required to realise pervasive environment. To establish pervasive computing environments effectively, it is unavoidable that user should provide support for enabling context-aware applications. So far all the problems and challenges have been carried over and over again to redefine each system. Extending support for context provision, context acquisition and context use will ensure the process of realizing context-aware applications as simple as possible.

2.8 Prediction Algorithms for Decision Making

Weiser's pervasive computing vision was human-centric that needs an input in terms of communication absolutely received from the environment. The design must be able to understand these inputs to determine regular activities and take automatic decisions. A smart environment in real time, enables the users to continue regular routines and observations without any device interruption. A prediction algorithm should be with minimal prediction errors and maximal usage of information without any delay. Plan recognition and sequence matching are the usual activities that will be useful for prediction and decision making. A smart environment is context-aware meant for perceiving inputs from numerous pervasive sensing devices which can be operated without human interruption. Location is the essential element in context aware for individual or group or for an organization to alter the pervasive computing environment. A smart environment would be able to determine and predict the location of the specific.

In the traditional environment location management was difficult and used prediction as transitional step to identify the location [7]. Location can be detected based on signals observed from the environment by a smart device is commonly known as device-centric (ex: GPS, RADAR). Network-centric identifies the location based on signals observed the smart device by pervasive sensors is known as network centric approach (ex: Active badges).

2.9 Role of Human Computer Interaction (HCI)

Human interaction with multiple heterogeneous devices spatially distributed in shared physical spaces and time is difficult to control centrally in the same way that humans can control a single device. It is considered as a model for all Human Computer Interaction (HCI), where the system is dynamic and autonomous, reducing decision making by humans in Table 3. It is about enhancing reality, not only enhance but also change HCI in wider ways. It is commonly distributed or virtual computing that focus on specific models of human and physical world interaction involving context awareness of implicit human computing interaction [8].

Pervasive Computing sometimes referred as Ubiquitous Computing which deals with "computing power". The availability of data at anyplace, anytime regularly so that it can be used for facing the challenges in social environment. Some of the opportunities and challenges in Pervasive Computing are addressed.

Table 4. Categories of wireless grids and their differences

Category	Differences	Potential Applications
Ad-Hoc Wireless	Support P2P Connections, Have No Predefined Entry Points	Disaster Management, Mobile Collaborations, Device, Sensor Network Applications.
Mobile Wireless	Supports Mobile Client, Services Or Both.	E-Health, E-Learning, Device Integration, Mobilized Enterprise Information Systems Etc.
Context Aware Wireless	Support Context Aware Interactions	Sensor Network Applications, Pervasive Grid Applications.

Recent and steady advances in the area of computing has the revolution which makes the people and communications closer. Various devices which are embedded together with computingare communicated with each other ranging from small to large and their differences are shown in Table 3.

Merging computing and communications together with devices meets the pervasiveness. The supporting system for understanding the situation is popularly known as context awareness. It seeks to shrink the World by enabling people to work together irrespective of the location. A collective knowledge based assistant assists us to work continuously in local or shared space to establish self-configuring computing and connectivity [9][12].

3. Evaluation of Context-Aware System

As context-aware systems use contexts, it demands self-evaluation. If functionality is the only available assured context, it is necessary to generate or simulate a specific situation that results the required context to assess the system. Bringing a specific situation and context together may have significant effect on measures in the assessment.

3.1 Context Use Related Objects

Many of these research problems are highly interrelated but some of the challenges can be undertaken independently. Many applications consider context-awareness as bottom-up approach. In the bottom-up method context acquisition and context use is related to objects. The following senses have been a fact of motivation when examining for sensing and perception technologies.

- Vision
- Audible
- Touch
- Odour

- Taste
- Temperature
- Acceleration
- Gravity
- Location And Constellation
- Magnetic Fields
- Electrical Phenomena

Pervasiveness requires instant accessible of data, sometimes priority preferred on data over huge volume data is difficult task in pervasive environment. Gathering large volume of data needs a mechanism developed for congestion free and absolutely available link to compete the speed of smart devices communication. The specific region is allotted with numerous heterogeneous nodes that could control and sense contexts or events for generating raw fact.

Table 5. Basic Layered model for Position based objects

Place-based communities
Services
Applications
Limited range wireless LAN Infrastructure and mobile devices

The Basic layered model for position based objects is shown in Table 5. All these useful information are offered to the outside world using widgets and applications which can be used normally in a smart device. Through user, physical and environmental contexts event is ensured for decision making that does not require human access continuously.

Bayesian classification to calculate the probability of actual contexts to achieve context representations [10, 11]. The context probability is represented as,

$$P(h_j/X) = \prod_{i=1}^{n} P(\frac{x_i}{h_j})P(h_j) \tag{1}$$

X_i denotes contexts observed and X_i € 1, 2….n. h_j denotes context values and h_j € 1, 2….n. Finally the maximized value context probability is elected for representation. To aggregate and normalize the contexts from gathered records, it is given as,

$$C_i = \frac{Context\ value_i}{Context\ value_{max}} \tag{2}$$

Comparison of context cases from databases is processed using Euclidean distance is given as,

$$ED_i = \sqrt{\frac{(C_i^{old}-C_i^{new})^2 \ldots (C_n^{old}-C_n^{new})^2}{K}} \tag{3}$$

$ED_i$is the distance context actuality, C_i^{old}indicates the historical contexts and C_i^{new}denotes the actual contexts. The priority (μ) among the contexts are identified is given as,

$$\mu = \sum_{i=1}^{n} \frac{W_i}{n} \quad (4)$$

W_i weight value of each contexts and n indicates number of contexts. Based on the priority, the suitable contexts are computed by

$$c = \frac{\sum_{i=1}^{n} ca_i \mu_i}{\sum_{i=1}^{n} \mu_i} \quad (5)$$

ca_i is adjusted range, μ_i indicates priority, n denotes number of contexts.

4. Context Perception

The sensory perception will differ from familiar contexts to a new context. For a location based contexts, lack of reference points and inexperience are not supporting complete visual matching but in familiar locality, expectation would be there about visual matching. For unfamiliar locality context, the system will guide you to your destination. The destination with non-optimal flow will satisfy user expectation in an unfamiliar environment. For familiar non optimal flow includes few blocks because of flow is an either out-dated or missing alternate/new flow.

Finally familiar environment user has a considerable awareness whereas in new surrounding we have insignificant disparity [12]. A good system aims at designing system with minimal awareness mismatch. It is more difficult for the user to understand the casualties behind the system behaviour. System may suggest different decisions from time to time as it is not the same. If the user has no knowledge about that the system make the suggestion based on the current scenario, it is likely to hard to understand what system does. User has to understand the system behaviour and hints are essential to be aware of mismatching contexts.Sequential step by step procedure for the design of context perception systems is given in Table 6.

Table 6. Steps followed for design of context perception

Steps	A Method For Designing Context Perception Systems
1.	Identifying contexts that matter.
2.	Determine variables that distinguish contexts selected
3.	Finding appropriate Sensors to cover all variables at minimum cost.
Optional	Building and assessing a prototypical sensing device.
4.	Selecting recognition and abstraction technologies.
5.	Specification of a context acquisition system.
6.	Build applications.

5. Flow of Contexts

To provide framework for realizing context aware applications that intended for pervasive environment are context oriented and data acquisition design is automatically sense real time facts then presented to the end user. Context widget accepts the required context information form attribute based data centric sensor nodes. The interconnected components share the observed data using various sensors observations that implied to widgets based on the purpose mentioned. The context aggregators aggregate the gathered contexts with respect categories. The applications obtain aggregated contexts and continue them to the smart devices used. The computational contexts status are confirmed before directing them to external devices. Properties and principles of context in a distributed system are,

- Locality and Proximity
- Time
- Independence between context Acquisition and Use
- Distribution and Scalability
- Transparency

While creating context adaptive system, mainly concentrate on basic approach to define a set of contexts that are relevant for adaptation. Next is to select a set of function/apps that are used and then create a mapping between the contexts and functionalities. The proposed ubiquitous model is designed for communicating heterogeneous devices across various network service providers. Every smart device is associated with internal gateway, which interacts with third party agent known as network interoperating agent to handle the context perception successfully in order to communicate data as soon it is generated. It uses wide range of platforms and advanced radio models for low power communications using different routing protocols. Increased number of nodes and received packets are taken to analyse the network consistency. Table 7 shows decrement in packets received, when number of nodes are increased because of bandwidth shared among the nodes.

Table 7. Comparison of number of nodes, packets received and energy consumed

Number of Nodes	Packets received (Bytes/sec)	Energy consumed (Joules)
8	596	0.084
16	395	0.086
50	330	0.135
100	337	0.146
200	274	0.152

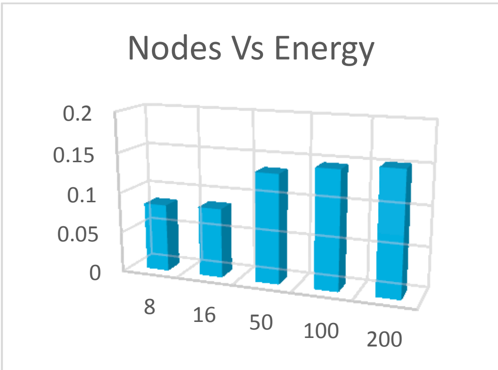

Fig .1 Comparison of number of nodes and energy consumed

Similarly for energy consumption, in Figure 1 though the difference is not much, it is slightly increasing when number of nodes are increased because of energy consumption of sensors even it is inactive.

6. Conclusion

To offer the services requested by the applications, the proposed infrastructure allowing an applications across the network to access local, global and remote contexts in the heterogeneous communication. It allows various modes of applications, variety of sensors and functions on contexts as well as restores the history of contexts sensed for analysing the decision making.

The presented model is a generic method for context-handling to provide an infrastructure based on available context services. Context services are suitable for context sharing and extending access to context backup history. Enabling these features to propose promising applications and developing more based on the infrastructure of context services. It supports to facilitate applications to receive and adapt an event from different types of devices and situation also permitting the users to observe the list of all active and expired events.

References

1. Schmidt A. (2015) "Societal Discussion Required? Ubicomp Products beyond Weiser's Vision." IEEE Pervasive Computing: 14(1):8-10.
2. Schmidt A, Takaluoma A, Mantyjarvi J.(2000) "Context-aware telephony over WAP." Personal and Ubiquitous Computing: 4(4):225-9.
3. Younis M, Akkaya K.(2008) "Strategies and techniques for node placement in wireless sensor networks". A survey. Ad Hoc Networks: 6(4):621-55.
4. Oyomno W, Jappinen P, Kerttula E, Heikkinen K. Usability study of ME2. 0.(2013) "Personal and ubiquitous computing: 17(2):305-19.
5. Korn O, Funk M, Schmidt A.(2015) "Assistive systems for the workplace: Towards context-aware assistance." Assistive Technologies for Physical and Cognitive Disabilities: 121-33.
6. Kannadasan R, Saleembasha MS, ArnoldEmerson I.(2015) "Survey on Molecular Cryptographic Network DNA (MCND) Using Big Data." Procedia Computer Science: 1(50) :3-9.
7. Kubitza T, Pohl N, Dingler T, Schneegaß S, Weichel C, Schmidt A.(2013) "Ingredients for a new wave of ubicomp products." IEEE Pervasive Computing: 12(3):5-8.
8. Prabakaran N, Kannan RJ.(2017) "Sustainable life-span of WSN nodes using participatory devices in pervasive environment". Microsystem Technologies: 23(3):651-7.
9. Kannadasan R, Saleembasha MS, Emerson IA.(2016) "A Frame Work for Learning Drug Designing through Molecular Modelling Software Techniques and Biological Databases for Protein-Ligand Interactions." International Journal of Engineering Research in Africa. 1(27): 326-343.
10. Shih KP, Wang SS, Chen HC, Yang PH. CollECT.(2008) "Collaborative event detection and tracking in wireless heterogeneous sensor networks." Computer Communications: 31(14):3124-36.
11. Zhou Y, Xu T, David B, ChalonR .(2014) " Innovative wearable interfaces: an exploratory analysis of paper-based interfaces with camera-glasses device unit." Personal and ubiquitous computing: 18(4):835-49.
12. Yick J, Mukherjee B, Ghosal D.(2008) "Wireless sensor network survey. Computer networks": Aug 52(12):2292-330.