Context Awareness Monitoring Model for Smart Office Environment

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***Abstract*—Administrators conventionally write information on paper or on a notice board to monitor subordinates' activities within an organization. Unfortunately, the information cannot be stored and retrieved for future use. This paper presents a case study for the implementation of a smart notice board. The analysis focuses on the presence and transition of staff work activities. The staff activities are evaluated to allow administrators to be aware of their work status. Based on the smart office board design, we propose a context-aware monitoring model in a smart office environment. This model provides a platform to gather useful information of staffs during their working hours. Therefore, top-level administrators can identify staff status (present, absent or busy) and perform statistical analyses on staffs' availability. Thus, they can plan, schedule, make decisions and prepare reports instantly.**

Keywords-collaborative; context-aware; monitoring user activities; workspaces; smart office; smart notice board.

I. INTRODUCTION

Generally, an organization uses a notification board to inform their staff of theirs' daily activities. The activities depend on the current work mode, which deals with different tasks, tools, and information [1]. Nevertheless, networked collaborative virtual environments allow workers to work in a shared virtual space at real-time. However, virtual space lacks contextual elements as in a real life-working situation. The virtual workspace should make optimum use of human computer interaction. It should provide relevant information or services to adapt the system behaviours for a specific user [2]. In addition, context-awareness is one of the vital features, which helps users to map their tasks by considering the parallel interaction in networked virtual environments [3].

A context-aware service should provide accurate information to assist people in setting goals, making plans and performing the necessary actions in their daily work activities. Recognizing people activities in a virtual work space will help users to react automatically to a person's identity, location, activity, and facial expression [4]. They should be informed about others' work to obtain the information at the right time, right place and communicate in a meaningful way.

Today, most people spend a lot of time working in spaces, like offices and committee rooms. Most of the researchers are focused on the development of smart and intelligent working environments [5]. A smart environment is defined as a situation in which a user interacts with another user in a flexible, personalized and domain-specific manner [6],[7]. The goals of a smart environment are to support and provide task-relevant information services to sense context in a variety of user environments [8]. The smart environment can provide a unique service in designing, researching and addressing issues in a multi-agent system [9]. There are some examples of smart environments such as the smart home [10], [11], [12], the smart hospital [13], the smart freeway [14] and the smart office [5].

The smart office is defined as an environment that enables the user to adapt user needs, routine tasks, preferences, and access on-time services [15]. It represents a user's work, as in a normal office. In addition, it allows the user to acquire and apply knowledge to improve their experience and synchronous communication in a particular environment [7],[16]. The synchronous communication and data are integrated with other information to enable users to gain knowledge of current and past activities in the working environment [1].

Furthermore, the smart office handles several devices that supports everyday tasks, anticipates user intentions, and reduces the conflict in decision making [5]. There are several examples of smart office systems such as intelligent meeting rooms [5], the virtual secretary [17], and the smart doorplate project [18]. This paper focuses on designing a smart notice board as part of the smart office environment. Designing a context-aware system in a smart office environment is a complex and challenging issue. Most of the studies do not fully address specific characteristics of context management [19]. Therefore, in Section II, we will analyze and categorize the most common characteristics used in the smart office environment.

The rest of this paper is organized as follows: Section III observes smart office scenarios and related activities for a smart office in an academician environment. Next, Section IV presents a context-aware monitoring model for the smart office environment. Finally, Section V discusses the conclusion in relation to the research work.

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II. CONTEXT CATEGORIZATION

Human activities can be classified into personal, community, and social activity [20]. Each of the activities will involve different types of context depending on the location, time, resources, task, and situation. The context has been used as a tool to select the correct action, improve the quality and efficiency of case-based reasoning within the diagnostic domain virtual workspace [21]. When dealing with a different state or situation, context is the key element used to infer possible action and support the user with contextual information [22]. It is crucial to understand context and its relation with adaptability (i.e. device, environmental setting, and time) to construct context-aware software development that is beneficial to the users [23].

Many researchers define and classify context to support and develop context-aware systems. Dey and Abowd [24] identified four primary context types (i.e., location, identity, time, and activity). It provides task-relevant information and interaction between the user and the context-aware application. Prado [2] defines three types of context (i.e., device-related, environmental and user context). This context deals with the impact of application on different user interfaces, information and functionality of context. In order to model the relationship of activities and situations in a context-aware system, Kofod and Cassens [22] suggest five categories of user context (i.e., personal, task, social, spatio-temporal and environmental context).

Soylu et al. [23] propose eight categories to develop context-aware systems (i.e., user, device, application, information, environmental, time, historical and relational context). In addition, Villegas and Muller [25] classify five categories of context (i.e., individual, human, artificial, activity and compositional relations context) to control and govern context information within a smart environment. Furthermore, Kapitsaki et al. [26] apply three context categories within the tourist service (i.e., user, context information and services). It is found that user, system, physical, time and history are the most important context for mobile map applications [27]. Generally, it is concluded that most of the context-aware systems involve three main contextual entities: *user*, *activity* and *events*.

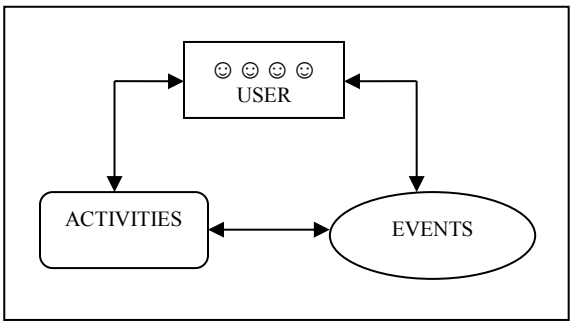

Figure 1. The contextual entities.

Fig. 1 depicts the most common context entities within the smart environment. All of these entities are dependent on the application, environment and goal, which the context-aware system is used. Based on this contextual entities, we observed the academicians' work modes to illustrate the context–aware activities within the smart office environment.

III. OBSERVING SMART OFICE ACTIVITIES

This study is conducted as an observation case study on staff activities during office hours. It is built on monthly activity that requires users to fill in information on the notice board. The aim of this case study is to extract important features to be used in designing a smart notice board. Contextual elements in the case study are analyzed in order to provide accurate information about staff work activities. The information is useful for the management to plan, schedule, and take appropriate action. Through the smart notice board, top-level management can identify whether staff are present, absent or busy. In addition, staff data can be used for further statistical analyses when top level management need to make decisions based on the system's report.

Scenario: Assume academicians are users in the smart notice board working environment. Let U be the set of lecturers = $\{U_1,\ldots..,U_n\}$. Lecturers can insert their monthly activities in a smart notice board as shown in Table I. The activities are based on daily activity, which involves contextual ontology. Contextual ontology is referred to as the shared understanding of some domains such as entities, relations, functions, and instances [28]. It provides a shared vocabulary and matches specific user queries, service descriptions and information in a context-aware system [29]. Each member of staff will input all monthly activities for the duration of the office hours (8.00 am – 5.00 pm).

TABLE I SMART NOTICE BOARD REPRESENTATION

Day / Person	1	2	3	……	……	……	31
U_1							
U_2							
U_3							
:							
:							
:							
U_n							

Users are categorized into two levels; academicians and administrators. The users' contextual activities can be in the form of teaching, research and development (RnD Context), administration and personal context. Contextual activity relates to an event based on three contextual elements,

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which are sensed-data, time-line and location. Table 2 presents the details of the user classification, their contextual activities, and events as portrayed in Fig. 1.

TABLE II CONTEXTUAL ONTOLOGY EXAMPLE

USER	CONTEXTUAL ACTIVITY	EVENTS

• Administration
• Academicians
  • Dean (U_1)
  • Assistant Dean (U_2)
  • SeniorLecturer (U_3)
  • Lecturer (U_4)
	• Teaching Context
	  • Teaching(C_1)
	  • Evaluation (C_2)
	  • Invigilation (C_3)
	• RnDContext
	  • Conference (R_1)
	  • Consultation (R_2)
	• AdminContext
	  • Clerical Work (A_1)
	  • Meeting (A_2)
	  • Personal Context
	  • On Leave (P_1)
	  • Undefined (P_2)
		• SensorData
		• DateNTime
		  • Morning(T_1)
		  • Breakfast(T_2)
		  • Afternon(T_3)
		  • Lunch (T_4)
		  • Evening(T_5)
		• Location
		  • Home (L_1)
		  • Office (L_2)
		  • Classroom (L_3)
		  • Meeting room (L_4)
		  • Conference room(L_5)

The activities can be divided into two states: present and not present as described in Table 3. The data will be input based on individual activity. The contextual activities are classified as present (i.e., teaching, consultation and meeting) and not present (i.e., conference, on leave, undefined). For example, a teaching schedule will be extracted from a class schedule, and the faculty provides these schedules for each semester. Consultation and on leave will be input as individual activities and conferences are based on the application and calls for meeting. Each of the users will input their activities for the whole semester based on the academic calendar, except for on call activities.

TABLE III CONTEXTUAL ACTIVITY OF STAFF PRESENCE

User	Contextual Activity		Event
	Present	Not Present	
Dean Assistant Dean SeniorLecturer Lecturer	Class Consultation Meeting	Conference On Leave Undefined	Breakfast Lunch Classroom Meeting room Conference room

When dealing with a context-aware system, it should select the most appropriate content and features depending upon the usage context, such as context views [30]. Fig. 2 summarizes the context view for a smart notice board application.

User:	Contextual activities	Events:
Lecturer (U_4)	Teaching (C_1), Evaluation (C_2), Meeting(A_2), Consultation(R_2)	• Timeline : Morning(T_1),; Afternoon(T_3);Evening(T_5) • Location-: Office(L_2), Classroom(L_3), Meeting room(L_4)

Figure 2. Context entities for a smart notice board application

The context view is used to view shifts from one-node to other in the state transition activities. The graphical notation simplifies and helps the software developer to analyze, redesign and define the software requirements between users and environmental services [31],[32]. Fig. 3 shows a general context view of the state of transition for academician activities during office hours. This scenario shows how one user (U_4) represents normal daily activities, which involve the *time-line* (i.e., morning (T_1), afternoon (T_3), and evening (T_5)), *location* (i.e., office (L_2), classroom (L_3), meeting room (L_4)) and *contextual activities* (i.e., teaching (C_1), evaluation (C_2), consultation (R_2) and meeting (A_2)).

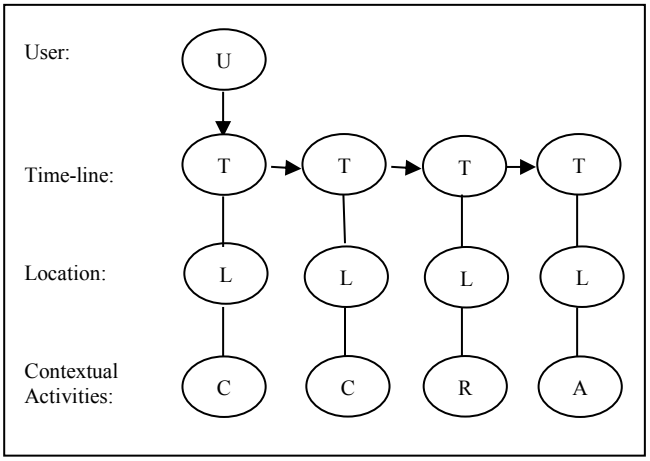

Figure 3. General context view of state transition activities

The activities are considered as dynamic since it might change from one-node to another node. All of the activities will be analyzed and monitored by top-level administrators. They should be aware of each activity in order to identify the work status whether the staffs are present, absent or busy. The provision of awareness is a key factor for keeping users up-to-date with what happens around them [33]. Therefore, a notification system is important to deliver current information effectively without causing unwanted distraction to ongoing tasks [34]. Through the notification system, the top-level administrators can use the information to make necessary actions and achieve the task objectives.

We illustrate four scenarios in academic work activities to determine the most available time for all academicians' staff. The scenarios show common activities for academicians, which involve three contextual entities (regardless of their location):

i. User - Dean (U_1), Assistant Dean (U_1), Senior Lecturer (U_1), Lecturer (U_4)
ii. Contextual activities - Available (√), Not available (X)
iii. Events - D ay (1, 2, 3, and 4)
Time slots: Morning (T_1), Breakfast (T_2), Afternoon (T_3), Lunch (T_4) Evening (T_5)

The four scenarios represent the daily activities from day one until day four. In each scenario, it will involve the four types of user (i.e., dean, assistant dean, senior lecturer, and lecturer). The contextual activities are considered as available (√) and not available (X). The available activities refer to free time, whereas not available means the users are on duty (i.e., teaching, conference, meeting, or on leave). The events are based on five standard time slots (morning, breakfast, afternoon, lunch and evening). The time slot for breakfast and lunch are blocked out as break-time. Each user will input data into the smart notice board system.

Scenario 1: In this scenario, it shows that all users are busy and not available.

TABLE IV SCENARIO 1 OF ACADEMICIANS ACTIVITIES

DAY	1				
TIME	T_1	T_2	T_3	T_4	T_5
USER	CONTEXTUAL ACTIVITIES				
U_1	X		X		X
U_2	X		X		X
U_3	X		X		X
U_4	X		X		X

Scenario 2: In scenario 2, it shows only 50% of the users available during the morning slot and most users are not available during the afternoon and evening slots.

TABLE V SCENARIO 2 OF ACADEMICIANS ACTIVITIES

DAY	3				
TIME	T_1	T_2	T_3	T_4	T_5
USER	CONTEXTUAL ACTIVITIES				
U_1	X		X		√
U_2	X		X		X
U_3	√		X		X
U_4	√		√		X

Scenario 3: In scenario 3, it shows 80% of the users are available in the evening slot.

TABLE VI SCENARIO 3 OF ACADEMICIANS ACTIVITIES

DAY	2				
TIME	T_1	T_2	T_3	T_4	T_5
USER	CONTEXTUAL ACTIVITIES				
U_1	X		√		X
U_2	√		X		√
U_3	X		X		√
U_4	X		X		√

Scenario 4: In scenario 4, it shows all users (100%) are available in the morning slot.

TABLE VII SCENARIO 4 OF ACADEMICIAN ACTIVITIES

DAY	4				
TIME	T_1	T_2	T_3	T_4	T_5
USER	CONTEXTUAL ACTIVITIES				
U_1	√		X		X
U_2	√		√		X
U_3	√		X		X
U_4	√		√		X

The scenarios show, that the most available time for all staff is during scenario 3 (80%) and scenario 4 (100%). Therefore, the administrator can monitor and make a decision to do any activity such as call a staff meeting, a conference or an evaluation of staff performance. As data is stored within the computer system, statistical reports along with general reports can be produced at real time. Based on the context awareness-monitoring model, a smart notice board system will be developed.

IV. CONTEXT AWARENESS MONITORING MODEL

Adapted from a previous study (Fig. 4), the monitoring manager will interpret, filter and select rules to analyze and manage the interactive data.

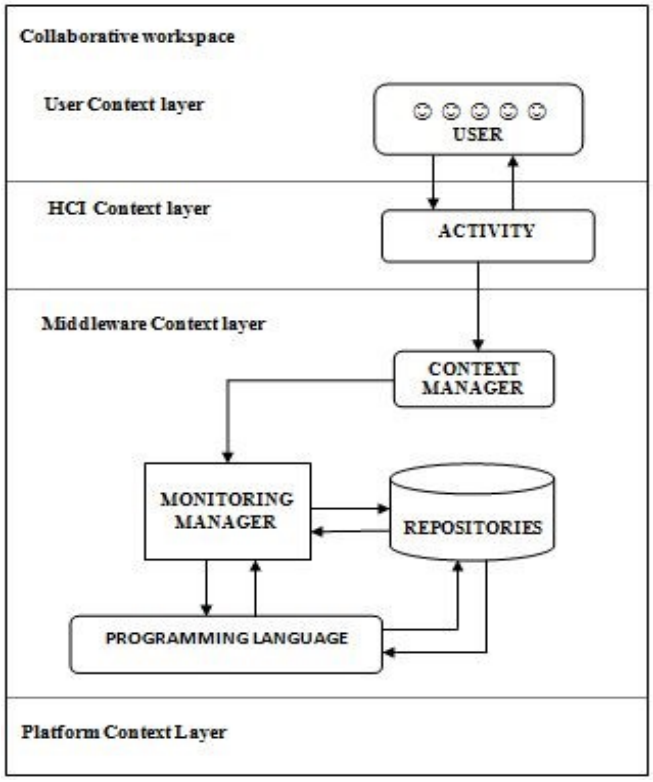

Figure 4. A general context awareness monitoring model [35]

Based on the four scenarios, the rules represent the logic and reasoning mechanism to choose the most available time for all staff.

Scenario 1-4 : General Rules

IF (user({U_1,.....,U_n})
AND (day(({D_1,.....,D_n})
AND (time(({T_1,.....,T_n})
THEN
isAvailability ({yes, no})

The monitoring process deals with the communication between at least two of the users who should observe their enviroment and activities (shown in Fig. 5). The awareness provides information about the activity and the availability of all users. Besides the rules, the *contextual media* (e.g., text, graph, colour-coded, keyword, image, and messages), will be considered as an important elements to monitor user activities within the collaborative workspace [35],[36]. For example; the change of colour in text (e.g., available, or not available), shows different action has been taken by a user. The person who monitored the system, should also be aware of the signal given by the other user.

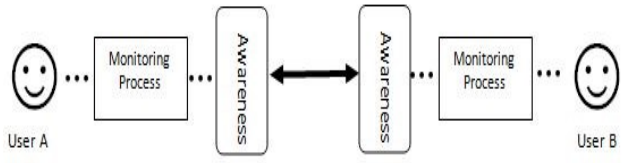

Figure 5. The user interaction in contextual awareness activities [36]

The implementation of the smart notice board system, involves the communication between an object (i.e., user, task, and resources) and the monitoring system [37]. This communication is governed by a monitoring process, which consists of the contextual monitoring components (i.e., contextual activity, event, time, and location) as depicted in Fig. 6. The sensor-data detects the presence of any action during the execution time in the monitoring process system.

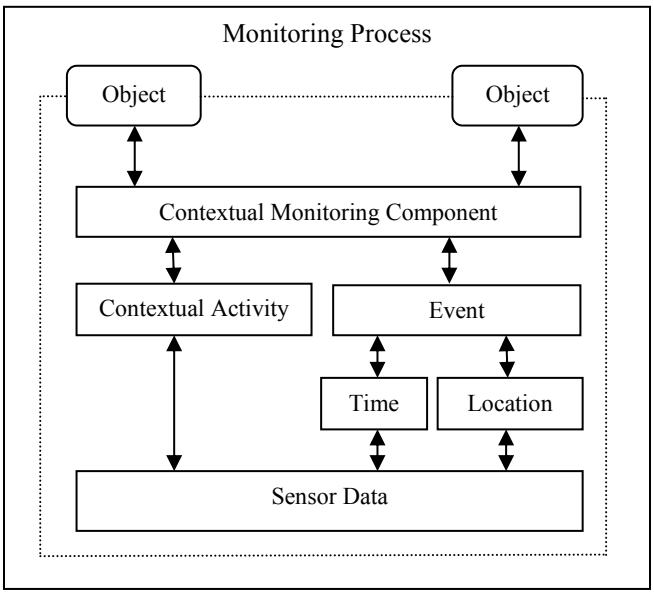

Figure 6. The monitoring process components

In order to design the smart office notice board system, all of the monitoring process components are mapped into the context-monitoring model (shown in Fig. 7).

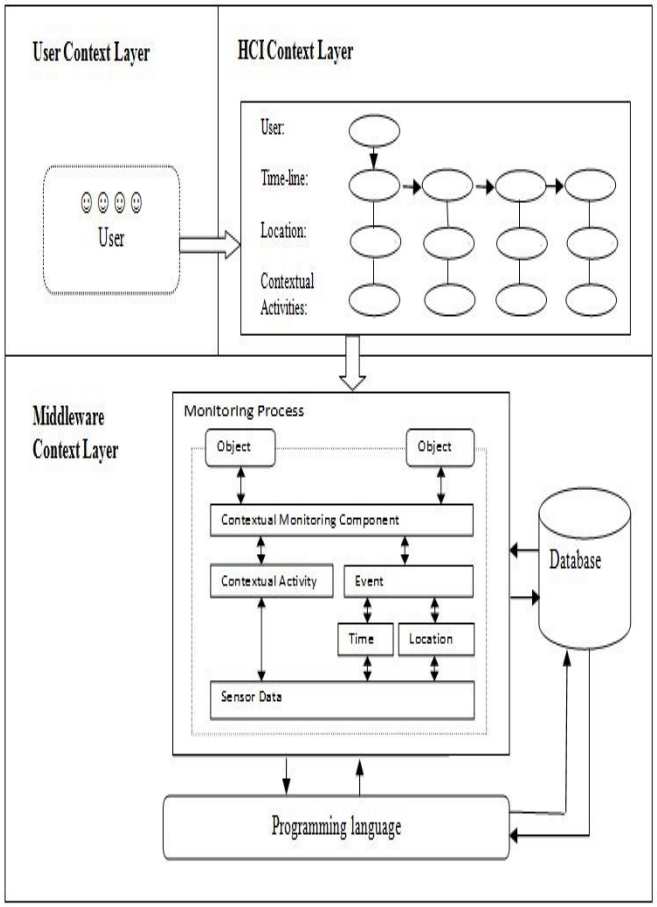

Figure 7. Context monitoring model for smart office environment

The context monitoring model design focuses on the development for a smart office notice board system. This system will be developed and manipulated by programmers in commonly available languages (e.g., Java, C, or C++). The data analysis is based on the user activities and the assessment on the availability of free time for each user. Basically, the monitoring process deals with the contextual media elements, which automatically senses the contextual activities. This will allow sensors to configure the appropriate action in response to user requirements. The sensors will recognize and respond to the performance of the activity. The result of tracking activities will be displayed in an assessment console. Through the data analysis, this information will be utilized and helps the top-level management in decision making.

V. CONCLUSION AND FUTURE WORK

This paper has analyzed user activities in a smart office environment. Basically, a context-aware system involves three common entities namely: user, activity and events. We

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illustrated a scenario of contextual elements for academicians in their working environment by using a smart notice board prototype. The contextual awareness elements provide information about the activities and availability of all staff. Finally, a context awareness-monitoring model for the smart office environment has been proposed. The context-aware system should offer easier and more intuitive ways for the service provider to add and to subscribe new services through the historical context, log in service and feedback systems so as to enhance and better deliver a more appropriate quality of services [38]. Therefore, our future work will analyze and construct a general platform for monitoring a user activities system, which can be applied to any smart office environment.

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REFERENCES

[1] W. Geyer, H. Richter, L. Fuchs, T. Frauenhofer, S. Daijavad, S. Poltrock, and I. B. M. T. J. Watson, "A team collaboration space supporting capture and access of virtual meetings," 2001, pp. 188–196.

[2] A. G. De Prado, "Context-Aware Services : A Survey on Current Proposals," *Service Computation 2011, The Third International Conferences on Advanced Service Computing*, pp. 104–109, 2011.

[3] G. Niezen, B. J. J. van der Vlist, J. Hu, and L. M. G. Feijs, "From events to goals: Supporting semantic interaction in smart environments," *The IEEE symposium on Computers and Communications*, pp. 1029–1034, Jun. 2010.

[4] J. Krumm, S. Shafer, and A. Wison, "How a Smart Environment Can Use Perception," in *Workshop on Sensing and Perception for Ubiquitous Computing (part of UbiComp 2001)*.

[5] C. Ramos, G. Marreiros, R. Santos, and C. F. Freitas, "Smart Offices and Intelligent Decision Rooms," *Handbook of Ambient Intelligence and Smart Environments*, pp. 851–880, 2010.

[6] J. Weissman and Z. Zhang, "Smart Environments : Middleware Building Blocks for Pervasive Network Computing (A Position Paper)," *Developing an Infrastructure for Mobile and Wireless Systems*, pp. 90–105, 2002.

[7] M. Youngblood, D. J. Cook, and L. B. Holder, "Seamlessly Engineering a Smart Environment," *2005 IEEE International Conference on Systems, Man and Cybernetics*, vol. 1, pp. 548–553.

[8] A. K. Dey, G. D. Abowd, and D. Salber, "A Context-Based Infrastructure for Smart Environments," pp. 1–15, 1999.

[9] D. J. Cook, "Multi-agent smart environments," *Journal of Ambient Intelligence and Smart Environments*, vol. 1, pp. 51–55, 2009.

[10] M. Lyons, P. Lyons, A. T. Cong, H. J. Steinhauer, S. Marsland, J. Dietrich, and H. W. Guesgen, "Exploring The Responsibilities Of Single- Inhabitant Smart Homes With Use Cases," *Journal of Ambient Intelligence and Smart Environments*, vol. 2, pp. 211–232, 2010.

[11] M. Jahn, M. Jentsch, C. R. Prause, F. Pramudianto, A. Al-akkad, S. Birlinghoven, and S. Augustin, "The Energy Aware Smart Home," in *Future Information Technology (Future Tech)*, 2010, pp. 1–8.

[12] A. Helal, D. J. Cook, and M. Schmalz, "Smart home-based health platform for behavioral monitoring and alteration of diabetes patients.," *Journal of diabetes science and technology*, vol. 3, no. 1, p. 141, Jan. 2009.

[13] A. Coronato, M. Esposito, and G. Pietro, "A multimodal semantic location service for intelligent environments: an application for Smart Hospitals," *Personal and Ubiquitous Computing*, vol. 13, no. 7, pp. 527–538, Apr. 2009.

[14] S. K. Lo, "A collaborative multi-agent message transmission mechanism in intelligent transportation system–A smart freeway example," vol. 184, pp. 246–265, 2012.

[15] I. Marsá-maestre, E. De Hoz, B. Alarcos, and J. R. Velasco, "A Hierarchical , Agent-based Approach to Security in Smart Offices," 2006.

[16] C. Röcker, "Services and Applications for Smart Office Environments - A Survey of State-of-the-Art Usage Scenarios," *International Conference on Computer and Information Technology (ICCIT 2010)*, pp. 385–401, 2010.

[17] M. Danninger and R. Stiefelhagen, "A context-aware virtual secretary in a smart office environment," in *Proceeding of the 16th ACM international conference on Multimedia, 2008*, 2008, pp. 529–538.

[18] J. Petzold, F. Bagci, W. Trumler, and T. Ungerer, "Next Location Prediction Within a Smart Office Building," *Cognitive Science Research Paper Unversity of Sussex CSRP*, vol. 577, p. 69, 2005.

[19] H. Vahdat-nejad, K. Zamanifar, and N. Nematbakhsh, "Context-Aware Middleware Architecture for Smart Home Environment," vol. 7, no. 1, pp. 77–86, 2013.

[20] Y. Lee, S. Oh, C. Shin, and W. Woo, "Ubiquitous Virtual Reality and Its Key Dimension" *Proc. of IWUVR*, vol. 9, pp. 5–8, 2009.

[21] M. Vladoiu and Z. Constantinescu, "U - Learning Within A Context-Aware," vol. 3, no. 1, 2011.

[22] A. Kofod-petersen, "Using Activity Theory to Model Context Awareness : a Qualitative Case Study," *Modeling and Retrieval of Context*, pp. 1–17, 2006.

[23] A. Soylu, P. De Causmaecker, and P. Desmet, "Context and Adaptivity in Context-Aware Pervasive Computing Environments," *2009 Symposia and Workshops on Ubiquitous, Autonomic and Trusted Computing*, pp. 94–101, 2009.

[24] A. K. Dey and G. D. Abowd, "Towards a Better Understanding of Context and," 1999, pp. 304–307.

[25] N. Villegas and H. Muller, "Managing dynamic context to optimize smart interactions and services," *The smart internet*, pp. 289–318, 2010.

[26] G. M. Kapitsaki, G. N. Prezerakos, N. D. Tselikas, and I. S. Venieris, "Context-aware service engineering: A survey," *Journal of Systems and Software*, vol. 82, no. 8, pp. 1285–1297, Aug. 2009.

[27] A. Nivala and L. T. Sarjakoski, "Need for Context-Aware Topographic Maps in Mobile Devices," *Proceeding of ScanGIS 2003*, pp. 15–29, 2003.

[28] T. Gu, X. H. Wang, H. K. Pung, and D. Q. Zhang, "An Ontology-based Context Model in Intelligent Environments," *Proceeding of communication networks*

 ISBN: 978-1-61208-287-5

and distributed systems modeling and simulation conference, pp. 270–275, 2004.

[29] T. Broens, S. Pokraev, M. Van Sinderen, J. Koolwaaij, and D. Costa, "Context-aware, ontology-based, service discovery," *Ambient Intelligent*, pp. 72–83, 2004.

[30] T. Hussein, W. Gaulke, and T. Linder, "Improving collaboration by using context views ¨," 2010.

[31] R. Paiano, A. Pandurino, L. Mangia, P. Marra, and M. Russo, "Collaborative Business Applications: A New Methodological Approach," *IBIMA Business Review Journal*, vol. 2011, pp. 1–18, Jun. 2011.

[32] A. R. Tripathi, D. Kulkarni, and T. Ahmed, "A specification model for context-based collaborative applications," *Pervasive and Mobile Computing*, vol. 1, no. 1, pp. 21–42, Mar. 2005.

[33] L. Ardissono and G. Bosio, "Context-dependent awareness support in open collaboration environments," *User Modeling and User-Adapted Interaction*, vol. 22, no. 3, pp. 223–254, Aug. 2011.

[34] L. McCrickard, D. S., Czerwinski, M., & Bartram, "Introduction: design and evaluation of notification user interfaces.," *Journal of Human-Computer Studies*, vol. 58(5), pp. 509–514., 2003.

[35] N. A. A. Fadzillah, N. Omar, and S. Z. Z. Abidin, "A Framework for Monitoring User Activities in Networked Collaborative Workspace." Unpublished.

[36] N. A. A. Fadzillah, N. Omar, and S. Z. Z. Abidin, "Activity-Based Entities Relationship in Monitoring Context Awareness," in *Context-Aware Systems and Applications*, Springer Berlin Heidelberg, 2013, pp. 1–9.

[37] N. A. A. Fadzillah, N. Omar, and S. Z. Z. Abidin, "Application-based context awareness in collaborative workspaces: A Review," 2012, pp. 411–415.

[38] S. Lee, J. Chang, and S. Lee, "Survey and Trend Analysis of Context-Aware Systems," *Information An International Interdisciplinary Journal*, vol. 14, no. 2, pp. 527–548, 2011.

 ISBN: 978-1-61208-287-5