Activity-Based Entities Relationship
in Monitoring Context Awareness

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Abstract. Communication and collaboration among members in virtual workspace are becoming more complex and challenging. Users are invisible and they are merely represented by their tasks in align with resources. In order to maintain effective communication among users, monitoring context awareness in a collaborative space is crucial. A vital aspect of awareness is associated with coordinating work practices by displaying and monitoring virtual users' actions. This paper focuses on user activities in five dominant domains for the purpose of understanding phenomena in contextual awareness. Activities and their relationships are explored to produce an activity-based entities relationship in monitoring context awareness.

Keywords: Collaborative workspace, context-awareness, entities relationship, activities, monitoring.

1   Introduction

Collaboration involves groups of people working together to achieve certain goals. It relies on the ability to work either virtual or physical of the on-going and seamless transition between individual and collaborative task [1]. In network collaborative virtual environment (NCVE), each collaborator holds a specific job function such as manager, supervisor, administrator, secretary and day-to-day operation workers [2]. It involves common people behavior such as eye contact, gaze duration and touch, which are invisible in the virtual world [1].

Today, the requirements for context-aware software, are more and more difficult to handle such as limited connectivity, hardware heterogeneity, and changes in user preferences [3]. Users are either less aware of others using the software or they are less comfortable posting because they do not know who is using the system [4]. They note that all users feel that sharing their locations or events context to other people in the system is important.

The context awareness applications usually make use of human computer interaction. When the interaction occurs, people tend to ignore whether the information is understood by others. People who are sharing their tasks do not know what others exactly do and what their task or work progress during the conversation in NCVE. In addition, misunderstanding emerges when people do not have the same background knowledge [5].

This paper is intended to explore and understand phenomena in contextual awareness. The relationships between user, task and resources will determine the entities involved in workspace environment. All entities and their relationships will be explored in order to determine the monitoring process of user task in the collaborative workspace.

2   Context Aware Entities

Collaborative virtual environment is used to support collaborative work between geographically separated and between collocated collaborators [6]. All collaborators should aware and understand the activities of others which provide contexts of their activities. A context is open and dynamic concepts which represent the activities performed in a workspace. It can be used to facilitate the communication in human-computer interaction. This context is used to ensure that user contributions are relevant to the group's activity [7]. It is important to recognise the context within the group and evaluate user actions with respect to group activities, progress and goals.

Workspace awareness aids coordination of tasks and resources, and assists transitions between user and shared activities [8]. Most activities involve *user*, *human computer interface* and *middleware* (Figure 1). *User* involves user needs, preferences and expertise [9]. Whereas, *human computer interface* is concerned on how people interact with computing technology [10]. At the architectural level, a *middleware* provides platform for *human computer interface* [11]. The *middleware* should consider both elements and mechanisms used in gathering awareness information in collaborative workspace [8].
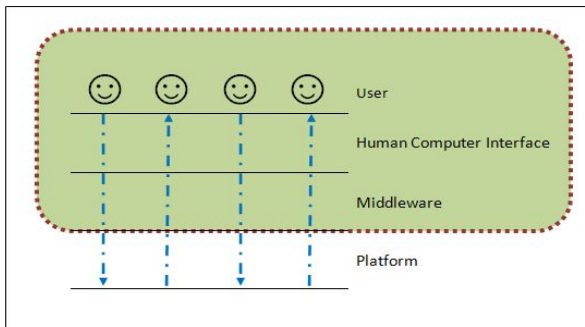

Fig. 1. General view of collaborative workspace

Our previous study has revealed eight elements that mostly associated with context-awareness research namely *domain*, *activity of user*, *context object*, *locations*, *type of communication*, *type of context*, *digital elements* and *models* [12]. Within these elements, *activity of user* should be focused in order to capture monitoring process and their relationships in the contextual awareness.

Most context-aware collaborative workspaces compose of *user*, *resources* and *task* [12]. In order to understand the process of collaborative communication, the user should be aware of who is online, what they are doing, and what their plans are [12], [13],[14]. When initiating a communication, it is important to be aware of the context that the inculator is operating in, and to establish a common understanding of the context [5]. Communication involves user relation, location and time [15], [16], [17]. Context-based workspace awareness can also be supported by computer technology [18]. Users should be assured that their partners have the same relevant information, device, media, and tools.

In addition, user activities play an important role in a shared-workspace collaboration [3], [19]. An activity is always user-centric and has some goals [20]. It can be defined as awareness of collaborators' work that supports performance in complex tasks [14]. Awareness of activities at different levels either individual, group or organizational, requires different information [3]. It also implies people's plan and understandings, knowledge of what one's collaborators are doing, and identifying, coordinating, and carrying out different types of task [21]. The next section investigates user activities in five dominant domains that use contextual awareness as part of the system.

3   Exploring Monitoring User Activities

The monitoring process is one of the main activities in the workspace. Designing efficient monitoring tools for online collaborative environments is certainly a complex task [18],[22]. A critical aspect of awareness is the associated coordinate work practices of displaying and monitoring actions [23]. This aspect concerns on how colleagues easily monitor the action which influent their work. Monitoring activities or practices in collaborative system is an important feature which allows user to obtain historical data and user's interactions in the collocated working environments [24], [25], [26].

Our analysis of activity awareness in the collaborative workspace was based on five dominant domains; education, context-based workspace, communication, visualization and business. The domains represent the activities during the collaboration in order to extract the contextual media used, how the media are monitored and the communication types involved among users (Table 1).

Based on Table 1, it is found that monitoring is important in collaborative learning because it gives vital information and allows user to take immediate corrective actions [27]. It also helps user dealing with the collaborative tools to accurately monitor multiple communication channels, make quick and effective decisions, and reply to critical messages [28]. For example, monitoring contextual activities in e-learning gives high learnability, low number of errors and no unrecoverable errors [29].

Table 1. Summary of the selected samples in monitoring user activities

Domain	Contextual Media	Contextual Activities	Type of communication
Learning	• Dialog box [18] • Color coded system [18] [30] [31] • Text chat box [30] • Whiteboard[30] • Tagging [32] • Group chat [22], [33]	• Change of color [18] [30] [31] • Comments [18] • Lesson Calendar [33] • Graph [22]	• Face to face [18] • One-to-one [14] [31] • Peer-to-peer [22] • Teamwork [18] [30]
Context-Based Workspace	• Status bar [27] • Audio [34] • Colored line-border [27] • Text editor [35] • Word [36]	• Change of color [27] • Drawing task [34] • Calendar [35] • Clicking on a word [36]	• One-to-one [27] [34] [36] • Teamwork [35]
Communication	• Keyword [28] • Text annotation [37] • Video chatting [38] • Chat [39]	• Highlight keyword [28] • Speech-to-text [28] • Voice [28] • Comment [37] [38] • Share activity button [39] • Onlline/offline filter [39]	• One-to-one [25] [37] • Group [38] [39]
Visualizing Approach	• Time tracking [29] • Finger-rays [40] • Blog, Twitter, Youtube [41]	• Colored points [29] • Line chart [29] [41] • Bar chart [29] [41] • Multitouch [40]	• One-to-one [41] • One-to-many [41] • Peer-to-peer [29],[40]
Business	• Image [42] • Member verification [43]	• Rating-based ranking [42] • System monitor panel [43] • Streaming controller modules [43]	• One-to-one [42] • Group [43]

Studies have revealed that contextual activities such as color coded system, colored-line border, chat box and keyword, can be used to monitor contextual awareness between users [18] [30] [31] [27]. In addition, images and suggestion lists help significantly in business activities [42].   Moreover, messages are easier to be used in communication activities [28].

However, there are still some issues for monitoring the contextual activities. Gutwin et al. [34] categorizes three limitations in visualizing user activities. First, display areas must be visible to all users to be useful since the awareness information is hidden in many scenarios (e.g., both small screen and large-screen setting). Second, visual information about activities may be difficult to see if the action is small or workspace is cluttered. Third, the observer must attend to the awareness display in order to notice changes in the display.

Furthermore, many factors such as system signals, user queries and attached devices could burden system performance [44]. In order to increase the performance, a mechanism is needed to distribute activity awareness to relevant contacts and allow users to control with whom they share their activity [39]. The next section proposes

activity-based entities relationship for context aware monitoring mechanism to understand the contextual awareness phenomena.

4   Activity-Based Entities Relationship

An activity composes of many entities and their connections. The activities need to be monitored to ensure that the goals are achieved. The monitoring process is usually based on type of communication, synchronous work session, monitoring interface and evaluation. Based on the requirements, context aware elements have been proposed [12] as depicted in Figure 2.
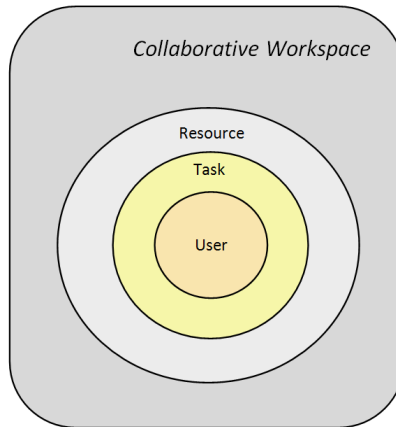

Fig. 2. Context-aware elements

    The communication involves one-to-one or a group of users. The users will communicate via network in a virtual environment to accomplish their goal. People who are sharing their tasks require details information of what others exactly do and what are their task progressions or work in the collaborative workspace [12]. For example, during the conversation, user A will communicate with user B (Figure 3). Both users should observe their environment and activities. They should respond and understand the action taken during the work progress to achieve the goals. This action would require contextual media to access and update their task.
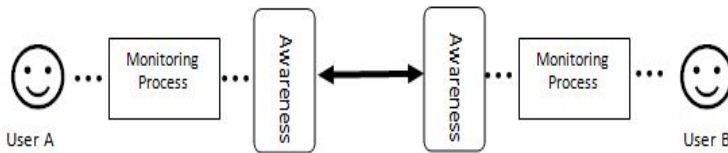

Fig. 3. The user interaction in contextual awareness activities

The contextual media are used to interact and convey messages among users. Examples of contextual media include online calendars, color coded system, dialog box, message, word, and text annotation. The media are monitored by an object that consists of user, task and resources (Figure 4). The communication between objects is governed by monitoring process that is supported by appropriate technologies.
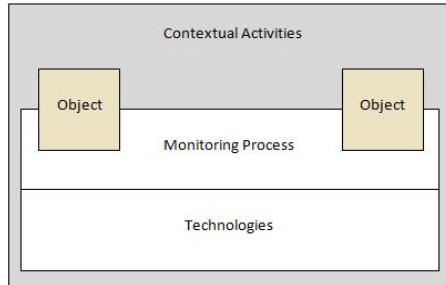

Fig. 4. The Contextual Activities

The communication in collaborative workspace usually involves a group of users from different domain. Each domain has a different activities and goals but may use similar contextual media. All objects will communicate with each other and it needs a monitoring process to ensure successful communication. Based on the contextual activities, an activity-based entities relationship is proposed for a group of users (Figure 5).
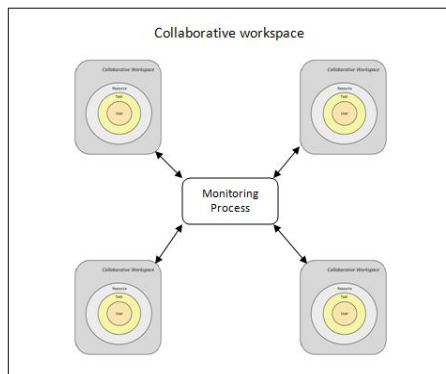

Fig. 5. An activity-based entities monitoring model for contextual awareness

The relationship shows that even though each object has its own monitoring process but the underlying middleware must be coordinated and synchronized in a single generalize platform to portray a comprehensive group work activities.

5 Conclusion

As the collaborative work faces uncertainty and complexity due to location, time and cultural differences among users, monitoring users' activities are difficult for completing their work tasks. This paper has explored user contextual activities in five dominant domains in order to analyze the monitoring process on how information is shared and monitored in the collaborative workspace. We examined the awareness activities and extracted the contextual media involved in each domain. Through this investigation, we found that the monitoring process help users to access and response to the taken action. Following this investigation, we proposed entities relationship for contextual awareness. Based on the relationship, our future work will investigate further on suitable underlying middleware that provide coordination and synchronization that are able to provide an aid in knowledge creation, transfer and sharing task among users especially in collaborative workspace.

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