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SISTEMA DE ESTUDIOS DE POSGRADO

DESARROLLO Y EVALUACIÓN DE PROTOTIPOS DE OBJETOS AUMENTADOS PARA NOTIFICACIONES EN AMBIENTES DE ESCRITURA COLABORATIVA

Trabajo Final de investigación aplicada sometido a la consideración de la Comisión del Programa de Estudios de Posgrado en Computación e Informática para optar al grado y título de Maestría Profesional en Computación e Informática

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Dedicatoria

Dedico este esfuerzo a mi Dios Todopoderoso quien me ilumina, me guía y me brinda fuerzas para continuar con cada meta que me propongo y es en quien pongo toda mi fe y mis proyectos.

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Resumen

En Computación Ubicua, los objetos aumentados se refieren a aquellos elementos del mundo real a los cuales se les ha proveído con capacidades computacionales para suplir una necesidad específica. Por su parte, los Ambientes de Escritura Colaborativa (CWE, por sus siglas en inglés) permiten a grupos de personas trabajar juntos e incrementar las posibilidades de éxito y compartir conocimiento cuando trabajan en documento compartidos. Un aspecto extremadamente importante en los Ambientes de Escritura Colaborativa son los mecanismos de notificación ya que estos son esenciales para proveer a los usuarios sensibilización acerca del trabajo colaborativo que están realizando. En esta investigación, nosotros describimos un conjunto de objetos aumentados creados para llevar a cabo las notificaciones en los Ambientes de Escritura Colaborativa; estos objetos pueden mejorar la forma en la cual las notificaciones son entregadas a los usuarios, de acuerdo con la estrategia de escritura definida por el equipo de colaboradores.

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Capítulo 1

Development and Evaluation of Augmented Object Prototypes for Notifications in Collaborative Writing Environments

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In Ubiquitous Computing, augmented objects refer to those elements of the real world which have been provided with computational capabilities to meet a specific need. Meanwhile, Collaborative Writing Environments (CWE) allow groups of people to work together and increase the chances of success and share knowledge when they are working on shared documents. An extremely important aspect in CWEs is notification mechanisms as these are essential to provide users awareness about the collaborative work they are doing. In this paper, we describe a set of augmented objects created to support the notification in CWEs; these objects can improve the way in which the notifications are delivered to users, according to the writing strategy defined by the collaboration team.

Capítulo 2

Introduction

Throughout the years, many people have been working together on different types of shared documents in a collaborative manner. Recently, the use of the Internet and other technologies to work with people from different geographic regions has caused an increment in the use of online tools for the creation and edition of digital documents. This situation generates a need to coordinate how the editing work will be done [1].

Collaborative Writing Environment (CWE) was proposed a solution. In a CWE, a group of people combine efforts in the edition of a shared document [2]. In this type of environment, communication and interaction within the group are of utmost importance [3]. In complex CWEs, the communication and interaction between users can become difficult to manage. Therefore, collaborators must be able to find out: if they have pending work, which documents require their attention, when are the deadlines, who is available at a given time, and what are the latest changes performed. These pieces of information could be delivered to the user through automatic notifications. This is why notifications in CWEs become a very relevant and transcendental topic.

Researchers found that awareness can be provided by applying new technologies and non-traditional interfaces in order to improve interaction between collaborators in a CWE [4].

Furthermore, it is possible to provide additional capabilities and functionalities to common objects (i.e., create Augmented Objects) through the incorporation of computational capabilities, and use them to improve the interaction between humans and the environments in which they operate their daily activities [5–7].

In this paper, we describe a set of prototypes that help improve the notification process to users in a CWE. We evaluated our set of prototypes by assuring that they aid a set of collaboration strategies [2]. Out system can be applied when users are collaborating with other people through online editing tools, such as Google Docs.

Capítulo 3
Notification Mechanisms Used in CWEs

Various examples of notifications and communications systems created to provide aware-ness in CWE can be found in literature. Many of these systems are based on Graphical User Interfaces (GUIs) to keep users informed. Examples found in literature include:

Doc2U. Authors propose a presence awareness system that implements document notifications. This system employs instant messages as notifications. Users (only 2 allowed) must register themselves and the shared document. Collaborators are notified when and in what section the document is modified via text message [8].

Notification based on annotations. This system provides a text editor, and a tool to create annotations to the documents [9]. Authors defined an annotation model and developed a version control to keep up with the changes. Replicating real annotations model was their goal. The system also provides the ability to send notifications through email.

Smartphone based notifications. Authors created a system that triggers notifications via users' smartphone [10]. The system uses information about the environment captured by ubiquitous monitoring devices. The collected data allows selecting the best way to generate the notifications, improving the user awareness even when they are performing multiple tasks.

Notification guided by Post-It. In this case, the authors have created an augmented object to deliver notifications. With this device, the user can be notified when the platform of collaboration triggers digital notifications, but in this case, the notification is presented to the user as a physical Post-it on his/her desk. This allows the user to know when the document has changed without the need to use a computer [11]. This paper, proposes an extension of this last described system. We use physical objects as means of notification allowing the user to know what is happening with both the documents and in the collabo-ration environment.

Capítulo 4

Design Issues from the Point of View of Ergonomics

Previously, some examples of notification systems and mechanisms to improve user inter-action in a CWE were specified. However, most of these cases are found in literature that correspond to desktop applications or web systems that manage the documents, making notifications and alerts in a digital manner. In other words, the notification system is based on instant messaging, email, or other graphical interfaces. In this context, users have to connect to these systems using a computer or digital device in order to know what is happening in their CWE.

Throughout the day, users tend to complete their activities using computers from time to time, but not actually being in front of them the whole time. Their time is usually distributed in executing different types of tasks that might be more physical than digital (e.s., revising physical documents, attending to meetings). It is during these shifts into these activities that many users might not be able to direct their attention to the different digital-ly delivered notifications. These notifications might fail, since they are restricted to their digital domains.

In relation to this, Iqbal and Horvitz [12] in their analysis of work environments concluded that even though desktop (GUI) notifications are valued by user in order to obtain information and awareness, most of these notifications are actually ignored. Moreover, we can indicate that digital notifications are not sufficient for CWEs. Many of these digital notifications and alerts are not reviewed by the users in the moment they are delivered. This means the users might lose important time on the shared documents because they are not aware on time about the changes that happen to these. In general, CWEs are used to not only share work, but also to deal with deadlines that can only be achieved as a group. Having to rely on these types of notifications might mean delaying the work of others, and essentially a delay in the work as a whole.

Capítulo 5

Solutions from the Ideology of Ubiquitous Computing

The existence of the various problems that emerge from implementing the digital notifications to users, implicates the existence of the need to improve the interaction between collaborators, systems and tools they choose to work on their documents.

From the ubiquitous computing perspective, we can base the design of this new notifications system or mechanism, to use everyday objects. These objects can have augmented characteristics to alert the user about the changes in the CWE. Moreover, these new notifications mechanisms can be as intrusive as they are required to be developed more natural according with the user's mental model. The main purpose of these objects is to pro-vide notifications in the users' workplaces, without having to log into a computer or other devices.

Using a notification system developed with augmented objects, users can benefit throughout the interaction within their groups. This is because once a user is alerted s/he will easily recognize what the notification is related to, and can decide whether to immediately take and action or ignore it. Moreover, depending on the availability of various augmented objects, the notification may be improved in the same context. It is then valid to define a notification environment, since this will be able to precisely inform the user about their CWE. In such scenario, a system that manages the augmented objects and that coordinates the notifications is required, in a way that the objects react in the actual moment that the changes are made. This system must also be able to coordinate new augmented objects as they are added.
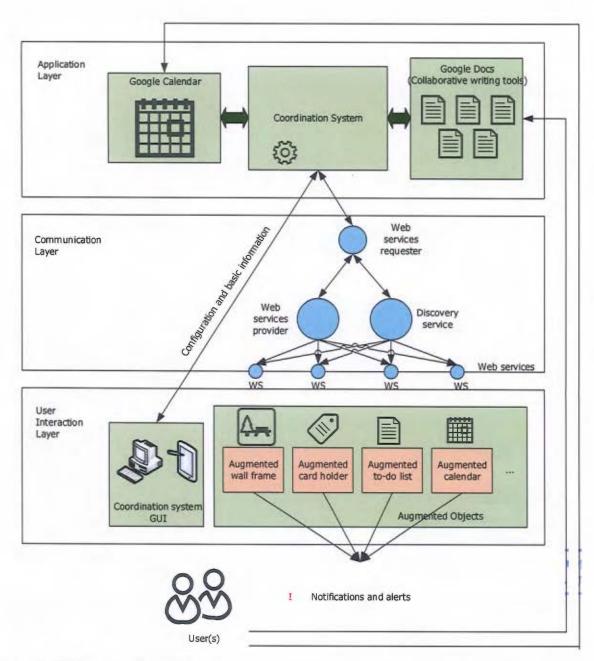
Fig. 1 Notification environment architecture

The coordination system would have the task to manage the registered documents in which the team or group of users are working on, and also to register the available augmented objects, the type of notification that those can execute, basic information about the notification context, and the collaborative editing strategy that is utilized in each document, among other aspects.

Increasing the number of objects as opposed to digital notifications has to be done in a way that is not extremely intrusive and harmful for the daily work of the user. Figure 1 shows the architecture of our notification environment. The Coordination system is in charge of verifying the documents' states and trigger notifications when necessary. These documents are shown inside the third party system that handles the collaborative editing.

Capítulo 6

Augmented Objects Proposals and Development Process

In this section, we present the selected objects that could act upon the notifications or alerts. For the creation of the augmented objects prototypes in this project, we followed the Framework for Designing, Developing and Evaluating Augmented Objects [7]. This methodology works on selecting the most natural objects to be augmented, so that it has the adequate capabilities to solve a particular problem. We developed augmented objects to notify about: a) Deadlines, b) Currently connected collaborators, c) List of pending documents, and d) Changes in the state of the documents.

Augmented Wall Picture to Notify User That They Must Work

With the objective to alert the user about the changes on the states of the shared documents, various candidate objects were found to be fitting to be augmented including: a paper weight, a wall frame and a desk organizer. From these objects, after being analyzed, the wall frame was selected.

Using a wall picture with an image representing the metaphor of work (e.g., hammer, cone, or helmet) could be appropriate. Our frame can change images in order to inform the user if s/he has to work on the document (see Figure 2 - left).

Augmented calendar to alert about document deadlines

In order to provide a notification about deadlines for the documents that a team is working on, various objects have the capability of outputting these alerts (e.g., post-it notes, tele-phone, calendar, yearly planner). The selected object was the calendar, since this object can show different deadlines at the same time and users can recognize that dates marked on it are important dates in the collaborative process. Figure 2 (right) shows the prototype, in that image it can be seen the calendar with an event related with the collaborative work marked (the date is filled).

Fig. 2 Left: Augmented wall frame prototype. Right: Augmented calendar prototype

Augmented to-do list to stay alert about pending work

If the users are interested in the information regarding which tasks are pending, and which ones are finished, it is possible to utilize the following candidate objects: a writing board, a to-do list, and a document organizer. In this case, and after some analysis, the to-do list was selected. Figure 3 (left) shows the prototype, in which the tasks finished are marked in red and pending tasks are marked in green. The colors change automatically depending on the document's state.

Fig. 3 Left: To-Do list prototype. Right: Augmented card holder prototype

In this prototype a discussion was carried to determine if the tasks should also be digital and change automatically or if the tasks should be static and the status dynamic. We found that both approaches are viable and useful; however, we only developed one in which the status of tasks is augmented (i.e., box color changes if the task is complete or incomplete).

Augmented card holder to inform who is online

If a user needs to know when a collaborator is connected and working on a shared document, various common objects could provide a way to present that information. Objects that seem to satisfy this need are: a telephone, a card holder, a pencil holder, and a paper weight. From this list, the card holder is the object that best fits into the user's cognitive process, without requiring too much cognitive work. In this situation the user would also be able to have other collaborators' contact information at hand. This can be helpful in clearing up ideas, doubts, or to talk about a specific aspect of the collaborative process. Figure 3 (right) shows the prototype.

Capítulo 7

Collaborative Writing Strategies

For the development of this project, the collaborative editing strategies that were defined by Lowry et al [2] were considered. These strategies refer to the general approach in which the working teams execute their work. The authors propose 5 strategies: group single-author, sequential, horizontal-division, stratified-division and reactive.

Group single-author writing occurs when a single person, that is member of a collaboration team, writes in representation of the whole group. A situation that exemplifies this is when one of the participants summarizes the notes taken during a meeting attended by all the members of the group.

Sequential writing occurs when only one person in the collaboration group writes at a time, in which one of the collaborators writes one section and when finished passes the document to the next person.

Horizontal-division writing is a bit more complex. This strategy is derived from the parallel strategy, in which the work is done without an order or consensus. When this happens, a group divides the work in small parts that can be done in a parallel by the collaborators. Then, these parts are compiled into the final document. An example of this strategy is Storybooks written a story per author, and then compiled into a whole book.

Stratified-division writing is also derived from the parallel strategy. In this case, the collaborators play a predefined role in the group according to their skills. One example of this is when research papers are written by team of authors, reviewers and/or editors.

Finally, **reactive writing** happens when a collaborator creates a document in real time and all of the other collaborators work on this same document in an unordered manner without consensus and coordination.

Capítulo 8

Use of Augmented Object Notification Environment

In this project, we used Google Docs as third party application to support collaborative work. Google Docs is an office suite that includes the primary tools to manage data: a text processor, a spreadsheet management tool, and an application for the creation of digital presentations [13]. Google Docs provides the ability to work with information in real time, and with a great number of collaborators. As mentioned previously, our goal is to augment objects that are naturally available in a business or home office.

This section describes the use of each of the proposed notification mechanism matching the collaboration strategies proposed by Lowry, Curtis and Lowry [2] and described in Section 6.

The first strategy is **Group single-author writing**. In a scenario, one of the collaborators is in charge of creating the document. Table 1 shows how the augmented objects are used to provide awareness to the main author in this strategy, while Table 2 shows how they are used for other authors (i.e., not in charge of creating the document).

Table 1. Use of augmented objects to provide awareness, to the main author, in group single-author writing.

Augmented Object	Applicability
Calendar	Shows the document's deadline and meetings arranged.
Wall frame	Displays when a meeting is approaching. It does not make sense to keep it notifying this user since he is the only one that must work on the document.
To-Do list	Not applicable (it will replicate information provided by other object).
Card holder	Not applicable.

Table 2. Use of augmented objects to provide awareness, to other authors (not the creator of the document), in group single-author writing.

Augmented Object	Applicability
Calendar	Shows the document's deadline and meetings arranged.
Wall frame	Displays when a meeting is approaching (the only work of this type of author is attending to meetings).
To-Do list	Not applicable.
Card holder	Informs when the main author is connected.

The second collaboration strategy is **sequential**. In this strategy the work is conducted progressively (i.e., one author after other). Table 3 shows how the proposed objects could be applied in this context.

Table 3. Use of augmented objects to provide awareness in sequential writing.

Augmented Object	Applicability
Calendar	Shows the user's deadline to him and the next author. Besides, it notifies about the document's deadline.
Wall frame	Notifies when the user must start working (his turn to edit).
To-Do list	Shows the pending tasks (or sections of the document) that the user is supposed to work in (only when is his turn).
Card holder	Only allows knowing which user is currently working on the document. It will only display one name at the time.

The third collaboration strategy is **horizontal-division writing**. At first each author works in a part of the document and when the parts are finished they are sent to one author to combine and edit them. Table 4 shows the application of our prototypes in this strategy.

Table 4. Use of augmented objects to provide awareness in horizontal-division writing.

Augmented Object	Applicability
Calendar	Indicates the user's deadline, the final user's deadline and the document's deadline.
Wall frame	Working image is showed from the beginning of the process and disappears when the author sends his part of the work. It will appear again when the "final" author finishes because the user should revise the document.
To-Do list	Informs the author of the sections that he is supposed to work in.
Card holder	It will show the collaborators of each section when they are working, during the edition process it will only show the final user.

The fourth collaboration strategy is **stratified-division writing**. In this strategy, three roles are required: author, editor and reviewer. The author is responsible of writing the first draft. The reviewer provides specific feedback about the draft he does not change the document. The editor is the person who has the responsibility and ownership for the over-all content of product. Table 5 shows the application of augmented objects in this strategy.

Table 5. Use of augmented objects to provide awareness in stratified-division writing.

Augmented Object	Applicability
Calendar	It indicates the deadline for each role, and the document's deadline.
Wall frame	Indicates to the reviewer when the author finished the draft of the document, then the author is notified when the document has been reviewed. Finally, the editor is notified when the final draft is sent to be edited.
To-Do list	Each member is reminded of their role in the document.
Card holder	Shows the name of the person currently working depending if the document is being written, reviewed or edited.

Finally, the fifth strategy is called **reactive**; in this writing strategy there is not a set of rules to follow in order to complete the work on a document. Table 6 describes how our proposed augmented objects apply in this scenario.

Table 6. Use of augmented objects to provide awareness in reactive writing.

Augmented Object	Applicability
Calendar	Displays the document's deadline.
Wall frame	Not applicable (it will be always displayed).
To-Do list	Not applicable (it will generate chaos since tasks could change while a user is working on it if others are working on it too).
Card holder	Shows which collaborators are connected at a given time.

Capítulo 9

Discussion

From an ergonomic perspective, the creation of the notification environment complies with the ideas of Wilson [14] since the activity was guided by the analysis of the individual parts of the system and the augmented objects that execute the alerts. Moreover, the notification environment complies with the requirements specified for our CWE. Also, other requirements can be achieved by adding new augmented objects to improve user awareness and interaction.

Even though this paper does not present evaluation of the augmented objects, the developing process followed evaluates them and their application. We decided to focus on the integration of several objects instead of the detailed description of each one. Moreover, we can assure that the proposed notification environment improves collaboration because it provides user awareness (a key factor in collaboration).

In the model that was proposed for the notification environment, it is possible to include a component that can capture external information from the user. This would allow the coordinating system to make better decisions. In Figure 1, this component could be located in the User Interaction Layer. Said component can be in charge of the obtaining other information from the user such as, for example, user's location, status (busy/available), etc. This information could be used to improve the way in which notifications are administered, possibly allowing the notifications to arrive at other different application contexts like an office at home or when user is inside the car. Our notification environment leaves aside the topics of privacy and security; however, authors agree that policies to assure both security and privacy must be defined by experts in the area.

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