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# Context-sensitive and Collaborative application for Distributed User Interfaces on tabletops

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## ABSTRACT

This paper focuses on collaborative work on interactive tabletops. To optimize the travel time of team members (remote workplace, telecommuting, and so on), collaborative work is now often remotely done. This brings many user interfaces issues between distributed platforms of each member. In the domain of context-sensitive user interfaces, which aims at an adaptation to the users, the platforms and the environment, context models have been proposed in the literature. We propose, in this paper, a context model for distributed applications centered on collaboration and interactive tabletops. The proposed model is validated by a distributed application, which is developed on two interactive tabletops with tangible interaction; these tabletops are equipped with RFID technology. This application, which has educational purposes, highlights the collaborative aspect and exchanges between remote users. The paper ends with a conclusion and several perspectives.

## Author Keywords :

Context; Model; Distribution; Collaboration; Interactive tabletop; Tangible object; RFID.

## ACM Classification Keywords :

H.5.2; H.5.3. Information Interfaces and Presentation (e.g.HCI): User Interfaces; Group and Organization Interfaces

## INTRODUCTION

With the development of remote work on various platforms, user interfaces have evolved. In the 2000s, an application was intended for a single end user and worked on a single platform in a single environment. Nomadic applications engendered researches about the adaptation of applications to the various types of platform (e.g. PDA, Smartphone).

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Thus, the consideration of the interaction context became essential for their adaptation. The introduction of interaction surfaces with a more important size has led to applications available to multiple users interacting in a single environment and on the same support [13]. The improvement of the network capacities has brought new remote collaborative applications based on a variety of platforms [9]. This led to treat the distribution of user interfaces. Collaboration became possible between users in the same interaction context or in different contexts.

This paper focuses on collaborative interactions on interactive tabletops. Section 2 presents the state of the art on collaboration. Some types of collaboration are presented with an example for each type. Section 3 is dedicated to present our proposition. It is a context model which supports collaboration between remote or collocated users. In section 4, a case study on a pedagogical application adapted from [10] is shown on interactive tabletops with a distributed tangible interaction. The paper ends with a conclusion and research perspectives.

## COLLABORATION AND INTERACTIVE TABLETOPS

The high quality networks coupled with the arrival of efficient systems increases the remote collaborative work. Many researches are carried out in the field of CSCW since [7]. Some researches dealing with collaboration are focused on many domains, such as education [11], information retrieval on the web [6, 5], and so on. In this paper, we particularly focus on collaboration via interactive tabletops according to two types of collaboration: (1) collaboration where the team is in the same workspace (co-located) and (2) remote collaboration (Distributed).

The technology of interactive tabletops allows sharing information and tasks between team members located face to face or side by side thanks to their large surface. It is therefore particularly suitable for the co-located collaboration. Interactive tabletops provide the ability to handle multiple real and / or virtual objects depending on the capture technology used.

The DTLens system [4] uses an interactive tabletop in a multi-user environment. It is based on a zoom-in-context that enables group exploration of spatial data with multiple

individual lenses on the same direct-touch interactive tabletop.

Most of the works, which aim to realize distributed collaborative systems, seek to find a good remotely data presentation to perform a task or a common work between the different members of a geographically dispersed team [2]. Balakrishnan and colleagues are looking for solutions to solve complex problems by sharing remote data visualizations [1]. They conclude that the more members have access to a complete visualization of their data, the more they can be fruitful and provide solutions to problems. Another research encourages task sharing and data personalization in a collaborative framework: Brennan and colleagues adopt an approach that requires the explicit sharing and merging views of data during distributed analysis [2]. In this way team members can first work separately on sub-tasks, and then gather all the ideas in a common view that takes charge of the construction of the common sense. The Keel system [8], which is dedicated to analysts of distributed data, offers a solution for group-work. Each member works in his/her personal workspace and offers the data considered as appropriated in the common workspace. This method allows the implicit sharing of information.

Collaboration takes place in a collaborative environment. This environment can support two types of interaction: synchronous or asynchronous [14]. The types depend on the goal of the application and the manner in which several collaborators interact. [15] mentions a type of interaction called semi-synchronization. We face this situation when it is possible for some users to see and interact with the work of other absent users. This is possible thanks to traceability of past activities.

In the case of the tangible interaction, the concept of Tangiget was proposed in [13]. Tangigets are tangible objects which support the interaction on one or several tabletops. They are divided into six categories: (1) Control objects of the application, (2) Context objects of the application, (3) Control of the interface objects, (4) Communication objects, (5) Coordination objects (6) Creation objects. Among these categories, we note that some Tangigets support communication and coordination, two activities required during collaboration. They are exploited in our proposition.

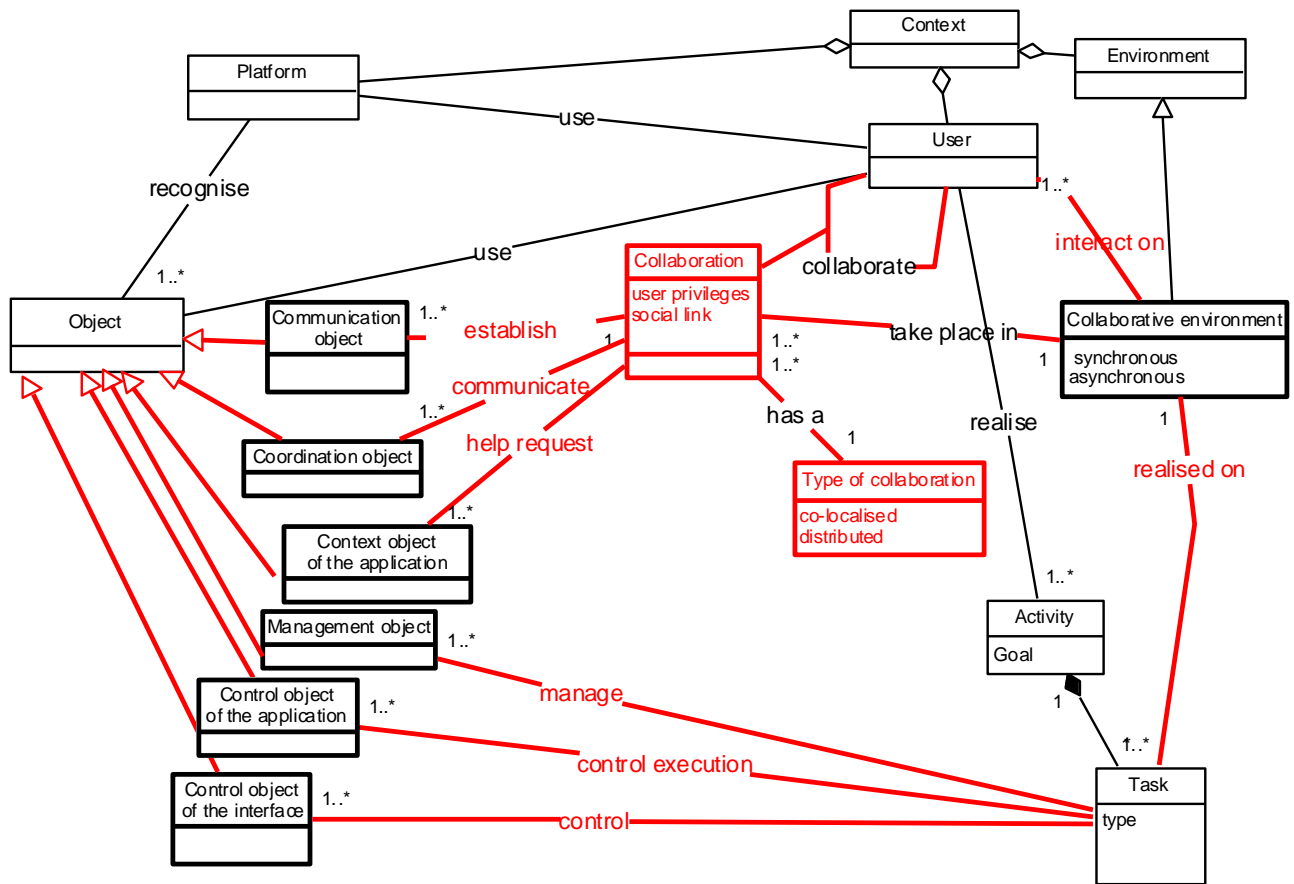


Figure 1. Context model focused on collaboration properties

## PROPOSITION

Our proposition is based on the work of Calvary and colleagues [3]: they define the context as a triplet <user, platform, environment>. This model was adapted by [9] to focus on interactions on interactive tabletops in a distributed context. Our goal is to incorporate in this previous context model [9] the notions linked with collaboration presented above and the different types of Tangigets used for collaboration between remote tables.

Main evolutions are shown in bold in the Figure 1. Concerning the **user** part, the most significant changes are the adding of a reflexive relationship between users and of a *Collaboration* class. This class contains the properties of the collaboration between users. It sets the *privileges* granted to each user according to his or her role in the application and the social link between the users who collaborate. Another class named *Type of collaboration* is added. This class specifies the type of collaboration between users. An *Interact on* relationship is added between user and collaborative environment in which he/she interacts. Concerning the **environment** part, a relationship named *realised on* is created between tasks and collaborative environment. Another relationship named *takes place on* specifies the environment in which the collaboration is performed. Concerning the **platform** part, the several categories of Tangigets were introduced in the model through six new classes. They are connected either to the *Collaboration* class or to the local tasks.

## CASE STUDY: COLLABORATIVE APPLICATION

The “learning color” application (previously proposed and described in [10]) is developed with a collaborative goal, following a scenario inspired from [9] in which a child and parents interact in a distributed manner. This distribution is achieved through a multi-agent system developed with JADE [12]. The child is doing his or her color learning exercise on one tabletop. Parents are in another room where they also have a tabletop. The two tabletops are connected. There could be several users on each table. The scenario which aims to generate collaboration is: “*The child has a difficulty; he or she wants to seek assistance from their parents who are distant but also possess an interactive tabletop. Parents wish to let the child work independently but also want to control the work done by the child without disturbing him or her with their presence.*”

A remote collaboration between users is possible. The child can ask parents for help. Parents can have a visualization of child labor. The picture shown in Figure 2 shows the distributed application on both *TangiSense* tabletops equipped with RFID technology (developed by the RFIdées Company, <http://www.rfidees.fr/>). On one side (child), we see tangible objects placed by the child and their virtual feedback. On the right side, parents have a view of objects put by the child. Parents in this way can monitor the progress of the game on the tabletop without having to move.

In Figure 3, we present the object diagram of the *Request for assistance* collaborative use case. We see in the figure the Tangigets use for the realization of a distributed task between a child and his father.



**Figure 2. Picture of the distributed application showing the child's view on the left side (with tangible objects) and the parents' view on the right side (with virtual objects as feedback).**

## CONCLUSION AND PERSPECTIVES

In this paper, we focused on the concept of collaboration between users on interactive tabletops involving distributed user interfaces. Two types of collaboration were considered: co-located collaboration and distributed collaboration. Based on this notion of collaboration exploiting a distribution of user interfaces, a context model has been proposed, built on the distributed interfaces and integrating collaboration features on tangible inter connected tabletops. A case study involving two RFID interactive tabletops with tangible objects implements this model. As research perspectives we aim to diversify the types of distributed platforms and to implement variants of the tangigets proposed in [13].

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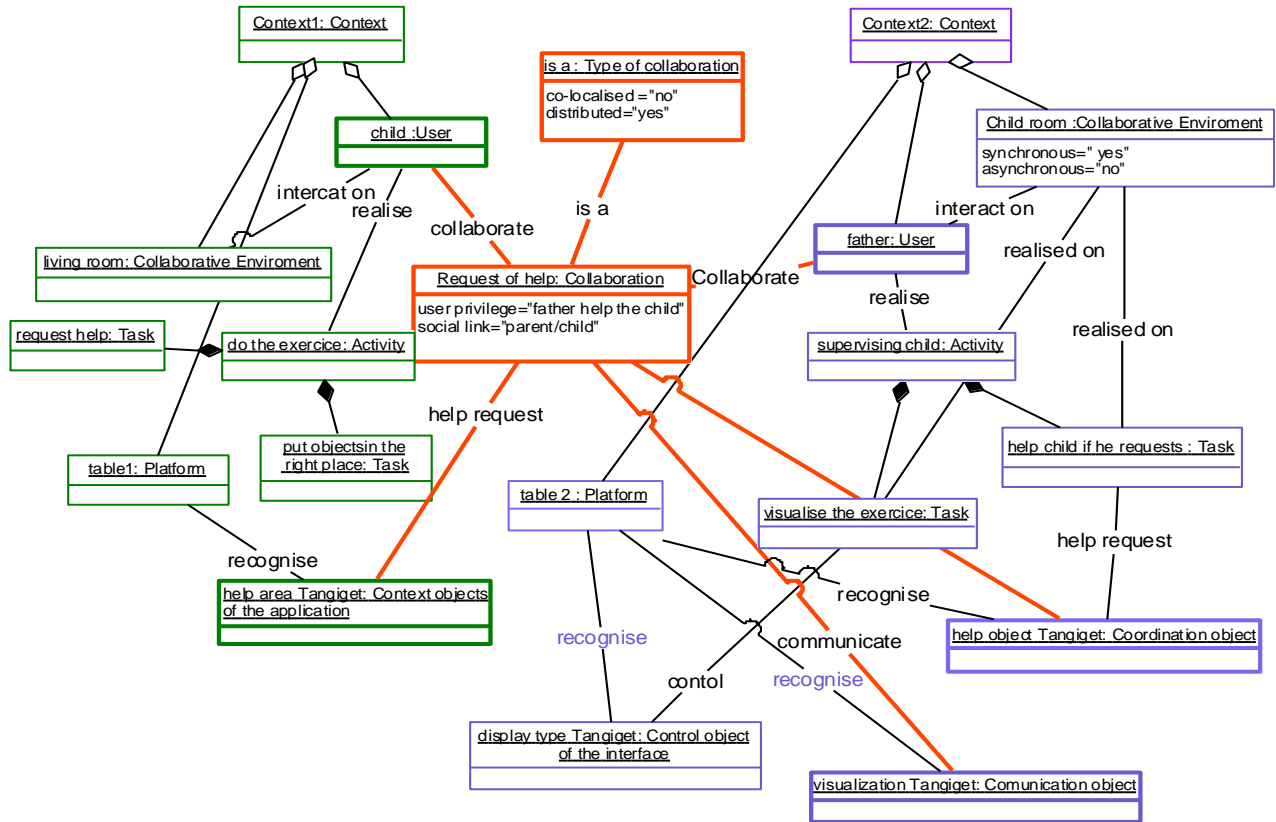


Figure 3. Object diagram for the use case "request for assistance"

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