Distributed tabletops: Study involving two RFID tabletops with generic tangible objects

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Abstract. This paper describes a study on an innovative system designed to support remote collaborative game running on tabletops with tangible interaction. Twelve test groups, each composed of three participants, tested a distributed application for learning and recognition of colors. We propose a set of generic tangible objects. They model a set of collaborative styles which are possible between tabletop's users. Our goal is to obtain objects that provide remote collaboration among users of interactive tabletops for tangible interaction. This study is supported by observations, trace analysis and questionnaires. It analyses if the use of generic objects is easy and understandable by users in the case of remote collaboration. More it determines the user satisfaction when using the distributed tangible tabletops.

Keywords: Tangible interaction, tabletop, distributed UI, remote collaboration, tangible object, tangiget, RFID

1 Introduction

Collaborative work proves important within a team, or more generally within a group of users. In fact, Team people often needs to exchange ideas [9], to work on common tasks [10] or to be informed about the progress of a task [11]. Many works were done in this subject concerning the flow of information between users and platforms [2]. We seek in this work to facilitate the collaboration between different people working together by offering a system that provides remote collaboration throw interactive tabletops with tangible interaction [1]. Collaboration in this system is based on a set of generic tangible objects, called tangigets, provided by Lepreux *et*

adfa, p. 1, 2011.

al. in [8] and Caelen and Perrot in [3]; these tangigets will concretize a set of collaboration styles listed by Isenberg *et al*. in [4].

In the paper we describe the design of the system and the interaction, as well as principles for remote collaboration on tangible tabletops. The study is then presented, and the first results are explained. Finally the paper concludes and proposes research perspectives.

2 System Design: DUI on two RFID tabletops

As Distributed User Interface (DUI), we use two *TangiSense* interactive tabletops allowing tangible interaction [6] (designed by the RFidees Company; see www.rfidees.fr). These tabletops use the RFID technology to recognize objects placed on the surface, as shown in Fig. 1.

The application used in our study is a distributed version of an application on RFID tabletop allowing the learning and recognition of colors presented in [7]. A set of business objects are used; they present various colorless pictures. For this application the final users are very young children learning colors; they have to arrange the business objects in color areas according to dominant colors. These objects are divided into 4 categories; each category contains 8 objects of varying difficulty.

Fig. 1. Two different system interfaces shown on the interactive tabletops with some of used (business and generic) tangible objects: on the left, user Interface displayed on the *child* tabletop during the correction of exercise; on the right, interface displayed on the *adult* tabletop during the supervision of the exercise realization

A set of generic tangible objects, called tangigets, are used to ensure remote collaboration between interconnected tabletops and give users the ability to interact remotely using the features provided by the interactive tabletop.

3 Interaction Design: use of generic tangible objects

Remote collaboration between users on tabletops is carried out by the use of a set of generic objects (tangigets).These generic objects can support an inter-user dialogue using only features offered by interactive tables:

- *Identification* tangiget: Used to identify users who are currently using the collaborative application and want to enter in collaboration with other users.
- *Task assignment* tangiget: Used to organize tasks between different users of the collaborative application.
- *Starting synchronization* tangiget: Used to synchronize the start of the activity distributed on connected tabletops.
- *Display Mode* tangiget: Used to change the display of the main interface according to the user needs.
- *Request help* tangiget: Used to ask for help or ask a question about a step or a detail of the collaborative activity.
- *Provide help* tangiget: Used to offer help about a step or detail following a request.
- *End task* tangiget: Used to mark the end of a task and/or to switch to another task.
- *Criticism* tangiget: Used to work on all of the activity (not on one task).

Fig. 2 shows two examples of Tangigets used in this application, they correspond respectively to Criticism tangiget (Magician object) and Provide help tangiget (Erase object)

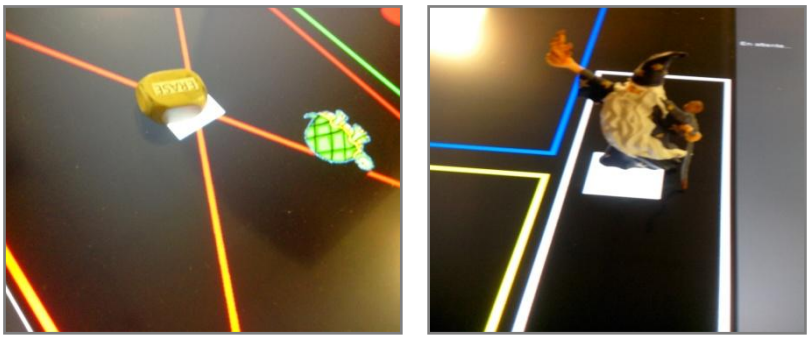

Fig. 2. Some of used Tangigets in the application: on the left, Provide help tangiget (represented by *Erase* object); on the right, Criticism tangiget (represented by *Magician* object)

4 Remote collaboration on tangible tabletops

Isenberg et al. [4] listed 8 collaboration styles which cover any type of collaboration (co-located or remote). To be sure that the proposed tangigets are complying with the standards of collaboration, we instantiated each style by an action on the system in which we use a tangiget or a coupling between two tangigets.

Table 1 shows the correspondence between the action of each tangiget and one of the collaboration styles.

Table 1. Tangigets representing collaboration styles.

Collaboration styles proposed in [4]	**Representative action on the application by the use of a generic object**
Active **disc**ussion	*Request help*
View **E**ngaged	*Task assignment*
Sharing of the **S**ame **V**iew	*Starting synchronization*
Sharing of the **S**ame **I**nformation but using **D**ifferent **V**iews	*Display mode*
	Identification
Working on the **S**ame **S**pecific **P**roblem	*Task assignment coupled with identification*
Working on the **S**ame **G**eneral **P**roblem	*Provide help*
Working on **D**ifferent **P**roblems	*Criticism*
Disengaged	*End task*

5 Case study

In the application, we propose to use a set of tangigets useful for remote collaboration. Table 2 shows those objects and their main functionalities in the application.

A presentation of the system and its functioning as well as the functioning of each tangiget was done for each group of three participants. It was followed by a familiarization phase with the interactive tabletops: the participants were encouraged to try the application and all items offered and to freely ask questions. After that, tests were started with different scenarios provided. We designed three experimental conditions that varied aspects of the use of the Help request and the correction of the color exercise. In these different conditions, instructions were provided to users from the *child* tabletop. They perform a definite number of mistakes and requests for help. Fig. 3 provides an illustration of the participants of a test group set relatively to their different roles. To simulate a remote collaboration, participants were in the same room; the

tabletops were separated by a folding-screen to prevent users from each table to see the contents of the other table. Moreover, to prevent that the participant "Parent" is disturbed by possible natural discussions towards the child tabletop, he or she had an earphone with music.

Table 2. Instances of tangigets used for the application.

Type of tangiget	Instantiation	Definition of its role
Identification	**Identification**	Identify the person present remotely and ready to play
Starting Synchronization	**Start**	Start the game on the two connected tabletops
Task assignment	**Category**	Assign a category of object to the person identified
Request help	**Collaboration area**	Placing a colorless object in the collaboration area means a request for help about it
Provide help	**Erase**	Offer help by crossing color areas
Display mode	**Focus**	Display the results of the exercise in a textual form
End task	**End exercise**	Indicate the end of the exercise for each user
Criticism	**Magician**	Correct remotely the exercise

After the study, each participant had to complete a questionnaire. The questionnaire concerned, firstly, information on the usability aspects and participant satisfaction with the system. Secondly, he or she had to fill more specific information on generic objects, ease of use and their significance in relation to their role set by the designer.

Fig. 3. A participant testing the application in the *adult* tabletop

Finally, the evaluator used a trace file in which were recorded all the games played by the group in order to understand how they have addressed the problem and get their feedback on the technologies and principles used . The analysis of the trace file is based mainly on the nature of the reaction of the user following the action by the other user of the remote tabletop. This reaction is classified under one of three categories: expected answer, acceptable answer and incoherent answer. As an example, we illustrate our analyses with two tangigets (1) *Erase* object used by the user of the *adult* tabletop and (2) *Identification* object used by the user of the *child* tabletop. The results of the questionnaires for *Identification* and *Erase* objects are summarized in Fig.4, and the score of each answer is shown for each question. We can find from the figure that participants give high marks on the global situation. They think these tangigets are easy to use and have a meaningful form. Also they have understood the goal of collaboration. To study if the use of tangigets by the participants confirms or not their subjective answers, we analyzed all the trace files in which we recorded the events concerning all games played. We extracted all uses of tangigets; after that we classified them as expected use, acceptable use or incoherent use. Analyses relative to *Identification* and *erase* objects are summarized in Fig. 5 .

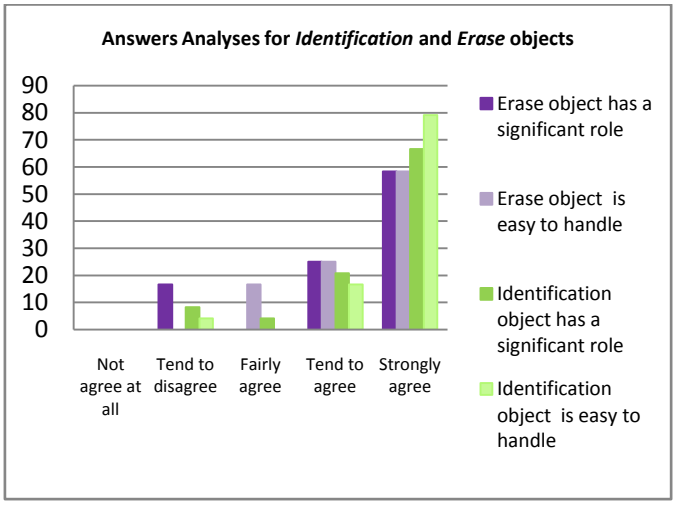

Fig. 4. Subjective answers of participants who used *Identification* and *Erase* tangigets

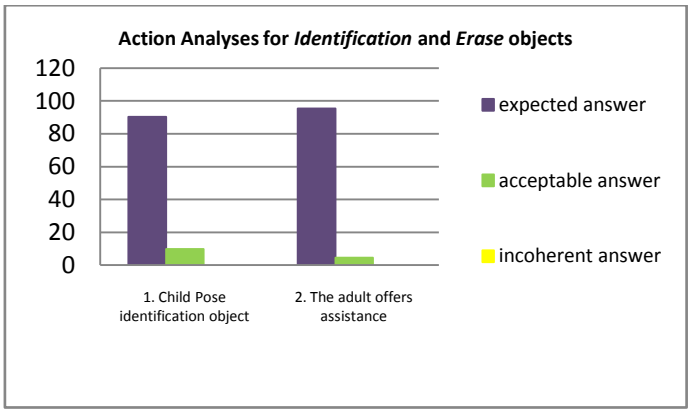

Fig. 5. Objective answers of participants who used *Identification* and *Erase* tangigets

6 Conclusion

In this paper, we introduce an innovative distributed application for learning and recognition of colors. Generic tangible objects, called tangigets, are used to facilitate collaboration and exchange between distant participants about the exercise. This system takes advantage of large-scale tangible tabletops, 1) providing a simple user interface easy to manipulate; 2) enabling several users to collaborate remotely in each step of the exercise; 3) providing the possibility to cover a set of collaboration styles (in the sense of Isenberg et al. [4]) by the use of tangigets. A study was conducted with twelve groups of three users. The results are promising and show the interest of the distributed approach. In future works we aim to test such tangigets with other more complex applications to verify if collaboration remains easy/possible.

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