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. This system is a 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 users. Our goal is to obtain objects that provide remote collaboration among users of such interactive tabletops. This study is supported by observations, trace analysis and questionnaires. In this study, we analyze if the use of generic objects is easy and understandable by users in case of remote collaboration. The user satisfaction when using the distributed tangible tabletops is also studied.

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]. Much work has been done on the 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. Our objective is to propose 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, initially defined by Lepreux *et al.* in [8] and Caelen and Perrot in [3]. These tangigets will materialize 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.

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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.

Fig. 1. Two different user 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

The application used in our study is a distributed version of an application on RFID tabletop allowing the learning and recognition of colors; the initial version was presented in [7]. A set of business objects is 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 levels.

A set of generic tangible objects, called tangigets, is used to ensure remote collaboration between interconnected tabletops. These objects 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). The aim of these generic objects is to support an inter-user dialogue using only features offered by interactive tabletops:

- *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).

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

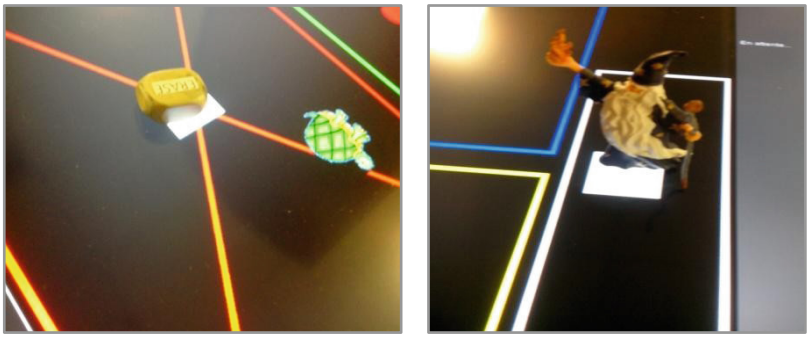

Fig. 2. Some of used tangigets in the application: on the left, *Provide help* tangiget (represented by *Erase* object); on the right, *Criticism* tangiget (represented by *Magician* object)

4 Remote Collaboration on Tangible Tabletops

Isenberg et al. [4] listed eight collaboration styles covering any type of collaboration (co-located or remote). The proposed tangigets have to comply with the standards of collaboration. So we instantiated each style by an action on the system by using: (1) one tangiget or (2) 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 contributing to 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.

Table 2. Instances of tangigets used for the application.

Type of tangiget	Instantiation	Definition of its role
Identification	Identification	Used to 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	Request remote assistance by placing in this area object(s) requiring help
Provide help	Erase	Offer help by crossing color areas
Display mode	Focus	Display the results of the exercise (textual representation)
End task	End exercise	Indicate the end of the exercise for each user
Criticism	Magician	Correct remotely the exercise

A presentation of the system and its functioning as well as the functioning of each tangiget was given for each group of three participants. It was followed by a familiarization phase with the interactive tabletops during which the participants were encouraged to try the application and all items offered and to freely ask questions. After this phase of familiarization with the system, tests were started with different scenarios provided. We designed three conditions that varied aspects of the use of the *Help request* and the correction of the exercise. In these different conditions, instructions were provided to users of the *child* tabletop. We aimed to get a definite number of mistakes

and requests for help. Figure 3 provides an illustration of the participants of a test group set in relation to their different roles.

Fig. 3. A participant testing the application (*adult* tabletop)

To simulate a remote collaboration, participants were in the same room; the two tabletops were separated by a folding screen to prevent users from each tabletop from seeing the contents of the other tabletop. Moreover, to prevent that the *Parent* participant from being disturbed by possible natural discussions coming from the *child* tabletop, he/she had a headset with music.

After the study, each participant had to complete a questionnaire. The questionnaire firstly concerned 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.

Finally, the evaluator used a trace file in which all the games played by the group were recorded in order to understand how they had addressed the problem and to get their reactions on the technologies and principles used. The analysis of the trace file is based mainly on a set of reactions of the user following the action by the other user of the remote tabletop. According to the response received, we classified them into 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; 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.

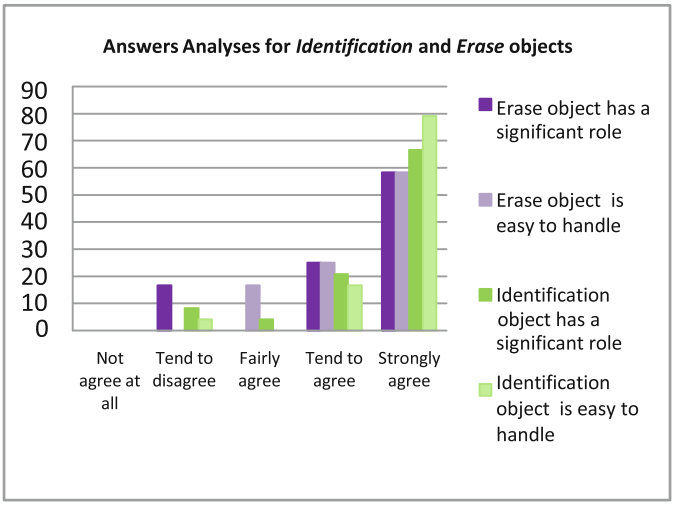

Fig. 4. Subjective answers of participants who used *Identification* and *Erase* tangigets

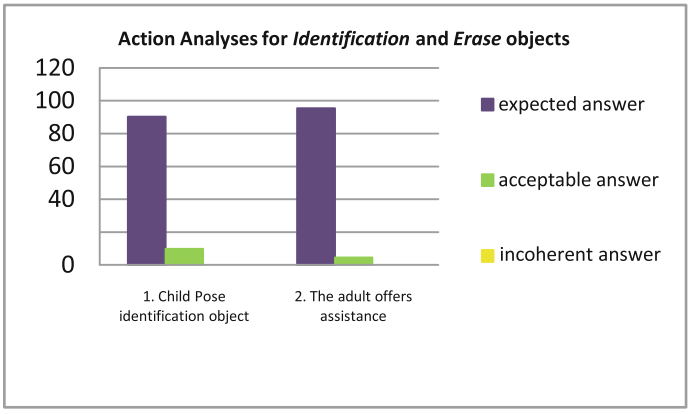

Fig. 5. Objective answers of participants who used *Identification* and *Erase* tangigets

6 Conclusion

In this paper, we introduce an innovative distributed application for the 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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