Exploring Opportunities of Tabletop Interfaces for Promoting and Analysing Collaboration

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Abstract
Shared interfaces such as multi-touch tables and tangible tabletop interfaces were found to mediate and support collaboration. With this work, we present an interactive tabletop mediated environment called Orbitia, which induces participants' face-to-face collaboration in the context of a joint problem solving activity. We discuss how interactive tabletops can elicit users in applying and progressively refining their collaboration strategies. This workshop aims to provide opportunities for learning about the design details and rationale behind different features and elements of such applications. Participants, after knowing about the fundamental aspects of collaboration in such context, will develop and reflect their ideas through crafting and prototyping. They will further learn how to test and evaluate the data collected in the context of tabletop mediated joint problem-solving activities.

Keywords
Interactive Tabletops, Tangible Tabletop Interfaces, Collaboration, Joint problem solving

1. Introduction

To support people in learning how to collaborate, new tools are needed that provide situations where they repeatedly need to apply productive collaboration strategies and experience their collaboration as successful.

Big shared screens and the ability for direct and simultaneous interaction by multiple users opens the floor for shared interfaces such as multi-touch tables and tangible tabletop interfaces. These shared interfaces, oftentimes, were found to mediate and support collaboration [1] in which they "enhance the sense of teamwork", "invite interaction and willingness to participate in group tasks", "increase equity in physical interaction", and "promote joint attention on the task" [2].

While multi-touch tabletop interfaces are operated using finger touches, tangible tabletop interfaces (TTI) provide the possibility of using physical objects that can be placed, moved or rotated, in order to interact with the system. The physical objects support participants in partitioning and coordinating their activities, and moreover, it is reported that they facilitate individual ownership and announcement of tool use as support for group awareness [3, 4].

Both tangible and multi-touch interfaces share common potentials such as increasing awareness in groups, promoting collaboration and physical interaction equity [5, 6, 3]. However, for a better selection of the appropriate method, the challenge is to consider the affordances of both interaction styles and to identify the costs and benefits of each technology according to the purposes and tasks.

Potentials of tangible and multi-touch interfaces in terms of supporting collaboration, do not necessarily guarantee the effectiveness of the applications designed for the tabletops. It is reported that

Figure 1: Participants jointly collaborate to solve the tasks of the activity.

more careful interpretations are needed in terms of the benefits provided by interactive tabletops and it is concluded that there is not just one absolute and ideal design of a multi-user interface [7]. Therefore, what is needed to be done is more investigation on adjusting the design of the tabletop interfaces to the purpose of the application, the level of required awareness and control, and the composition of the group.

A smooth collaboration in a tabletop-based application, thus, has its roots in taking into account the possibilities of both tangible and multi-touch interaction as well as understanding how the design of tabletop systems can support collaboration in different settings. This, led us to develop Orbitia, a joint problem-solving tabletop mediated activity, that it is described in the next section.

2. Orbitia

Orbitia is an interactive tabletop activity developed for the purpose of studying collaboration in a face-to-face setting within the context of the ORBIT project [8].

To develop a scenario that induces participants to collaborate, it was needed to focus on the design of the TTI and learn which tools and features promote participants to establish and maintain collaborative behaviours. Hence, during the design procedure, we had one eye on the preconditions of collaboration. According to Roschelle and Teasley [9], collaboration is a coordinated, synchronous activity where mutually engaged participants rely on a mediational framework to construct and maintain a negotiated and shared emerging conceptual space to jointly solve a problem. With this in mind, we defined the idea of the three scenarios potentially soliciting participant's collaboration and in a design workshop, we tested the paper prototypes of each scenario [10]. The aim was to define the design requirements for an activity in such context and to choose the best out the of three scenarios
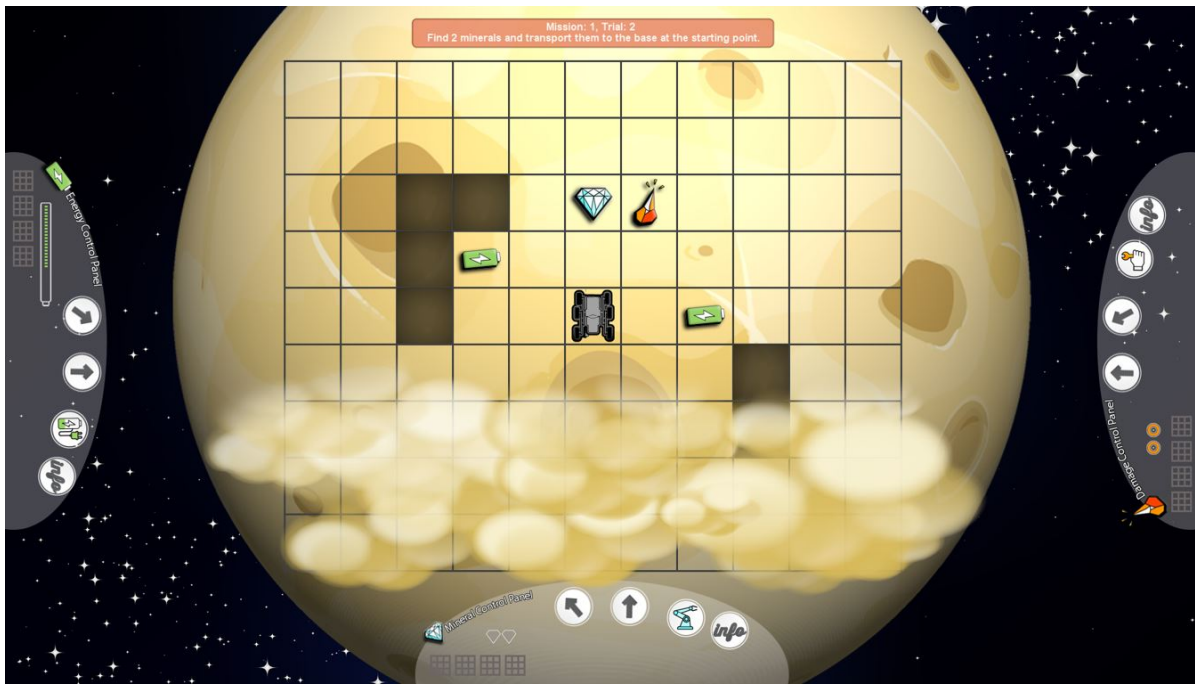
Figure 2: Overview of the activity in the first mission (level 1).

fulfilling the defined requirements.

Orbitia is the digital implemented version of the selected scenario. In the activity narrative, participants (three people) are located on Orbitia, an imaginary planet where they need to act as space mining crew in order to mine valuable minerals and ship them to earth. The main task of the activity is designed as steering a rover and operating a radar drone on the planet surface in order to find and collect the required minerals. Meanwhile, participants need to deal with limitations of the environment, such as obstacles and energy constraints (Figure 1).

The main shared space of the activity is a grid located in the center of the tabletop screen (Figure 2). Activity elements such as the rover, minerals, batteries and threads are located inside the grid cells. In addition to the shared area, there are three personal areas known as control panels which are placed in the three sides of the screen; each provides participants with the opportunity of individual control over certain aspects of the activity in a complementary manner.

Controlling the rover and manipulating the control panel is designed to be touch-based, whereas the radar drone is a tangible object.

According to the narrative, part of the planet is affected by a dust storm and therefore, the items located in that area are hidden. In order to provide participants with the clues regarding location of the hidden items, an active tangible, known as radar drone, is presented to them. Participants need to collaborate in order to decide about the best strategy to scan and to reveal the areas and further, to plan the route towards requested items (Figure 3).

In addition to the drone, the highlight marker, another tangible object, is added into the activity in order to aid participants with the route planning (Figure 3).

The main features of the activity such as division of the activity space into shared and personal areas, the complementary competencies given to each participants, and the tangible object which provide cues during the problem solving process, are added to support participants with their collab-
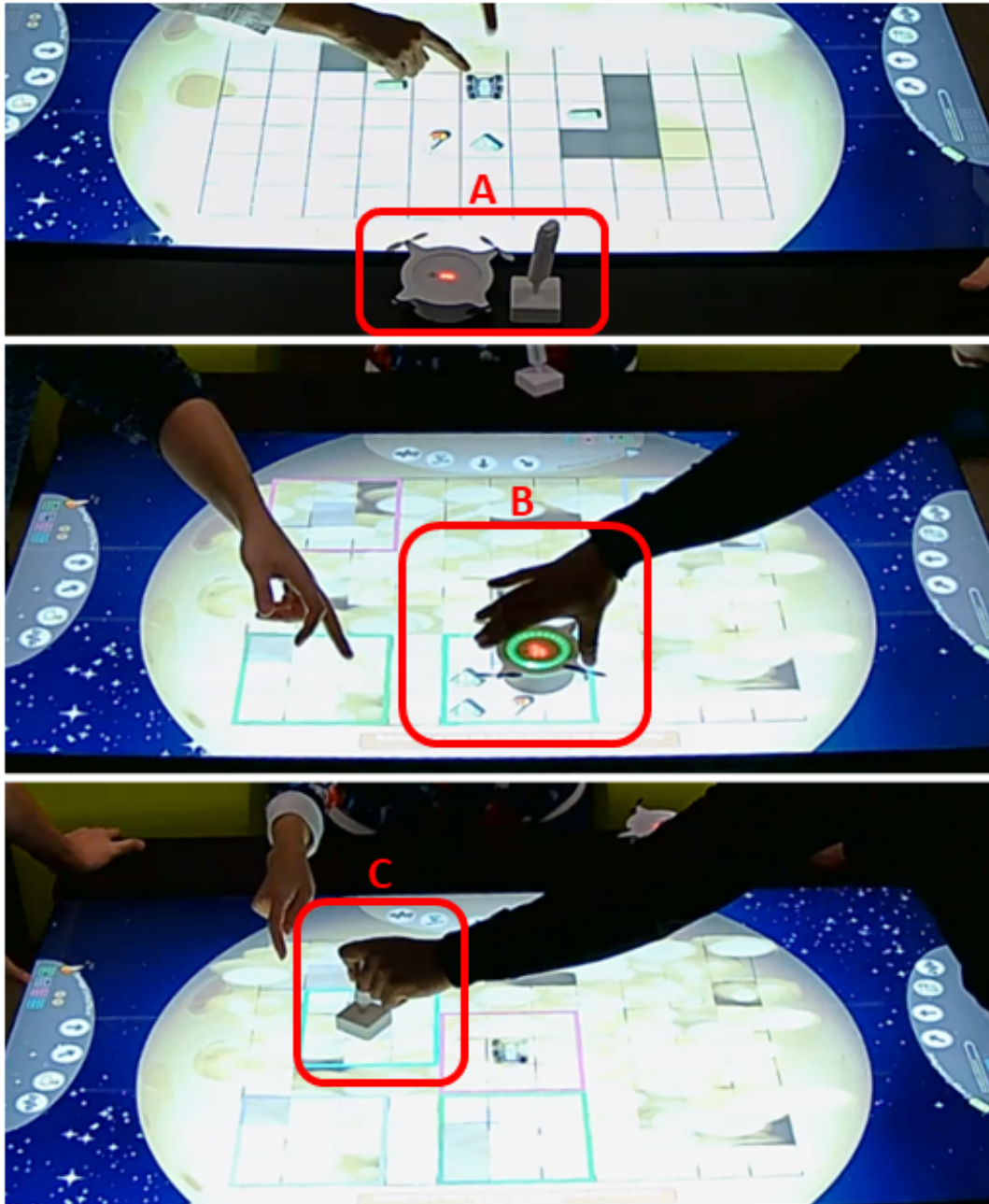
Figure 3: The tangible objects within the context of Orbitia; A: two tangibles, the radar drone (left) and the highlight marker (right). B: participant is scanning the grid area by using the radar drone. C: participant is using the highlight marker to mark certain cell of the grid in the route planning procedure.

oration. The next step is to gain insight on types of collaboration and experiences that emerge while using different features and elements of the activity.

To do so, certain criteria could be taken into consideration such as the overall time to complete the activity missions, the performance in terms of number of failed attempts and the taken strategies. In addition, questionnaires such as NASA TLX and UEQ could provide insight more on the overall experience of the participants towards the activity. Qualitative data collection and analysis is also

another way to learn about the details of collaborative conduct. All these criteria contribute to the knowledge of the different types of features and elements are used to collaborate in a joint problem-solving activity.

3. Workshop structure

What we propose in this workshop is to provide opportunities to learn about the notion of collaboration and to discuss possibilities for promoting it in a context of a joint problem-solving activity. Participants of the workshop will collaboratively decide about the design requirements, features and elements of a problem-solving activity and at the same time, they will be testers of the designed activities by their peers.

After a short introduction on the concept of collaboration and Orbitia, they will be exploring different possibilities to enhance the collaboration experience in that context. By prototyping, they will turn their ideas into a testable format (i.e. a paper prototype). Then by testing it they will learn what to look for during the data collection and how to evaluate the collected data. This, we expect, will provide them with an introductory knowledge over the concept of tabletop mediated joint problem-solving activity.

Specifically, during the workshop, participants will have the opportunities to:

- Getting to know about collaboration principles and definitions (e.g. distinctions between collaboration and cooperation, positive interdependencies).

- Applying their design ideas on the structure of a problem solving activity (Orbitia).

- Crafting the design ideas into the activity and testing it.

- Learning about the data collection and analysis by introducing the methods and data samples.

- Discussing the collected data.

The overall aim of the workshop is to explore opportunities of tangible and multi-touch tabletop interfaces to promote face-to-face collaboration in tabletop-based problem-solving, and to discuss a conceptual and technical framework for data collection and analysis.

4. Discussion and reflection

In order to gain better a understanding of the basic concepts of collaboration, the workshop started with a brief session aiming to review notable literatures in this context. The reviewing session covered concepts such as joint problem space, positive interdependence, interchangeable roles and negotiation. We then continued with reviewing studies to see how collaboration in shared interfaces is carried out and after, presented Orbitia, a tabletop-mediated application, designed to induce collaboration. We then moved on to the discussion session, where participants were asked first, to make a word cloud of the keywords from the reviewed concepts. After that, participants, by considering Orbitia's features and by using the word cloud items, shared their thoughts on impact of each feature on collaboration. This was done in order to think that how the design of different features could promote collaboration. Finally, participants were asked to share any new ideas regarding collaboration enhancement in the context of Orbitia. The result was a nice set of ideas concentrating on different features of the Orbitia, for example, using hexagonal grid, adding time to increase competition, and feedback about

the taken path. The outcome of the discussion phase showed that the participants could apply the reviewed concepts of collaboration in action and use them to identify the design rational of Orbitia and moreover, could propose further ideas to explore more in this regard. For the organizers, the workshop warped up with ideas forming a future plan in terms of designing new features to induce collaboration.

Acknowledgments

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