Using Mid-Air Gestures To Enhance Collaborative Experiences For Disabled Users On Multi-Touch Tables

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Abstract. Multi-touch tables can help facilitate and improve collaborative interactions yet many users with physical disabilities (e.g. wheelchair users) find it extremely difficult to interact with large tables. This paper presents work-in-progress that is exploring the potential to enhance multi-touch table accessibility to enable disabled users to participate more effectively in collaborative interactions. An overview of a prototype that allows disabled users to manipulate digital content via mid-air finger gestures is provided along with details of upcoming research studies we will be conducting.

1 Introduction

Multi-touch tables can help encourage collaborative and shared experiences through enabling multiple users to interact with digital content simultaneously. However, whilst they hold much potential in facilitating collaborative interactions, there remain many users with physical disabilities who find it extremely problematic to interact with them. This is especially true for wheelchair users who find it difficult to park close to tables and as such are severely restricted and constrained in their ability to use a touch table. This, in turn, makes it particularly challenging for disabled users to effectively participate in collaborative interactions with non-disabled users.

We are currently exploring a low cost solution to examine whether the use of mid-air finger gestures can make touch tables more accessible to wheelchair users and the impact this has on their ability to actively contribute in collaborative tasks. To investigate this we are making use of the new Leap Motion sensor that enables users to control interfaces using their fingers and other "pointers" (e.g. a pencil or stick). This sensor can "see" a user's hands and can be programmed to detect different mid-air gestures performed by users in a 3D space (e.g. grab, swipe, and wrist rotation). The Leap Motion sensor is also small and light enough that it can comfortably be incorporated into the border around a table thus providing wheelchair users with an unobtrusive tool for accessing all areas of the screen.

The combination of multi-touch and mid-air gestures in a single interface holds much potential for enhancing the accessibility of multi-touch tables. In this paper we provide details of a prototype that enables wheelchair users to interact with multi-

touch tables via mid-air gestures. We highlight the research questions we plan to explore, our proposed methodology, and details of future planned work.

2 Related Work

Multi-touch tables are increasingly being used in public settings, but little work to date has looked at enhancing their accessibility for people with physical disabilities. One possible solution is to augment touch interactions to provide disabled users with additional options for manipulating digital content on interactive surfaces (e.g. [1-3]). In particular, the ability to interact with computers via mid-air gestures has become more feasible in recent years with the release of affordable sensors such as the Microsoft Kinect [4] and the Leap Motion controller [5]. This has led to researchers exploring the potential of mid-air gesture interactions and the usability issues that they present (e.g. [6-9]). Recent work has also looked at the use of mid-air gestures above touch tables to examine how interfaces can be enhanced through an additional input medium (e.g. [10-13]).

However, we are aware of no work to date that has looked at the use of mid-air gesture interactions to help enhance the accessibility of touch table interactions for physically disabled users. There are a variety of potential approaches for making touch table interactions more accessible - for example, one solution is to use vertical multi-touch displays alongside the touch table that wheelchair users can use to interact with the table. This is technically feasible, but it may not be ideal for collaborative tasks as disabled users are unlikely to be positioned directly around the table with other users. This could also be an expensive solution as an additional display is required to help make the interaction more accessible. Another possibility is to use a device like a smart phone or tablet that can be used to control the application on a touch table (e.g. [14]). Whilst this approach has much potential, it also presents some issues in that users will need to ensure that they have a compatible device with appropriate software installed prior to starting an interaction. Public organisations such as museums and art galleries could freely provide mobile devices to enable the general public to interact with their touch tables, but this presents a risk as these devices could be stolen or easily damaged.

In both of the above approaches a separate experience is created for disabled users that (to a degree) results in them being segregated from the main table interaction. In some scenarios this may not be an issue (e.g. when a disabled user is using a table on their own), but for collaborative interactions it is especially problematic. The use of mid-air gesture interactions is an alternative approach that is potentially useful as the sensor will be built directly into the border around a table meaning that no additional expensive devices are required (e.g. smart phones or tablets). This approach also provides some advantages over, for example, mobile devices and applications as users can simply approach and use their hands to control the interface. Users do not need to be concerned about having a compatible device or having to deal with the inconvenience of downloading an application before starting an interaction. The touch table application would also not need to be adapted in any significant way to accommodate disabled users with limited reach. Both disabled and non-disabled users

can share the same interface - although this can also present some interesting interaction issues that we would like to explore further.

The work we propose in this paper will therefore be amongst the first to explore the interaction issues around the combination of mid-air and multi-touch technology and the impact it has on accessibility and collaborative experiences.

3 Proof of Concept

To test the viability of this approach and the impact on collaboration we are currently integrating the Leap Motion sensor into a multi-touch table application (Fig. 1) that we built in collaboration with The Hive in Worcestershire (UK) - the first integrated public/university library and history centre in Europe. This application allows visitors to manipulate images taken from the Hive's varied archive via multi-touch gestures (i.e. drag, rotate, flick, pinch/zoom - see [15] for more details on this application). The Leap Motion sensor will enable wheelchair users to perform the same image manipulations through the use of mid-air finger gestures. The application will also provide mid-air selection techniques such as pointing at objects of interest or a lasso gesture for multiple selections. Users can then drag out-of-reach objects to an area on the table where they can comfortably use touch gestures (as opposed to mid-air ones) to manipulate the objects. This prototype will be used as a means for exploring the interaction issues involved in shared and collaborative experiences between disabled and non-disabled users.

Fig. 1. Multi-touch Application + Leap Motion

4 Research Questions / Methodology

This project presents numerous new and interesting research questions that we plan to explore using the prototype described above. In particular, there will be two key phases in this project - the first will involve developing a robust application that will enable wheelchair users to use mid-air gestures to interact with multi-touch tables. This will initially involve exploring the following types of broader research questions:

- Which types of mid-air finger gestures are best suited to 2D/3D object selection, scaling/zooming, and rotation?
- Do users prefer to always use mid-air gestures for manipulating digital content on tables or is a combination of mid-air and multi touch preferred (e.g. the user performs a mid-air gesture to select an out-of-reach object and bring it closer to them - they then use touch-based gestures on the table to zoom, scale, rotate, etc.)
- What are the key usability issues involved when using mid-air gestures to control digital content within multi-touch table applications?
- How much of a screen can disabled users comfortably see when positioned in a wheelchair? What is the optimal height for touch tables to comfortably accommodate both disabled and non-disabled users?

The second phase will involve exploring the impact of both disabled and non-disabled users in collaborative tasks. The research areas we are interested in here include:

- How does the use of mid-air gestures by disabled users influence collaborative and shared experiences around a table?
- Are disabled users able to use mid-air gestures to help them actively contribute to collaborative tasks with non-disabled users?
- How do disabled users share the screen space? Does the ability to lasso and select objects that are out-of-reach (via mid-air gestures) invade the table space of other able-bodied users?
- How do you subtly and efficiently educate disabled users about the gestures available without significantly altering the interaction for non-disabled users?
- How do users with no impairment use the system – does it interfere with surface-based interactions or is it a useful augmentation for them too?

We are running an evaluation with wheelchair users at The Hive (in November 2013) to start examining further the potential of this approach and to help understand better the interaction issues involved. An initial exercise will involve asking participants to complete multiple tasks without the Leap Motion (e.g. performing manipulations on out-of-reach objects) to get some baseline data. The assumption here is that the interaction will be cumbersome and frustrating for wheelchair users as they will have to continuously move around the table. We will then ask users to perform similar tasks using the Leap Motion prototype to examine the strengths and weaknesses of this approach and to compare with the baseline data collected.

In a separate study, we will explore the issues when working on a collaborative task - for this we will use one of the albums in The Hive application which includes old photos of shop fronts from Worcestershire High Street (Fig 2). The captions associated with these photos contain the address for each shop (e.g. 25 High Street, 31 High Street, etc.) and are initially jumbled. We will therefore ask a group of 3-4 people to work together to put the objects in the correct order and to make them all approximately the same size. This should ensure that all users will need to perform the main actions and gestures available in the application (select, drag, rotate, scale, etc.) We plan to film these tasks and then analyse how effective the interaction was in assisting with collaboration between disabled and non-disabled users. We will also conduct semi-structured interviews with all participants to determine how they found the collaborative task and the impact they felt the use of mid-air gestures had on the interaction.

Fig. 2. Shop Fronts album in the Hive application

5 Conclusion

The use of mid-air finger gestures (via the Leap Motion sensor) can potentially enable people with a broad range of physical disabilities to interact more comfortably with multi-touch tables. The work presented in this paper will help us to understand better the interaction issues involved in using mid-air gestures in collaborative interactions with non-disabled users. It is also important to note that whilst we are focusing on a specific set of users in this project (i.e. people in wheelchairs), this type of technology will also be of use to those with other types of disability (people with stumps, missing limbs, restricted and uncontrolled movement of head and arms, etc.), young children, and elderly people who have limited reach. This work is still at an

early stage which is why we feel it would be particularly useful to attend the workshop to discuss and share our ideas further and to get feedback on the proposed methodology prior to running our initial studies in November.

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