COMET: Collaboration in Applications for Mobile Environments by Twisting

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Abstract

In this paper, we describe a novel way of collocated collaboration with mobile devices using physical deformations to their shape. These deformations include bending and twisting gestures to improve user experience while collaborating with limited screen estate and device footprint.

Keywords

Collaboration, Computer Supported Collaborative Work, CSCW, Collaborative User Interfaces, Deformable user interfaces, gesture input, bending, mobile computing, design, experimentation, human factors

ACM Classification Keywords

H.5.2 [Information interfaces and presentation (e.g., HCI)]: User Interfaces - Haptic I/O, Interaction Styles, Prototyping; H.5.3 [Information interfaces and presentation (e.g., HCI)]: Group and Organization Interfaces - Computer-supported cooperative work, Synchronous interaction

Introduction

One of the reasons for the popularity of mobile phones, ultra-portable laptops and similar devices is their small size and less weight. This makes them easy to carry around and to use such devices while in a meeting or

otherwise, while collaborating with each other. This can be simple contact exchange, making appointments or complicated collaborations like document editing.

There have been several ideas on how to physically deform computers, e.g. [1, 2, 3, 5, 6, 7, 8, 9, and 10]. However, there is no prior work that refers to using these deformations for collaboration. Also, the suggested deformations and haptic feedback in the mentioned works have restricted functionality and cannot adequately model a collaborative environment.

COMET, which stands for Collaboration in Mobile Environments by Twisting, deals with three different paradigms with inherent challenges that should be handled carefully – collaboration environments, mobile devices, and physical deformations.

Collaboration environments should help users orient and align their local work along with the collaborator. They should provide easy ways of communication, cooperation and collaboration, but still handle privacy of the collaborators. Thus, they require *visibility* of the collaborators' actions, *feedback* of the results of the actions and finally *communication* between the collaborators. We describe them in the section Collaboration Environments.

Mobile devices have small displays, require small onscreen or physical buttons to be pressed to execute functions, and have restricted menu structures. As mentioned in [1, 4, 5, 8], WIMP interfaces are not the best-suited interfaces for such devices. Thus, COMET is inspired by the physical deformations mentioned in [8,
10] to help reduce the need for hand movements and pointing by fingers and/or stylus.

Physical deformations are a novel way of interacting with mobile devices. They should be designed to prevent accidental triggering but not so difficult that they become obstructive to the flow of thought. Thus, having natural gestures helps reduce the discomfort. We describe them in the section Deformation Gestures.

The hardware prototype of our solution is based on the TWEND device detailed in [10], and as shown in figure 1. We refrain from reiterating the implementation details in this paper, and instead focus on collaborative aspects of its use.

Hence, our goal is to investigate the effects of using deformations in collaborative environments and to generate a vocabulary of useful gestures for such applications with mobile devices. Our gestures are complemented by the existing distinct deformation gestures for selecting, deselecting, zooming in/out, and scrolling described in [4, 8, and 10] for standalone devices.

Collaboration Environments

People like to collaborate to reach a common goal or to share some information with each other. However, they also wish not to be disturbed when working in private with personal information. This gains more importance when collaborating with mobile devices because often, these devices carry personal information. Users usually do not feel comfortable when someone disturbs them while they are busy working on their mobile device.

Hence, collaboration with mobile devices introduces data- and location- related privacy concerns. We solve this by suggesting three relevant environments in which users feel comfortable by choosing their intended level of collaboration.

Figure 1. The TWEND device, which can be held by both hands on each side for the physical deformations.

Figure 2. Bending across the two diagonals, one after the other creates BREAK gesture.

Figure 3. Creating a hill and a trough performs WAVE gesture.
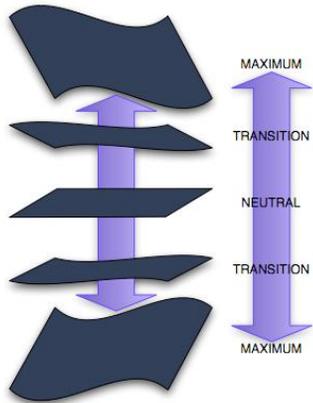

Figure 4. Device can be bent to varying levels to provide a continuous input from Neutral to Maximum. These in-between positions are called Transitions.

PRIVATE: is the default environment that users start with initially. Their work cannot be seen or edited by others. They use this environment to work individually.
PUBLIC: is used to share files and documents with other users. These files and documents may be viewed by other users but cannot be edited. They use this environment just for sharing information.
Collaboration: is used for collaborative editing of files and documents simultaneously. They use this environment to make changes together, and to notice their effects.

The state of environment of each user is visible to every collocated user. This is essential to prevent inadvertent communication between users who might be collocated but do not wish to collaborate together.

We now discuss three important deformation gestures to collaborate in these environments.

Deformation Gestures

The collaboration begins with a request from a collocated user for collaboration. Users can decline the request or switch between the three environments by using the deformation gestures. Of the many possibilities, we suggest using the following gesture:

BREAK: The user first bends across one diagonal and then across the other diagonal, as shown in figure 2. Performing the two actions in quick succession brings the user to the next environment. In this way, users can cycle through Private, Public, and Collaboration

There are other possibilities for this; however, we consider this to be a good choice because of two reasons:

First, using a deformation instead of stopping to hold the device with one of the hands, moving hands/fingers and pointing to a location on the screen or device is less convenient than keeping the hands in their place and just deform the device.
Second, the gesture is sufficiently difficult to prevent any unexpected accidental switch in the environment. It is also a close natural mapping to "breaking" the current environment.

Once the users are in their desired environment, they might wish to either share information (Public) or edit files together (Collaboration). We suggest the following deformation gestures to help perform these tasks:

WAVE: The user holds the device such that one half forms a trough and the other half forms a hill, as shown in figure 3. After relaxing, the display is partitioned into two spaces. One of these is the local display on which the user may continue to work on her own files. The other half shows the collaborating user's display for sufficient *visibility*.

We think this is a good deformation gesture to split the display into two parts because of the two reasons:
First, users can see the vertical divide between hill and trough on the screen quite distinctly to mark the division of the two parts.
Second, the hill portion of the WAVE is closer to the users and hence, can naturally map to the local half. Also, the trough portion is away from the users and hence can naturally map to the remote half.

WAVE deformation is a continuous input deformation. This means that the behavior of the device changes according to the extent of deformation. We can define
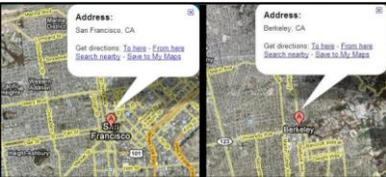
Figure 5. Moving the WAVE gesture from one end to the other end, creates a PULSE gesture

a)

b)

c)

Figure 6. MAPS application a) First user's display. b) First user creates a WAVE and relaxes to view the second user's display on his split screen. c) She creates a slow WAVE and increases the deformation to see details and directions on the translucent window in the center.

this continuous input as a variation from the NEUTRAL position to MAXIMUM position. The in-between variations can be referred as TRANSITION positions. This is shown in the figure 4 on the previous page.

A quick WAVE gesture from NEUTRAL to MAXIMUM position splits the screen after relaxation. Another quick WAVE gesture from NEUTRAL to MAXIMUM position resumes the screen to local display after relaxation. This cycling is consistent with the BREAK gesture.

However, users can also create a WAVE slowly while they have split screens. This creates a red-bordered window of translucence over their display. The more the user deforms the device, the more opaque and detailed this window gets, displaying the collaborative results of merging the two single displays. This provides appropriate *feedback* in a continuous way [8].

PULSE: The user sends a pulse of the WAVE from one end of the device to the other end, as shown in figure 5. This leads to real transfer of information. The direction of the PULSE determines the receiver. Thus, the user can hold the device and point their PULSE to the intended receiver for COMMUNICATION.

We think that this is a good deformation gesture in this context because of two reasons:
First, the dynamic nature of the gesture suggests that there really is some sort of a movement of information occurring out of their device. This seems like a good natural mapping.
Second, it involves pointing to the intended receiver. This also improves the experience and helps create the feeling that the data is flowing from the user into a particular direction towards her target.

Applications

In this section, we describe some applications inspired by [11], to show how deformations can be used for collocated collaboration.

FILE EXCHANGE
We start by discussing the simplest case of a user wanting to send a file to another user.

Users pick up their devices and BREAK the environment once by folding across the two diagonals to enter the Public environment. Finally, one of them sends a PULSE in the direction of the other user to send the file.

MAPS
Users often share their addresses and directions to their homes or work places when they meet each other. This can be accomplished by following these steps:

Users pick up their devices. They BREAK their devices twice to reach the Collaboration environment. Each user locates the intended address on their local map application, and then they create a WAVE to see each other's locations on split screen. Now they slowly create a WAVE again after relaxation to see their locations get connected and to see the directions. They can also increase the deformation to increase the details like route, distance etc. This is shown in figure 6. They can also PULSE their addresses to each other.

DOCUMENTS – EDITING & MERGING
Just like MAPS, users can edit documents together. They can make changes locally and see the changes being made by the other user on the split screen. They can slowly WAVE to see how the local and remote changes affect the document in the Collaboration
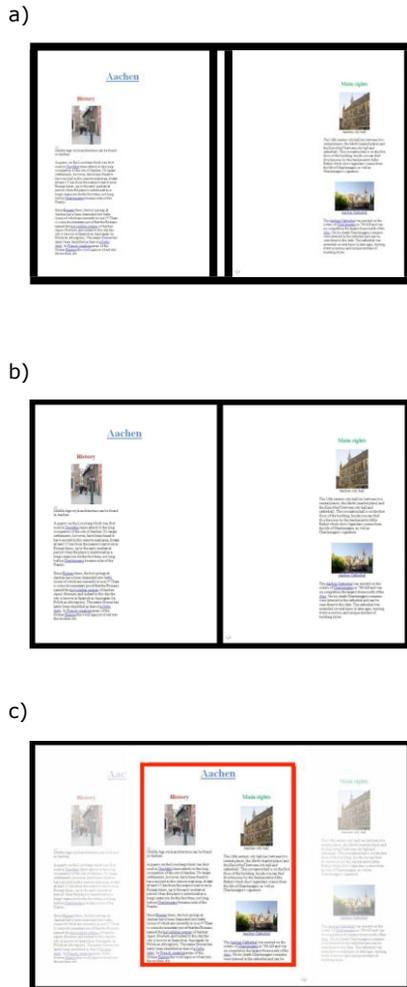
a)

b)

c)

Figure 7. DOCUMENTS application.
a) The individual displays of the two users.
b) The split screen of the first user after creating a WAVE c) The merged results in the center translucent window after creating a slow WAVE by the first user.

environment. They can also see the annotations made by the other users. This might also involve some discussions. This is shown in figure 7. When they are satisfied with the results, they can also merge their works by sending a PULSE from one to the other.

CONTACTS

Mobile devices should be able to exchange contact information painlessly and quickly. This can be accomplished by sending a PULSE to each other in the Public environment. This reduces the necessity to find, dictate and note numbers and names when people meet while they are on the move.

MUSIC/PHOTOS

Users can exchange music, track-lists, photos or albums by sending a PULSE to each other in the Public environment. If they want to let other users leave comments or recommendations, they can use the Collaboration environment instead. Finally, they can make a slow WAVE on their split screen devices and see the comments left by the other users on their shared photos or music habits.

CALENDAR

Users can exchange their calendars to make an appointment with each other. They can open up the Calendar in their respective local displays in the Collaboration environment. After creating a WAVE, they can see each other's calendar.
However, to ensure privacy, unnecessary calendar details of the collaborators are not shared and only the temporal information is shown. They can also create a slow WAVE to merge their calendars and make the appointment, as shown in figure 8 on the next page. This is then reflected on their local displays.

INSIDER'S VIEW

Users can use their devices to reveal hidden details in documents, such as Images etc. This can be used for security purposes as well. One of the collaborators can decide the level of detail and the context of detail accessible to the other user. In the Public environment, the requesting user sends a PULSE of an image. The controlling user can make a WAVE and zoom into the image locally to reveal the details to the requesting user. The requesting user creates a WAVE on the display to notice the details being shown by the controlling user.

The Experimental Setup

The setup consists of two users, with independent TWEND devices and independent displays, located next to each other. The users can look at each other to verbalize their thoughts or concerns while performing the above-mentioned tasks, as shown in figure 9. Preliminary anecdotal reviews have been encouraging. Users liked the idea of not having to move their hands or point at the device with a stylus or fingers to collaborate with each other.

Figure 9. The experimental setup

We also plan to simulate these tasks with a range of mobile devices: mobile phones, PDAs and ultra-portable devices. To be consistent, all the devices will have a
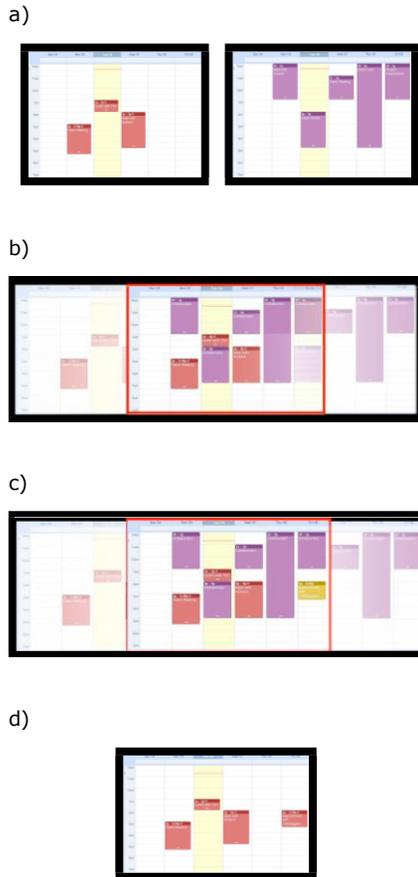
a)

b)

c)

d)

Figure 8. CALENDAR application. a) Shows the two calendars of the users. b) Shows the merged calendars, after hiding details of the other collaborator. c) Shows the agreed appointment in Yellow on the merged calendar. d) Shows the agreed appointment added to the user's local calendar.

touch screen and experiments would be conducted to use their touch screens versus the deformations on our device. To keep the experiments identical, we plan to channel the output of all the devices onto the computer display and turn off the display on the devices.

We also intend to do a user study of the various mentioned gestures to ascertain the closest natural gestures for the desired actions. We intend to do this in two phases. In the first phase, we will hand the device to the users and give them the above-mentioned scenarios. We would expect them to come up with their preferred gestures. In the second phase, we will compare the efficiencies of the gestures mentioned here with the newly suggested gestures by our users.

Ongoing and Future Work

COMET has been designed currently for use by two collaborators. One restricted solution for multiple collaborators, consistent with PULSE, is to WAVE in the direction of the intended collaborator from the group to split the screen accordingly. However, only two users can collaborate simultaneously still. Thus, we want to continue to find a solution for multiple collaborations. Our application set is also limited at this moment. We intend to increase this set over time to include other interesting applications by further understanding the user behavior during mobile collaboration. We intend to conduct user studies in the future with the existing hardware (and with flexible displays, when available) and incorporate changes in our system.

Acknowledgements

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