Memory Stones: An Intuitive Information Transfer Technique between Multi-touch Computers

Kaori Ikematsu
Ochanomizu University
g0920502@gmail.com

Itiro Siio
Ochanomizu University
siio@acm.org

Figure 1: Proposed drag-and-drop method between two computing devices.

1. MEMORY STONES

In the real world, we can transfer objects such as printed documents by picking them up from one desktop and putting them down on another desktop. If the object we pick up is solid, such as a stone, the form of our fingertips is unchanged over the course of picking up, carrying, and putting down the object. Our proposed user-interface method, termed "Memory Stones," applies these common actions to the copy-and-paste operation between two devices equipped with multi-touch input. Using our method, a user can copy-and-paste an information object using the same actions he or she would apply to a physical object like the aforementioned stone: "picking up" the information object from one device screen, "carrying" it to another device screen, and "putting down" the object on that screen. Figure 1 illustrates this sequence of actions by a user who copies a Web page from a smartphone and pastes it to a tablet PC. The user first picks up the Web page by touching the screen with three fingers (Fig. 1(a)). Next, she moves her hand to the target computer keeping her fingertip positions unchanged, as if she were carrying a solid object (Fig. 1(b)). Finally, she touches the target computer display with the same fingers and fingertip positions, at which point the Web page is copied to that computer (Fig. 1(c)). Using this method, she can copy-and-paste intangible information as if she were moving a tangible object. We have added visual feedback in the form of a virtual stone (a "Memory Stone") to both the source display and target display as an indication that the copy-and-paste action was accepted and completed. This visual feedback also reinforces the metaphor of carrying something tangible from one device to another. Our Memory Stone method utilizes off-the-shelf multi-touch devices such as touch-panel displays and trackpads. By comparing the shape of the two polygons formed when a user's fingertips touch the displays of two different devices, the system can identify and pair the source and destination devices to which the copy-and-paste action should be applied. As multi-touch input becomes popular on a wide range of computing devices including smartphones, tablets, notebooks, and desktop PCs, we expect that our proposed method will be widely implementable without requiring additional input devices or sensors.

2. SYSTEM OVERVIEW

The prototype system functions as a simplified Web browser for computing devices running iOS and OS X operating systems. When a user touches the multi-touch display or the trackpad of the device with multiple fingers, the URL of the Web page is copied to the system. The URL is pasted to the target device when the user touches the multi-touch display or trackpad of the target with the same fingertip pattern, after which the pasted URL is loaded into the simplified
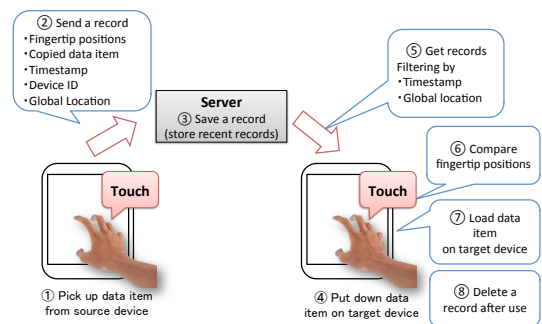
Figure 2: System configuration and operation.

Web browser running on the target. To indicate to the user that his or her copy-and-paste operation was successful, the system displays the image of a stone on the screens of both the source and target devices. When a user touches with multiple fingers on the source device, a stone scaled to fit within the polygon formed by his or her fingers appears on the screen, and disappears when the user lifts his or her fingers from the display. The same stone appears when the user touches the destination device with near-identical fingertip positions to indicate successful completion of the copy-and-paste operation. In the current prototype, the user must copy-and-paste using more than two fingers in order to avoid conflict with commonly adopted multi-touch operations using two fingers.

3. OPERATION

Figure 2 shows the series of operations between devices when a user perform a copy-and-paste action. When a user touches a source computer to pick up an information object (e.g., a Web page), the client application pushes the following data to a prepared server: the timestamp, the global position of the computer, the URL of the data object (Web page), the unique device ID and the fingertip positions. The server preserves this data. When the user touches the destination device to drop the information object, the client application on that device fetches recent records from the server. From the received recent records, those that are physically farthest from the destination device (based on global positioning) are removed. After excluding unqualified records, the program uses a polygonal congruence condition to try to find a record with a matching fingertip shape. Specifically, if the square summation of the difference between the lengths of corresponding sides is less than a given threshold, then the two fingertip shapes are considered a match. If a match is found, the client application fetches the URL from the matched record and loads it into the browser, thereby completing the copy-and-paste procedure.