SqueezeBall: Enabling Intuitive Copy and Paste using Soft Ball-Type Device as Mobile Clipboard

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Abstract

This paper presents a novel interface driven by squeezing forces, and its application as a mobile clipboard for intuitive copy-and-paste operation using soft ball-type device, termed SqueezeBall. We designed and developed a ball-shaped interface with handheld size. Sensors and communication modules are embedded in the soft ball to react to the squeezing force of the user and to interact with multiple devices. The user can conduct a copy-and-paste operation among the several devices more intuitively by squeezing and rolling it by hands.

1. Introduction

Nowadays, the several types of computing devices such as smart-phone, notebook, and desktop computer dynamically take part in communication for providing interactions with each other [1]. One may wish to copy some images or text edited by his/her notebook computer and paste it into his/her desktop computer. In this situation, one of the challenging issues is how we can conduct a copy-and-paste operation among the several devices more intuitively. In a conventional manner, a transferring some data from one computing device to another one usually takes several steps which include configuring a security policy, enabling radio interfaces for connection, selecting data to be sent, and pressing transmit button [2]. Therefore, it is essential to devise novel interface for exchanging data among the devices in more intuitive and user friendly ways [3, 4, 5].

In an attempt to provide an intuitive copy and paste operation among the several computing devices, this paper presents a novel interface driven by squeezing forces, and its application as a mobile clip-board[1]. Our design goal is to facilitate the copy-and-paste operation

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[1] Clip-board: it is temporary data storage for data transfer between documents or applications, via copy and paste operations.

Table 1. SqueezeBall Interface

		Action	Operation
1		Roll	Move the pointer in accordance with the rolling direction
2		Grasp	Copy the pointing content (ctrl + c)
3		Release	Paste the stored content at the current location (ctrl + v)
4		1→2→3	Copy-and-Paste *(ctrl + c → ctrl +v)*
5		Toss	Cancel (esc)

among the multiple computing devices by providing an intuitive interface using soft ball-type device, namely *SqueezeBall*. Like the commonly performed copy-and-paste operation, *SqueezeBall* provide an intuitive interface for transferring digital data such as photo and text on a computer to the other computing devices. Unlike the conventional copy-and-paste operation, *SqueezeBall* interface allows a user to physically grab a digital object from one computing device, roll it through real space, and release it in a different computing device. Just like grasping an object for moving it from one place to another place, *SqueezeBall* provides a method whereby a user can physically carry data as if it were a real object.

2. *SqueezeBall* Interface

The proposed *SqueezeBall* Interface is illustrated in Table 1. *SqueezeBall* Interface is broadly classified into four types: roll, grasp, release, and toss as follows:

- **Roll:** The gesture of rolling the ball is interpreted as up, down, left and right movement commands which are directional movement commands similar to a conventional mouse. The *SqueezeBall* is able to generate continuous analog output for each direction as user rolls to any direction. Table 1-1 shows the roll operation on the basis of *SqueezeBall* Interface. Users are able to move the mouse pointer among several computing devices by rolling the ball.
- **Grasp-Release:** Table 1-2 to 1-4 show the interface by grasping and releasing the ball. In case of the grasping and releasing, the inside pressure of the ball varies according to the squeezing forces by the impact of grasping or releasing the ball. The gesture of grasping and releasing the ball is mapped to copy and paste operation respectively just like grasping an object for moving it from one place to another place. When the *SqueezeBall* change the inside pressure of the ball due to the grasping force of user, the signal from the pressure sensor which is embedded in the inside varies. Consequently, the signal which depends on the grasping performance is obtained by the output value from the pressure sensor.
- **Toss:** The gesture of tossing the ball is interpreted as '*cancel*' commands (pressing *esc* key). Table 1-5 shows the interface by tossing the ball. The detection of the gesture is accomplished by 3-axis accelerometer on the device.

3. System Implementation

To explore the benefits of the proposed input devices that support more intuitive copy-and-paste operation, we built the *SqueezeBall* device as a prototype as shown in Figure 1-b. The *SqueezeBall* is a cordless, ball type object that is designed mainly as an input device for interaction with multiple computing devices.

3.1. Hardware Architecture

To enable the interactions described in the previous sections, a means of sensing the gesture on the basis of *SqueezeBall* interface is required. Figure 1 shows an internal design, implementation, and prototype of the proposed interface, respectively. As shown in Figure 1-a, the proposed *SqueezeBall* input device consists of three sub-modules: the first one is a processing module, the second one is a sensor module and the last one is a communication module. The processing module processes sensed data from the sensor module and then converts the data into command data as an input device. The sensor module in Figure 1-a consists of a roll-
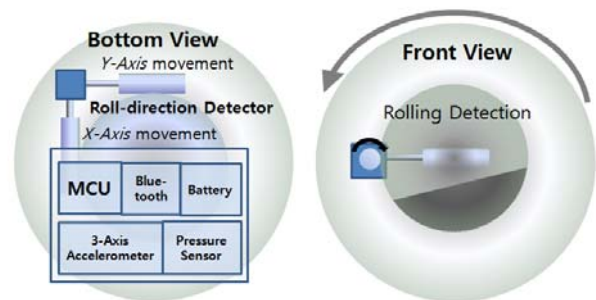
(a) SqueezeBall Prototype & Internal Design

(b) SqueezeBall Prototype
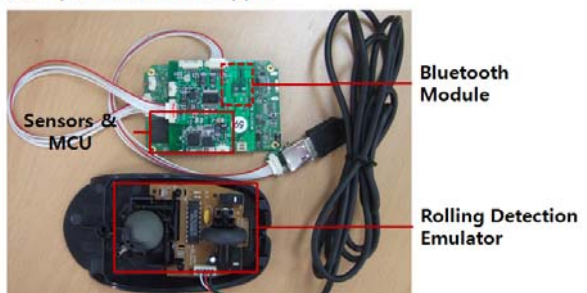
(c) SqueezeBall Implementation

Figure 1. Squeeze Interface Prototype & Implementation

detector, an accelerometer and a pressure sensor on a flexible printed circuit board. In the soft-ball, all electronics devices are embedded on the substrate. This substrate is fixed by urethane sponge inside the soft-ball. In our prototyped implementation, the ball mouse is used to emulate the inside ball and roll-direction detector as shown in Figure 1-c.

3.2. Software Architecture

In order to facilitate the *SqueezeBall* interface, we have developed a device driver for hiding the internal recognition mechanisms. It provides a backward compatibility for the conventional clipboard interface. For example, an application can send/receive data to/from another application of the other computing device because the clipboard is connected via TCP and shared among multiple computing devices. This driver interface was written in C# on .Net Framework 3.0 [6].
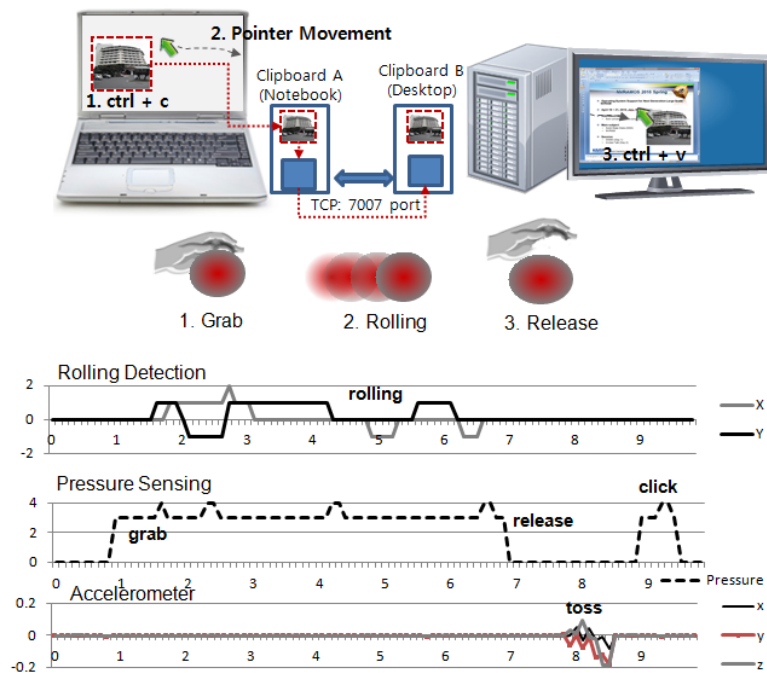
Figure 2. Internal Operation on the basis of Squeeze Interface

3.3. Application

Figure 2 shows typical usage of *SqueezeBall* interface between two computers and sensed data with varying the operation. When a user grabs the *SqueezeBall* with pointing some data such as image or text on the screen or the notebook computer, the data is stored on the clipboard which is connected and shared with another clipboard of the desktop computer via TCP. It represents a situation in which the *SqueezeBall* virtually holds the data (even though the ball itself does not contain any storage). When the user rolls the ball towards the other computing device, the pointer will move to the other device. Then the data icon with shadow appears on the display to show the ball is holding the data, before actually releasing it on the screen. Finally, when the user releases the ball, the clipboard transfers the data to the desktop computer.

4. Related Work

There have been several trials in seeking to find an adequate user interface which substitute existing interfaces such as mouse, keyboard and other ordinary input devices. Bricks [7] is a user interface that allows direct control virtual objects by physical handles for control. Illuminating Clay [8] is a clay type interface for real-time computational analysis of landscape models. If user alters the shape of clay, that depth of the clay works as an input to a library of landscape analysis functions through the ceiling mounted laser scanner. While the prior papers focused on the user interface for a domain specific application, this paper focuses on the general purpose tangible device to facilitate the copy-and-paste operation among the multiple computing devices for transferring data.

For that reason, another related field of this work is an intuitive copy-and-paste operation scheme. InfoPoint[9] provides data transfer operation in the real world using hand-held device. The hand-held device has small camera which detects makers and files on the display of desktops or laptops. Using cameras, buttons and wireless LAN, they implement drag-and-drop motion which provides the data transfer between two computers. In the point of transferring data, InfoPoint is fresh trial using new equipment.

Through the learning from past experiences in order to provide tangible or intuitive user interfaces, this paper suggests that a physically grabbing object and the capability of using realistic hand interaction will enhance the intuitiveness of copy-and-paste interaction. Therefore, we suggested a soft ball-type device and user interface to facilitate the copy-and-paste operation among the multiple computing devices by providing an intuitive interface, namely SqueezeBall.

5. Conclusion

In this paper, our aim was to present a novel interface driven by squeezing forces, and its application as a mobile clip-board for intuitive copy-and-paste operation using soft ball-type device, termed *SqueezeBall*. To accomplish this task, we designed and developed a ball-shaped interface with handheld size. The user can conduct a copy-and-paste operation among the several devices more intuitively by squeezing and rolling it by hands.

6. References

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