Mobile Assistant: Enhancing Desktop Interaction Using Mobile Phone

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Abstract
Touchscreen of mobile phone is an important input channel, whereas most desktop computers have no such a modality. Furthermore, we observe a common situation where ubiquitous mobile phones are placed aside while users operate computers. In this poster, we present Mobile Assistant (MA), which allows a touch mobile phone manipulated by the non-dominant hand to assist desktop interaction without introducing extra devices. To demonstrate this interaction concept, two tasks are investigated: Symbol Input and Button Access. The user study shows that MA can significantly improve the input efficiency for users to complete GUI tasks.

Author Keywords
Mobile Phone; Touchscreen; Non-dominant Hand; Desktop Interaction

ACM Classification Keywords
H.5.2 [Information Interfaces and Presentation]: User Interfaces.

Introduction
Mobile phone has become a necessary personal device for its increasing computing power and network connectivity. It can serve as a ubiquitous human-machine interface for many information systems. However, should we just leave the mobile phone sitting

beside the keyboard quietly when we are working on our computers?

Although there are works on extending desktop interaction with connected handheld devices [4, 5], little research has been done on using touch phones to augment interaction on desktops. Besides, a touch phone is already at hand for everyone, so the re-usage of it could achieve the same goal without introducing extra specially designed devices. On the other hand, researchers have investigated the possibility of having the non-dominant hand controlled devices to enhance human-computer interaction. Buxton [2] and Myers [4] demonstrated that human can perform both concurrent and sequential bimanual operations effectively. Myers [4] also used a Personal Digital Assistant as an auxiliary input device for the non-dominant hand.

Based on these findings, we present MA, which enables a mobile phone operated by the non-dominant hand, typically the left hand, to facilitate desktop operations. The basic idea of this technique is to move those difficult-to-access but frequently used GUI widgets to a phone's touch screen. Users can access these widgets with their non-dominant hand while interacting with other widgets on the computer screen with their dominant hand. Generally speaking, these difficult-to-access widgets can be divided into two categories: too deep in the interface hierarchy (e.g. multi-level menus), and too small or too far to reach. To address both cases, MA currently supports two representative tasks: Symbol Input and Button Access. Preliminary study shows that MA can significantly reduce the task completion time.

Discussion

Introducing a secondary display may lead to two drawbacks.

First, operating another device with the non-dominant hand may be inconvenient when accessing hot-keys, which will decrease interaction efficiency [1]. To address this issue, our design does not require users to move or hold onto the device when tapping or performing a gesture. Therefore, the phone can be placed in close proximity to the keyboard, making both the device and hot-keys within reach of the left hand, as shown in Figure 1. Second, the auxiliary display may cause view separation problems [3], as numerous eye movements are required between the computer screen and mobile phone. However, Tan [6] has shown that the effect of visual separation is relatively small, as our experiment results show how the effect of visual separation can be compensated through the advantages of both direct manipulation and usage of the non-dominant hand.

Figure 1. In our interaction design, both the phone and hot-keys are in the control range of the left hand.

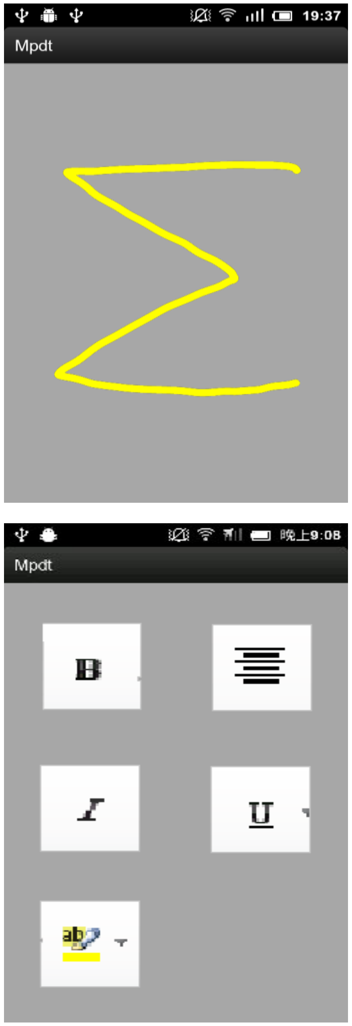

Figure 3. UI of MA for Symbol Input (left) and Button Access (right).

Interaction Design

The current version of MA supports two tasks: 1) Symbol Input, designed to input special symbols by performing gestures on touch phone; 2) Button Access, providing shortcuts on touchscreen for difficult-to-access buttons, making them easy to select with the non-dominant hand.

Technically, MA consists of two parts: a server running on PC and a client application running on a mobile phone. Users can touch the phone's screen with the non-dominant hand to generate corresponding commands. The server receives the command and executes it.

Symbol Input

To input a special symbol, a user can draw it directly on the touchscreen, as shown in Figure 3 (left). The client application can recognize the gesture and inform the server which symbol has been drawn. The server then inserts the symbol at the current location of the cursor. The users can configure the set of supporting gestures and respective symbols. Figure 2 illustrates the gestures and their corresponding symbols in our current implementation.

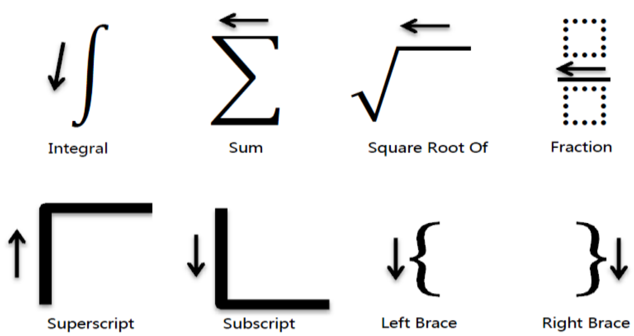

Figure 2. MA gestures for mathematical symbols.

Button Access

The interface of the client application for this task is mainly a table, with adjustable rows and columns. Each table cell contains a particular widget, as shown in Figure 3 (right). When a widget is tapped, the client application sends a TCP message to the server and a corresponding click action is simulated on the desktop.

The interface of server application contains a control panel. Once the user finds a button difficult to click, or without proper hot-keys, he can "move" this button to the phone. This is done by transmitting a screenshot of the target widget to the client. Further, users can personalize the arrangement of button icons. Given that the screen resolution of HTC Desire is 800 × 480 pixels, we recommend dividing the screen into 3 × 2 regions. This layout achieves a reasonable balance between the number of widgets and their accessibility.

User Study

We conducted an experiment investigating its performance when completing tasks in MS Word. Two tasks are designed: inputting a list of mathematical formulas and completing a series of formatting adjustment operations (e.g. adjusting the font and style of words, adjusting paragraph alignment). Users are required to complete these two tasks with and without MA support, which results in 2 x 2 combinations.

Fifteen students were recruited from the campus, all of them right-handed, familiar with MS Word, and using left hand to interact with MA. The completion time and error ratio of each task were recorded. Besides, an interview-based survey was conducted after the experiment.

Results (Table 1) showed that, the completion time of both tasks were significantly reduced (approximately 20%) when using MA; the error rate of MA is acceptable (about 3.6%). The post-experiment interview showed that subjects perceived no difficulty in becoming familiar with MA with the non-dominant hand.

Completion Time (ms) / Error Rate (%)	**Without MA Assisted**	**With MA Assisted**
Formula Input	202285 / -	156705 / 3.6
Format Adjustment	121388 / -	97644 / 0.0

Table 1. Results of two experiment tasks.

Conclusion

MA can significantly increase the interaction efficiency, as proved in our user study, by providing shortcuts for those difficultly accessible but frequently used GUI widgets. The proposed method combines advantages of both direct manipulation and the non-dominant hand usage.

Our future work includes improving the gesture recognition ability of MA and applying MA techniques to other desktop tasks. Furthermore, as mobile phones are highly personalized and can be carried around, user information and preferences would also be useful in refining this interaction technique.

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