

SmartPad: A Finger-Sensing Keypad for Mobile Interaction

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ABSTRACT

This paper introduces SmartPad, a new input device for mobile computers that is an enhanced physical keypad by a finger position sensor. This input device acts as a normal keypad for mobile devices, such as cellular phones, and also recognizes finger position on the keypad before the user presses the key. This feature is used to recognize finger gesture on the keypad, and can also be used to give preview information to the user before the user actually pressing the key. This previewable function helps users to predict the effect of the action, and it is also helpful when the key definitions are frequently changed according to the context, such as in the case of universal commanders.

Keywords

mobile devices, predictable user interface, touch-sensitive user interface, SmartSkin

INTRODUCTION

As mobile devices become common, designing effective interaction methods for those devices also becomes important. Unlike desktop computers, input devices for mobile computers often restricted with its limited size. As a result, multiple functions must be assigned to the same buttons, and it makes user interfaces complicated and unpredictable.

This paper proposes a new input device for mobile device, called SmartPad. SmartPad combines two input sensors; one is a normal physical keypad, and the other is a finger position sensor based on capacitive sensing (Figure 1). The position sensor recognizes finger proximity to the keypad, and position of the finger before the user actually presses the button. This feature enables two new input modalities. One is gesture sensing and the other is previewable interaction.

Figure 2 shows the sensor configuration of the SmartPad device. Combined with arrayed capacitive sensor, which is



Figure 1: A cellular phone keypad with an embedded SmartPad sensor. The recognized finger position appears on the screen.

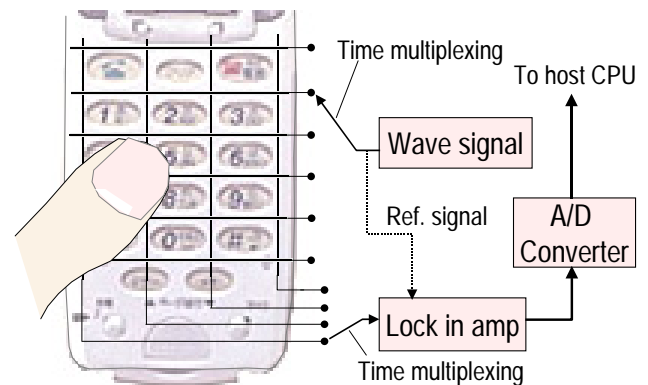


Figure 2: SmartPad sensor configuration: An arrayed electrode sensor detects finger position on the keypad. (Note: electrodes are embedded in the keypad.)

based on SmartSkin [5]. A grid of electrodes is embedded in the keypad surface (between keypad buttons), and each electrode intersection acts as a capacitive proximity sensor. The system interpolates these proximity values and detects a finger position. Figure 1 shows the obtained sensor value (appeared on the screen) and corresponding finger position.

GESTURE RECOGNITION

SmartPad can be used as a gesture input device as well as a normal keypad. For example, wiping on a keypad surface with a finger can be treated as a special command, such as turning the page (Figure 3 left). Normal keypad operation and this gesture can be distinguished by measuring finger

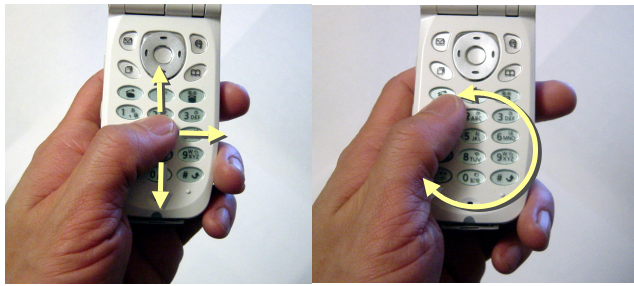


Figure 3: Gesture interface with SmartPad. (left) wiping, (right) virtual jog, (C)

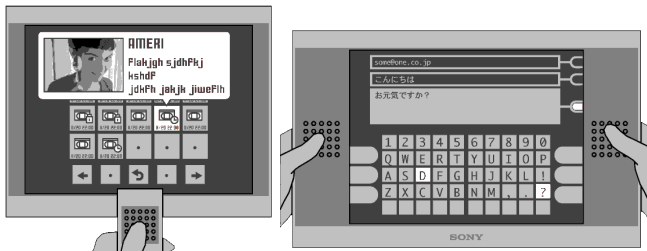


Figure 4: Examples of previewable physical interactions: (Left) See preview information before actually selecting it. Right: Key assignment visualization).

motion speed (i.e., gesture motion is much faster than finger motion during normal keypad operations).

Another example is a virtual jog dial (Figure 3 right). When a user makes circle motion with the finger, the system enters the jog dial mode. The user rotates the finger on the keypad, and this motion is treated as a jog dial rotation. Item selection can be performed by quickly lifting the thumb from the keypad surface.

PREVIEWABLE INTERACTION

The other function of SmartPad is its previewable capability. When dealing with physical input devices, such as buttons, preview information is normally unavailable; we can only see the result *after* pressing the button. This situation is quite different from GUI-interactors where preview information (e.g., tooltips) can easily be provided. Preview is much more important in the physical world than GUI, because undoing is often unavailable.

SmartPad propose a new interaction paradigm, which is called "previewable physical interactions". With SmartPad a user can first put his/her finger on the keypad, and preview information would appear on a screen, according to the finger position. Then a user commits the previewed command by physically pressing the button. Although similar interface can be implemented by a combination of arrow keys and a selection button, SmartPad's finger motion and key pressing is much faster than those alternatives.

Figure 4 shows examples of previewing. Figure 4-left shows a user is selecting appropriate item by sliding his/her finger

on the keypad. The screen displays corresponding information according to the finger position, and the user can commit a selection by physically pressing the button. The other example (Figure 4-right) shows a combination of software keyboard (on the screen) and small physical keypad. The user can see corresponding character on the screen before typing it. Even when the keypad is not large enough to print key-top labels, the screen preview information can help the user. This feature can also support multiple function keypads. For example, when a mobile device is used as a universal remote commander, keypad functions might change according to the current operation mode. With SmartPad, the user can quickly confirm what is assigned to the particular button before pressings it.

RELATED WORK

This work is inspired by the previous sensory enhanced mobile devices, such as [1, 2]. While these devices use additional sensor as a new (separated) input mode, we are more interested in enhancing existing input device (e.g., keypad) by sensors. SmartPad is a kind of "touch-sensing user interfaces" [3], but unlike previous systems, it also incorporates finger motion on the surface as well as finger contact.

CONCLUSION AND FUTURE WORK

This paper presents SmartPad, a new input device that combines physical keypad with position sensor. We are currently developing various applications using this device, implementing different key/sensor configurations (e.g., one-dimensional line of buttons), and planning to conduct a formal user study. We are also interested in adding a tactile feedback actuator [4] to this device.

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