Forearm Menu: Using Forearm as Menu Widget on Tabletop System

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Abstract

In this study, we propose a menu interaction technique that utilizes the forearm (the part of the arm between the elbow and the hand) on direct input surfaces such as tabletop systems. On such systems, users commonly operate various types of data, such as images, video, audio, and documents, using menus for each type of data. In this study, we focus on the space on user's forearms as a very easy-to-access area for displaying a menu to control the data in operation. In addition, since the tabletop surface and the forearm can be used as different layers, they can be divided into a "working area" and an "area for menu operation." Thus, a menu can be displayed without being hidden by the hand or forearm.

Author Keywords

Forearm; Interaction Techniques; Tabletop system; Menu.

ACM Classification Keywords

H.1.2 [Models and principles]: User/Machine Systems-Human factors; D.4.7 [Operating systems]: Organization and Design - Interactive systems; H.5.2 [Information interfaces and presentation]: User Interfaces - Interaction styles.

Introduction

Various types of data such as images, video, audio, and documents can be operated on tabletop systems. Users

(a) Document Menu

(b) Video and Audio Menu

Figure 1. Forearm Menu: Various types of data such as images, video, and documents are present on the tabletop system. To work with these data from the Forearm Menu, the user first touches a data type with their finger. Next, a menu appropriate for the selection appears on the forearm (automatically superimposed over the position and orientation of the forearm). By touching or scrolling this menu, the user can interact with each data type.

usually interact with the data from a menu that is different for each data type. Choosing the location and method of displaying a menu on a tabletop system is often problematic.

Several studies have focused on the display of menus on direct input surfaces such as tabletop systems. Bailly et al. [1] developed MultiTouch Menu, in which users can display a menu around their hand when it is placed on the tabletop system. To avoid the menu being hidden by the hand or forearm, Brandl et al. [2] proposed a method for displaying a pie menu on the basis of the location of the tip of a pen and the user's hand. Yoshikawa et al. [4] developed HandyWidgets, in which users can display a menu in the desired direction near their hand by performing a bimanual multi-touch gesture. Moreover, by displaying the menu on top of a specific type of data, users can change the parameters of the specified data. However, in these menus, the data could be hidden by the menu during operation.

Regarding the use of the forearm as a display area and an interactive surface, Harrison et al. [3] developed OmniTouch, a wearable depth-sensing and projection system that enables everyday surfaces to be used as interactive surfaces. It also enables the display of a menu on the forearm and recognizes touch gestures on it. In the aforementioned work, the focus was on utilizing everyday surfaces involving forearms as interactive surfaces. In contrast, we focus on the connection between the data displayed on a tabletop system and the menu displayed on the user's forearm to control the data on the tabletop system.

In this paper, we propose an interaction technique that utilizes the space on a user's forearm to display a menu and use it to control the data in operation (Figure 1).

By considering the advantages and disadvantages of existing menus and those proposed in related work, we aim to develop an easy-to-access and occlusion-free menu by displaying it on the user's forearm.

Menu Classification
First, existing types of menus are classified and their disadvantages are discussed, along with the proposal of a menu that overcomes these disadvantages.

Menu Bar
A Menu Bar is a menu displayed on the side(s) of the tabletop system (Figure 2 (a)). Tabletop systems usually have a large display area, which makes it difficult for the user to reach the Menu Bar when it is displayed to the left, right or on the opposite side of the user. When the menu is displayed on the near side of the user, the person's forearm might hide it and cause unwanted operations. Such type of menu does not have a strong connection between the target data and the menu because the menu is positioned far from the data. Thus, it is difficult for the user to understand which data is being operated on.

Menu Window
The position and orientation of a Menu Window can be changed at will by the users (Figure 2 (b)). Such type of menu might disturb the user's work, because 1) it is always displayed, 2) it might be hidden by other data making it hard to operate, and 3) some users might find it bothersome to locate the menu every time they need it as the menu position is not fixed. Similar to the Menu Bar, this type of menu has a loose connection between the data and the menu.
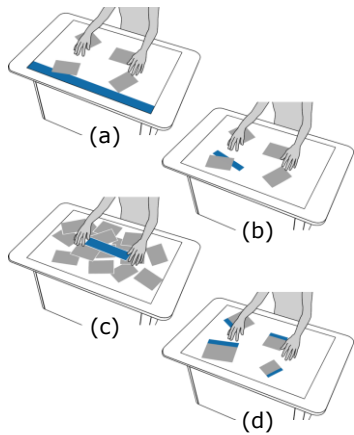
Figure 2. Menu Classification: (a) Menu Bar displayed on the side opposite to the user, (b) Menu Window hidden under other data, (c) Pop-up Menu hiding other data, (d) Data Side Menu adjusts to the scale and rotation of the data.
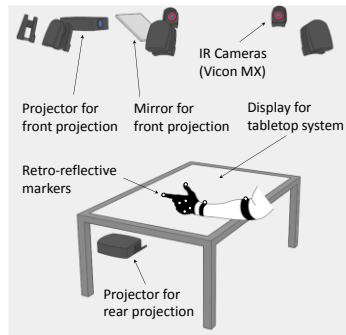

Figure 3. System configuration

Pop-up Menu

A Pop-up Menu is displayed by a touch gesture or by placing an object such as a hand, forearm, or tangible device on the tabletop system (Figure 2 (c)). Related works [1, 2, 4] can be classified as a Pop-up Menu, where users can decide the position and orientation of the menu at will. However, since the menu is displayed on the same layer as the data, there is a chance of some data being hidden by the menu.

Data Side Menu

Data Side Menu is a menu displayed on one side of the data (Figure 2 (d)). Such type of menu has a strong connection between the target data and the displayed menu. However, it can be difficult to operate, for example, when image data is scaled or rotated and the menu adjusts to this operation.

The Concept of a Forearm Menu

Here, we propose the Forearm Menu, which is projected on the user's forearm. When a user touches data with their finger, the appropriate menu appears on the forearm and they can operate the data by touching or scrolling the menu with the fingers of the other hand.

By displaying the menu on the user's forearm, many disadvantages listed in the previous section can be overcome. There are several benefits of a Forearm Menu. 1) The menu is always displayed on the forearm and hence is easy to access, and the user does not need to look for the menu, like in the case of a Menu Window. 2) Because the tabletop system and the forearm can be used as different layers, we can divide them into a "working area" and an "area for menu operation," enabling an occlusion-free menu. 3) Compared with the menus displayed on the tabletop system, it can reduce undesired operations through

unintended touch from the hands, arms, and sleeves. 4) The connection between the target data and the displayed menu is strong because the menu is only displayed when the target data is touched; therefore, the user will not be confused about the data in operation.

Implementation

System configuration

The touch input and forearm position is detected by a ViconPeaks motion capture system. It uses infrared technology to enable tracking of retro-reflective markers. The program estimates the positions of the fingers and the position and orientation of the forearm by detecting markers mounted on the fingers and forearm. We used a motion capture system to develop the pilot system, but we propose that this could be replaced by another low-cost tracking system. The display for the tabletop system uses a projector placed under the tabletop (rear projection) while the menu displayed on the forearm uses a projector placed above the tabletop (front projection).

Operation

The Forearm Menu is displayed and operated by performing the following procedure (Figure 4):

(1) Touch the data object of interest with a finger.
(2) The system then displays a menu appropriate for the selected data and fits it into the position and orientation of the forearm.
(3) The user can operate the menu with a finger of the other hand.
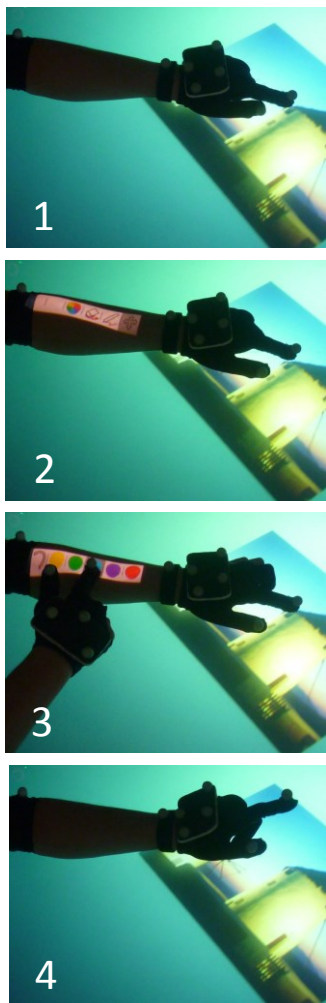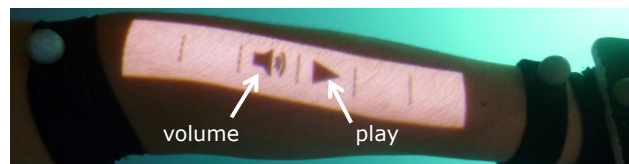(4) The menu will be hidden by releasing the finger from the data.

1

2

3

4

Figure 4. Operation procedure: When the user touches the image data, the system will displays the image menu.

*Examples of Implemented Forearm Menus*

(a) Image Menu: From this menu, users can draw on the image data by selecting a pen, color selector, and eraser icon.

(b) Video and Audio Menu: From this menu, by selecting the corresponding icons, users can play, pause, and resume video and audio data and can adjust the volume by scrolling its volume bar (Figure 5 (a) (b)).
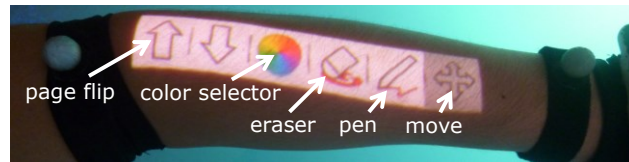
(c) Document Menu: Similar to the image menu, users can write characters on the document with a pen tool and erase it with an eraser tool using this menu. Users can also flip pages forward and backward (Figure 5 (c)).

volume   play

(a) Video and Audio Menu

back   scroll bar

(b) Volume bar

page flip   color selector

eraser   pen   move
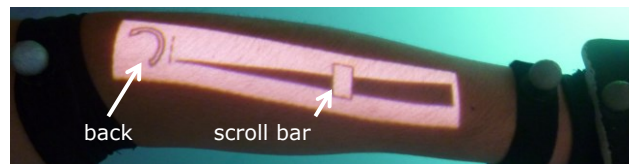
(c) Document Menu

Figure 5. Example of Forearm Menu

Conclusion and Future Work

In this study, we demonstrated using the space on a user's forearm as an area for displaying a menu and proposed an interaction technique to realize an easy-to-access, occlusion-free menu for tabletop systems. With this technology, it is possible to overcome many of the difficulties present in existing types of menus. We believe that when several data types on a tabletop system is to be manipulated, the Forearm Menu can make operations easier and more comfortable for the user.

Future work will focus on further evaluation of the Forearm Menu and the implementation of other interaction techniques that will make effective use of the connection between the space of the tabletop system and user's forearm. For example, by using the forearm for data storage, the user can see what data is stored by performing gestures such as hover, pinch, and touch.

References

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