An Interface with Weight: Taking Interaction by Tilt beyond Disembodied Metaphors

Daniel Fallman

Interaction Design Lab
Umea Center for Interaction Technology
Umea University Institute of Design
SE-901 87, Umea, Sweden
daniel.fallman@dh.umu.se
http://daniel.fallman.org

Abstract. We propose a novel way of using tilt as a style of interaction for palmtop computing, as well as a theoretical base for doing so. Beyond superficial and disembodied metaphors, the force of gravity has been chosen to guide navigation within a space larger than the palmtop's screen. Gravity allows the user to experience 'an interface with weight'; an understanding put forward as embodied which diverge from previous implementations of tilt interaction, as both the input style as well as the interface answer to the physical world.

1 Introduction

Mobile information technology, such as palmtop computers and cellular phones, is rapidly gaining ground as a new paradigm in computing. While their computational power increase dramatically, concerns remain regarding human—computer interaction issues, caused primarily by small form factors. In current research, inadequate input methods and small screens for output have been suggested as the two main barriers which confine usability in mobile computing [7]. Several suggestions on how these problems should be approached have been put forward. A growing body of research suggests that physical configurations of mobile devices should be determinant of their operation [2][3][7], following a trend in HCI away from dependency on superficial metaphors towards the phenomenological notion of embodiment, where meaning is created through engaged interaction with artifacts within the physical world [1]. This advance is also evident in exploration of tangible aspects of virtual phenomena [4].

1.1 Tilting as a Means of Interaction

Tilt has been previously suggested as an input method to ease interaction with palmtops. When utilized, tilting the device itself becomes the means of interaction, i.e. the way the user produces input to the system, as opposed to using a traditional stylus pen or a small-sized keyboard. Through tilting, computer devices could also be under-

stood as embodying their interfaces, making the device as a whole an interface [2]. Previous work in the field has been largely concerned with scrolling and pointing on graphical user interfaces, and for various kinds of menu selection [2][3][7].

2 Beyond Disembodied Metaphors

Previous implementations of palmtop tilt interfaces tend paradoxically to rely on metaphors and interaction abstractions similar to those that their authors reject—e.g. where tilt is used to control a pointer on the screen—or they introduce new metaphors with equally superficial connections to the physical world—e.g. where tilt left is used to scroll the screen to the left. This latter is a metaphor suggested by for instance aircraft and motorcycle maneuvering, but with weak connections to computer interface control. We recognize and draw on such previous work concerning this style of interaction, but our contribution is to found embodiment not only in terms of the input method, but also in terms of the feedback given to the user. In doing so, we intend to deepen the user's experience and take a step further away from resorting to disembodied metaphors to guide HCI design, by connecting the virtual world with the physical in terms of both input and output, corporal intimacy, and multimodal interaction.

2.1 Gravity Embodied

The force of gravity was chosen as the common denominator between the human user and the computer system, a form of shared understanding substantially deeper than a traditional user interface metaphor. In HCI, metaphors have traditionally been understood as devices for conveying a complex of concepts by presenting one thing as if it were another [6]. In contrast, Lakoff & Johnson [5] provide a thorough understanding of metaphors, in which they suggest that our mind operates by them—i.e. that we always think metaphorically—and that our everyday experiences are shaped by different kind of metaphor. Through language, we often tend to structure experience in terms of spatial orientation, viable in expressions such as *'I am feeling down'* and *'things are looking up'* [5][6]. From the perspective of the metaphor used for interaction in this prototype, it should be noted that Lakoff & Johnson suggest that meaning is fundamentally rooted in basic, bodily experiences of us residing in physical bodies with certain configurations, located on a planet with certain characteristics. Among these characteristics, gravity takes a principal position [5]. Hence, according to Lakoff & Johnson, at the core of the human mind is an embodied understanding of gravity.

Gravity *per se* can be defined as the force that attracts a body to the center of the earth or to other physical body having mass. Implemented in software and used in the context of a palmtop graphical user interface, the law of gravity provides the user interface the property of having weight and as such affords a basic understanding of a device's mode of interaction and explains its behavior. Use of software gravitational models is also frequent in related fields of research, e.g. computer generated graphical

effects, 3D animation, Virtual Reality (VR), and perhaps most prominently and frequently so in computer games.

3 Prototype Implementation

The research context for this prototype implementation is a large, ongoing multidisciplinary project funded by Swedish industrial company ABB; established to explore novel ways of interacting with mobile information technology suitable for assembly manufacturing settings. The work presented here transcends this particular use context, as the prototype has been designed and tested as a generic interaction technique with a graphical user interface free from assembly manufacturing specific information.

3.1 Interaction by Gravitational Tilt

A starting point and a working hypothesis for the project was that if we consider tilt as an interaction style, we will probably need to design the actual user interface in a way that answers to alleged benefits of the new interaction paradigm, rather than to force tilt to operate on a WIMP style interface originally designed for a 2D input device, such as a mouse. Our assumption was that this would do justice neither to traditional GUIs nor to tilt as an interaction style.

The basic setup of the prototype interface provides the user with a number of screens (320x240 pixels) aligned horizontally next to each other, each of which offers conceptually related functionality to its close neighbors. The number of available screens is dynamically determined by the executed application. Navigating the application's interface is hence a matter of horizontal scrolling of a flat surface, which is typically substantially larger than the palmtop screen. Selection is made by finger tapping the screen. A custom made tilt sensing device with two degrees of freedom, resembling a gyro sensor, is connected to the palmtop device. A model of gravity is implemented in software, controlling the user experience of the interaction where the interface slides one screen at a time in the direction the palmtop is tilted—hence in the direction opposite to which scrolling by tilt is typically implemented.

Acceleration of the sliding surface is based on a software model of gravity, and altering the 'friction' to the surface on which the interface is seemingly placed controls acceleration and sensitivity, adding to the user experience of having an interface with weight. Alternating the angle of the device hence controls the scrolling speed, which for instance allows for easy switching between two screens, quickly browsing a number of screens, returning rapidly to the leftmost screen, etc.

3.2 Technology Implementation

A custom made tilt device has been designed for this project, consisting of small, inexpensive, and standard electronic components. An AVR 2313 microcontroller is

connected to a 2G accelerometer with PWM output (ADXL202). The tilt sensor's signal is sampled by the AVR and transmitted to a Compaq iPAQ through a RS232 serial communication link.

4 User Evaluation and Future Work

Preliminary user testing (n=6) suggests that the proposed 'interface with weight' style of interaction is useful for navigating through the prototype system's different screens, that subjects very quickly seem to learn to control the interface and predict its behavior, and also that it is rated highly on a subjective scale of acceptance and appeal. A more systematic evaluation is being designed. Earlier in-house tests suggest, however, that it is much less useful for also controlling traditional interface widgets on these screens. The working hypothesis is that this is because the embodiment relation that is established between the user and the system for navigating between different screens is broken when interface widgets instead become the focus of attention. Operating widgets by tilt seems not to bring about embodied activity, possibly so because there is no natural mapping between gravity and the operation of these widgets.

These early user assessments have had two impacts: first, we have iteratively redesigned the interface to better fit the tilt style of interaction; and second, a larger quantitative study on the relative merits of tilt as a style of interaction is being designed to examine different ways of navigating a space larger than the actual screen.

5 Conclusions

This paper has presented ongoing work on exploring ways of interacting with mobile information technology. Primarily, we have proposed, explained, and discussed a novel way of using tilt as an interaction style to navigate a space larger than a palmtop screen. The notion of gravity has been introduced as the metaphor that forms a shared means of understanding between the user and the system, with the purpose of making the act of virtual navigation physical. Theoretical support for the use of gravity in this context has too been pointed out, drawing primarily on the work of Lakoff & Johnson.

References

1. Dourish, P.: Where the Action Is: The Foundations of Embodied Interaction, MIT Press. Cambridge MA (2001)
2. Fishkin, K.P., Gujar, A., Harrison, B.L., Moran, T., Want, R: Embodied User Interfaces for Really Direct Manipulation. Communications of the ACM, Vol. 43, No. 9 (2000) 74–80

3. Harrison, B.L., Fishkin, K.P., Gujar, A., Mochon, C., & Want, R.: Squeeze me, Hold me, Tilt me! An Exploration of Manipulative User Interfaces. Proceedings of CHI'98. ACM, Los Angeles CA (1998) 17–24
4. Ishii, H. & Ullmer, B.: Tangible Bits: Towards Seamless Interfaces between People, Bits, and Atoms. Proceedings of CHI'97. ACM, Atlanta GA (1997) 234–241
5. Lakoff, G. & Johnson, M.: Metaphors We Live By. Chicago University Press (1980)
6. Lund, A. & Waterworth, J.A.: Experiential Design: Reflecting Embodiment at the Interface. Computation for Metaphors, Analogy and Agents. University of Aizu, Japan (1998)
7. Rekimoto, R.: Tilting operations for small screen interfaces. Proceedings of UIST'96. ACM, Seattle WT (1996) 167–168