Ubiquitous Grasp Interfaces

Katrin Wolf
Technical University Berlin, Quality & Usability Laboratories
katrin.wolf@acm.org

ABSTRACT

Sensory hand augmentation extends the manual function spectrum from controlling analogue objects to digital or smart objects but also might add an interface to any graspable thing and therefore add a digital interface to everyday objects. We propose a finger-attached interface to control grasped objects intended to explore design parameters for always available interfaces. Our device detects finger motions and classifies them according to a set of five gestures. In user studies we found that our gesture classification has a stable performance with respect to different organic-shaped surfaces. Finally, the scalability of our approach towards generic object control will point out its potential.

Author Keywords

Grasp; back-of-device; gesture; seamless; wearable.

ACM Classification Keywords

H5.2 [Information inter-faces and presentation]: User Interfaces. - Input Devices and Strategies

General Terms

Design, Human Factors.

INTRODUCTION

Weiser's vision of ubiquitous computing is approaching a more realistic level nowadays as technology that can support ubiquitous interfaces has been developed, is affordable and users are becoming less afraid of always being surrounded by and connected to devices. The vision that any working and living environment, as well as any everyday object could become interactive seems to be close; however so far input devices that are decoupled from an output device are rare. Gestures are an input technique that allow input and output devices to decouple easily. For instance, cameras allow gesture detection from a distance but limit the mobility of the user as they are usually installed in the environment. Much more mobility is given if the sensors are built in mobile devices; but then the detection of gestures is usually strongly coupled with the device. Our aim is to explore the opportunity of grasp-based

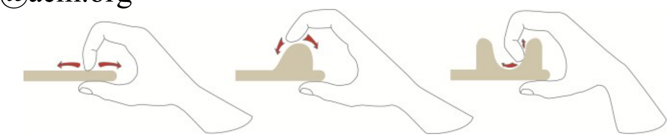

Figure 1. A form factor based surfaces classification is proposed for testing the ubiquity of a gesture set and a gestural input device: 1) flat 2) convex 3) concave.

interfaces that are physically decoupled from the grasped device. We believe that this is intuitive and natural: our analogue / manual skills are embodied in our hands. Therefore a hand-worn interface could provide ubiquitous accessibility to digital functions, which we understand as augmenting manual skills of the user. In this paper a basic gesture vocabulary consisting of tap, drag, swipe, pitch, and release gestures was identified, all of which work reasonably well while grasping objects. This is however, not the case for the common pinch gesture. Here the hand that executes the gesture always has to release the device completely. A motion sensing interface that is attached to users' fingers shows both equally good feasibility as well as stable classification of all gestures across all shapes; we discuss the benefit of simplicity of interaction and interface design and conclude with framing our findings within the context of mobile ubiquitous computing.

RELATED WORK

As the grasping fingers are located at the back of a grasped device, we mainly extend the concept of back-of-device interaction [1,9] through exploring ergonomic aspects of gestural interactions while grasping.

Harrison *et al.* [3], Saponas *et al.* [6], and Rekimoto [5] measure natural finger gestures by various signals, such as acoustic signals, electromyogram (EMG), via electrodes that record forearm movements. The *Body Coupled FingeRing* [2] allows discrete commands (finger-tip typing actions) to be detected using an accelerometer, while *Ubi-Finger* [7] uses bend sensors and acceleration for measuring finger movements in order to control continuous parameters, such as scroll bar or volume. We propose using acceleration sensors in combination with gyroscopes for detecting discrete as well as continuous commands, as they are smaller and less impairing than bend sensors and could therefore easily be included in jewellery. Moreover, this sensor combination is very promising for an even more nuanced gesture classification than the tap recognition done by Fukumoto *et al.* [2] through just using acceleration sensors. In contrast to related work, the proposed interface is designed for different objects that are represented through different form factors.

TEI 2013, Feb 10-13, 2013, Barcelona, Spain.

GESTURE BASED GRASP INTERFACE

Gesture vocabulary

The vocabulary of a gesture set that is performed by the fingers of a grasping hand is constrained by various parameters, such as feasibility, learnability, detectability by the sensing technology and distinguishability from natural movements. In an initial experiment, we did expert interviews with physiotherapists who were asked what finger movements would be possible with the three main grasp types: palm, pad, and side [10]. We collected 21 gestures that were also evaluated with respect to their feasibility for every single finger. The experts identified tap and touch based gestures that were performed through tapping and touching as well as moving fingers above the surface of grasped objects.

Gesture sensing

Our prototype consists of two IMU Digital Combo Boards with nine degrees of freedom through a gyroscope (ITG3200), an accelerometer (ADXL345), and a magnetometer (HMC5883L), which communicate over an I2C interface with an Arduino Nano V3. We were classifying the gestures through peak detection (tap, release via accelerometer), tilted fingers (pitch via gyroscope), directional accelerated movements (swipe via accelerometer), and position readjustment (drag via magnetometer).

Summary: Simple puzzles for a big picture

We are fully aware of the simplicity of our interface and gestural interaction design and have chosen the design to be as simple as possible, in order to rely on users' embodied knowledge about gestures, because everyday objects might not have a screen and therefore lack in affordances. The proposed gestures already allow function associations, such as increasing listening volume by dragging or swiping up. Therefore, relying on established human-computer semiotics is basically the best strategy for designing easy-to-use interactions that intuitively allow all kind of everyday objects to be controlled.

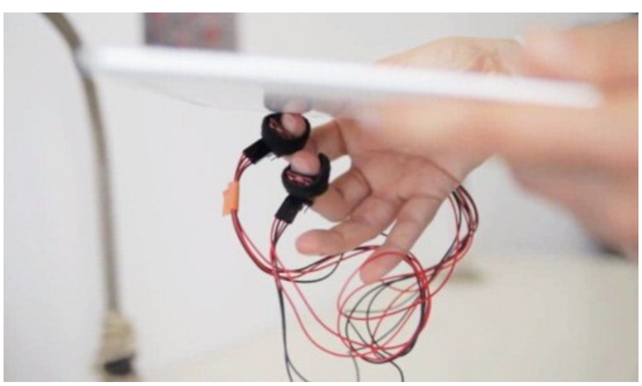

Figure 2. The prototype that is a fusion board containing an accelerometer, a gyroscope, and a magnetometer detects finger movements.

SCALABILITY TOWARDS MOBILE UBICOMP

In a first step we identified a gesture set that can be executed easily while grasping, learnt quickly or even known intuitively, and detected and classified in a stable and reliable manner when performed while holding any kind of object, irrespective of the shape it has: flat, convex, or concave [11].

In future work, we will consider how to connect our interface to all kinds of devices, in order to allow ubiquitous control of any object that surrounds us. This work aims to contribute to ubiquitous computing [8] especially for changing environments where gesture detection through cameras is unsuitable.

ACKNOWLEDGMENTS

I wish to thank Sebastian Möller, Michael Rohs, and Robert Schleicher for their great support and supervision of my dissertation.

REFERENCES

1. Baudisch, P., Chu, G. 2009. Back-of-device interaction allows creating very small touch devices. In *Proc. CHI 2009*, 1923-1932.
2. Fukumoto, M. and Tonomura, Y. 1997. 'Body coupled FingeRing': wireless wearable keyboard, In Proc. *CHI 1997*, 147–154.
3. Harrison, C., Tan, D. Morris, D. 2010. Skinput: Appropriating the Body as an Input Surface, In *Proc. CHI 2010,* 453-462.
4. Ketabdar.H., Yüksel, K., Roshandel, M. 2010. MagiTact: interaction with mobile devices based on compass (magnetic) sensor. In *Proc.* IUI 2010, 413-414.
5. Rekimoto, J. 2001. GestureWrist and GesturePad: Unobtrusive Wearable Interaction Devices, In *Proc. ISWC 2001*, 21-27.
6. Saponas, S., Tan, D., Morris, D., Balakrishnan, R., Tuner, J., Landay, J. 2009. Enabling Always-Available Input with Muscle-Computer Interfaces, In *Proc. UIST 2009,* 167-176.
7. Tsukada, K., Yasumura, M. 2002. Ubi-Finger: Gesture Input Device for Mobile Use, In *Proc. APCHI 2002*, 388-400.
8. Weiser, M.: The computer for the 21st century. Scientific American (1991) 94-104.
9. Wigdor, D., Forlines, C., Baudisch, P., Barnwell, J., Shen, C. 2007. LucidTouch: A See-Through Mobile Device, In *Proc. UIST 2007*, 269-278.
10. Wolf, K., Naumann, A., Rohs, M., Müller, J. 2011. Taxonomy of microinteractions: defining microgestures based on ergonomic and scenario-dependent requirements. In *Proc. INTERACT 2011*, 559-575.
11. Wolf, K., Schleicher, R., Kratz, S., Rohs, M. 2013. Tickle: A Surface independent Interaction Technique for Grasp Interfaces. In Proc. *TEI 2013*, 8 pages.