Interactive smart mirror

Benedikt Martens, Dominik Bittner, Dieter Meiller, Martin Frey, Ulrich Schäfer, Dominikus Heckmann

Department of Electrical Engineering, Media and Computer Science, OTH Amberg-Weiden

Abstract

We describe hardware design and software development of a low-cost interactive smart mirror. The project uses a one-way mirror with a LCD screen mounted behind to display information to a user. Interaction is possible by using hand gestures which are recognized by an electrical near field sensor. A camera is used to identify fiducials printed on medication packs. The software runs in a Java environment on a microcomputer. The system is connected to the internet and uses multiple web-connected APIs to access content like E-Mail messages and calendar events.

1 Introduction

The device, an intelligent mirror was created as a student project in the course "Physical Computing" at the University of Applied Sciences Amberg-Weiden during the winter semester 2016/2017. It is an experiment into ubiquitous computing in a traditional, non technologized shell : a mirror. The main targets of Physical Computing, and important criteria during the creation of our project, were a low budget and a short timeframe of approximately three months for both hardware design and software development. Future expandability and adaptability were also considered during the design phase.

2 Related Work

Multiple projects concerning smart mirrors have been published in recent years. M. Anwar Hossain and Saddik, 2007 use an LCD touchscreen and camera to simulate a mirror. Meine, 2003 proposes the usage of a reflective surface and touch interface. Our contribution greatly reduces complexity and cost of the system by using a reflective surface and low cost hardware. Colantonio et al., 2015 use data primarily collected through imaging systems to diagnose symptoms indicative of cardiovascular disease and other chronic and common conditions. Compared to

Veröffentlicht durch die Gesellschaft für Informatik e. V. 2017 in
M. Burghardt, R. Wimmer, C. Wolff, C. Womser-Hacker (Hrsg.):
Mensch und Computer 2017 – Workshopband, 10.–13. September 2017, Regensburg.
 https://doi.org/10.18420/muc2017-demo-0286

this approach, our aim was to create a more personal system focused not only on therapeutic measures but life-assistance and connection to modern media in general.

3 Interaction

The core of the prototype is a RaspberryPi 3 microcomputer running Raspbian. It is connected via Camera Serial Interface port to a RaspberryPi Camera v1 and uses the I^2C bus to communicate with the Pimoroni Skywriter[1] gesture sensor. This electrical near field sensor can recognize swipes, taps and finger positioning to enable navigation across the interface. The currently displayed widget can be switched by swiping horizontally while vertical gestures and taps manipulate the widget. By using this sensor, no fine motor skills are required and the system complexity and cost are reduced compared to a large-area touch input.

4 Functions & Visualization

The prototype software was created using the free and open source Processing[2] sketchbook and language based on Java, which allows quick development of visual interfaces on a variety of hardware and operating systems. This made the simultaneous development and testing of hardware and software possible and shortened development times. Objects, including images, shapes and text are drawn to the two-dimensional canvas. Easy integration of software libraries simplifies the addition of new features. The Temboo[3] platform was used to simplify API calls to the connected services including Google Maps, Calendar and Mail. Calendar events, driving directions to popular destinations and incoming mail are displayed on the interface without the need for the user to access these services in the more complex environment of web browser.
BoofCV, a computer vision framework is used to identify fiducial markers added to medication boxes. When a code is identified by the software, a currently manually updated XML file is used to find an image of the medication, appropriate dosage, and next scheduled administration, which are then displayed to the user. A checklist with the prescribed drugs is also visible and can be used to ensure regular uptake in accordance to the schedule set by a medical professional. The usage of OpenCV, an alternative framework capable of facial detection was discontinued by us due to a lack of performance when executed on the limited hardware of the RaspberryPi.

The focal point of the user experience is a mirror with a 50“ diagonal. Just behind the glass, covered with a reflective sheet, an LCD monitor is used to display information, reducing the reflection where not black, thus displaying information to the user. In addition to a clock, the upper right corner is used to show the different widgets which can be gesture controlled by the user. The dimensions of the system guarantee readability and creates an impressive canvas for information visualization.

[1] https://shop.pimoroni.com/products/skywriter
[2] http://processing.org/
[3] https://temboo.com/

Figure 1: smart mirror

Figure 2: interaction

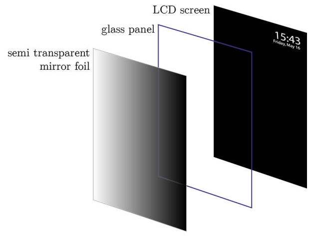

Figure 3: layer buildup

Every widget displays a logo of it's function in a prominent position. Below, the content is displayed in large writing. Additional design elements are added to visualize the relationship between information.

5 Future Work

In the future, we plan on expanding the functionality of our prototype. In addition to the gesture and camera as key interaction points, the inclusion of wearable devices could greatly enhance the user benefit. By tracking and connecting biometric data such as heart rate, blood oxygen or glucose levels, the device could be further specialized to aid the user in their daily life. Other, non wearable devices such as bluetooth scales could also be used to create a holistic overview of the users well-being. Emerging technologies such as ASR and speech dialogue could also be used to make the system more capable while maintaining simplicity. During further development of the prototype, we also plan on working closely with the intended target group to better understand specific needs for interaction. Surveys and rigorous testing will be needed as a basis of evaluating the interaction experience in the future. Due to the constraints of the prototype phase, this has not been closely studied yet.

6 Conclusion

Our project shows what is possible using a variety of hard- and software technologies today. Despite a short development time and a comparatively low budget, we were successful in reimagining an object of everyday use in terms of function, connectivity and intelligence. While we were able to realize most of the functions planned, the tracking of faces proved to be too much for the inexpensive hardware used. The electrical near field sensor, originally planned to be mounted between LCD panel and glass had to be repositioned due to the conductive properties of the reflective foil used. In terms of product design, this was a definite setback for us.

Acknowledgements

We would like to thank Christoph Müller and Gerald Weigl for their support during the creation process of the hardware for this project.

Contact

{b.martens,d.bittner,m.frey,d.heckmann,d.meiller,u.schaefer } @oth-aw.de

References

Abeles, P. (2016). Boofcv v0.25. http://boofcv.org/.

Colantonio, S. et al. (2015). A smart mirror to promote a healthy lifestyle. *Biosystems Engineering*, 33–43.

Kofler, M., Scherbeck, C., & Künast, C. (2014). *Raspberry Pi - Das umfassende Handbuch*. Galileo Computing.

M. Anwar Hossain, P. K. A. & Saddik, A. E. (2007). Smart mirror for ambient home environment. In *3rd IET International Conference on Intelligent Environments*.

Meine, R. K. (2003). *System and method for displaying information on a mirror*. US 6560027 B2.

Rosebrock, A. (2017). Pyimagesearch. http://pyimagesearch.com/.