Displayed Connectivity

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ABSTRACT

In this demo we motivate applications for using a set of small displays as tangible communication devices. In particular we investigate the effect of the chosen casing on the use. The displays are capable of displaying text and basic icons with a limited resolution and are connected wirelessly, either directly or over the Internet. Envisioned use cases are awareness scenarios like physical interfaces for status setting for instant messaging systems.

Keywords

Tangible User Interface, Ubiquitous Computing, Human-Computer-Interaction, Physical ICQ, Awareness systems

INTRODUCTION

In this paper we present the design and implementation of small independent displays that can communicate with each other. We show that such devices can be used for several domains like in awareness systems for setting the current state of the user (as is the case for most messenger programs). We conjecture that the tangibility of those small devices greatly increase the ease and frequency of using such functions.

Limited only by the design of the application, there can be an arbitrary number of devices communicating with each other. This can be done directly via radio frequency or through a gateway and the Internet.

COMMUNICATING DISPLAYS

To explore the application potential and to make informed decisions on the interaction design of connected display object we implemented a prototype.

Processing

Particle Computers [2] are small wireless sensor nodes. The hardware includes a microcontroller, wireless communication and memory. The nodes are powered by a single 1.2V rechargeable battery. The display board is designed as an add-on board to the base platform, see [1] for detailed information including schematic, layout, soldering instructions and part lists. The board includes two accelerometers and can connect up to 6 displays. In this project only one display channel per board is used. The hardware architecture can be seen in Figure 1.

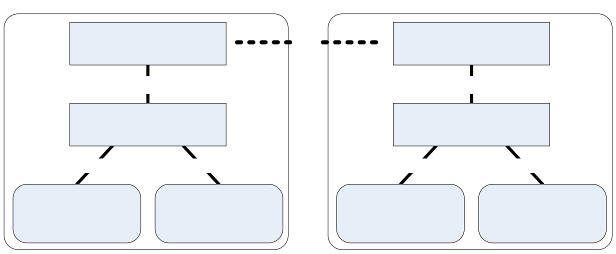

Figure 1: Connected display architecture for direct RF communication.

Detecting the State

Two accelerometers (ADXL311JE from Analog Devices) are orthogonally mounted. The accelerometers measure acceleration caused by interaction (e.g. gestures) as well as gravity. Only 2 dimensions are used as this is enough to figure out how the device is held or put on a table.

We associate a *state* with each possible stable position. The stable positions are affordances of the chosen housing design, one example is given in Figure 2. Depending on the design of the case there are at least 2 possible states but there can also be more than 10 different states.

Displaying the State

The add-on board attached to the Particle computer provides an I2C connection for a Barton BT94060 display. We developed code to display text and basic graphical shapes and icons. The display is black and white.

The screen resolution of 96x40 pixels is just enough to display a few lines of text or show representative icons. Text and images can be rotated in steps of 90 degrees so they should be readable in most possible states (with the exception of the display facing down).

Display Connectivity

Displays in RF range can directly communicate if this is needed by the application running on the platform. For displays with the need of communication over longer distances the connection is done over the internet. Using Particle Bridges (available as USB and Ethernet versions) or as peer-to-peer bridge, data can be sent from a PC to Particles in the neighborhood. We have developed a small web server that can be used to pass commands to such a display. These include writing text at a given position, drawing some graphics primitives like lines or ellipses and sending small 1-bit images. By specifying one of the unique Particle or Display IDs, specific devices can be controlled.

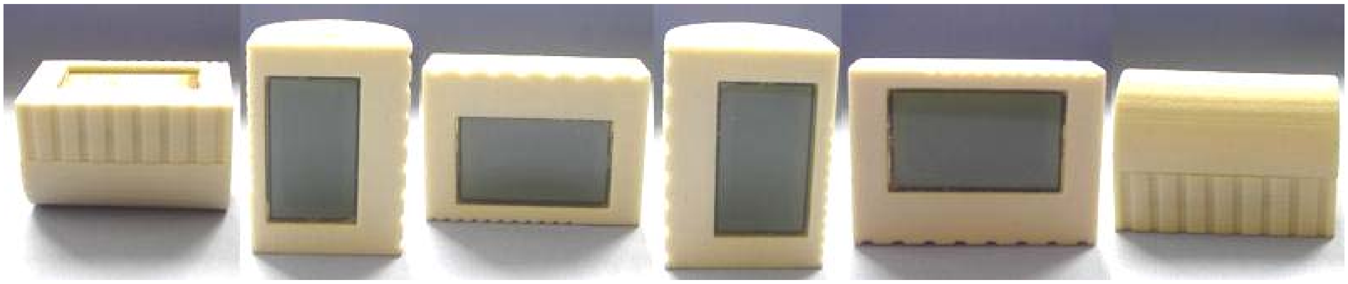

Figure 2. Six different states of the display that are stable and can be sensed by the included accelerometers.

CASE DESIGN

Using 3D printing facilities, we made a case that, depending on the position of the batteries and additional weights (and hence the centre of gravity for the display), allows for 4, 5 or 6 stable states. The design and 6 possible states are shown in the Figure 2.

The advantages of this design are:

- 4 or 6 states are suitable for many applications we have investigated so far
- the states are easily distinguishable and stable
- the display is visible from all (but one) state
- it explicitly allows to turn the display down (may be used similar to switching a mobile phone off)
- the size and weight of the appliance enables mobile use and the portability of the device.

In an informal evaluation the following shortcomings were identified, for which we are currently testing solutions:

- there is no way to change the possible number of states (there could be a design with additional foldable sides or an actuator that changes the center of gravity)
- content is only visual. (could use the built-in speaker or additional vibration motors for notification)
- there is no possibility for direct input (a microphone could be used to record voice)

When adding more functionality (like audio recording and transmitting), there is always a trade off between ease of use and a larger set of features.

APPLICATIONS

This section presents exemplarily two first applications of how to use one or several of such display devices.

I'm Currently Away from my Display

All kinds of communication services, e.g. awareness systems like messenger and chat clients are widely used across many platfroms. Besides very different designs and capabilities, most instant messaging tools have in common that users can set their state ("idle", "working", "away", …). Although most applications have some mechanism to find out about the state of the user (e.g. measure idle time, observe screen saver), however there are many situations where users should decide this themselves (e.g. it is extremely hard to find out when a user does not want to be contacted). Our observation so far indicates that people tend to forget to tell the system of any changes, e.g. when leaving for lunch. Especially if someone has several such systems, it can become tedious to alter all of them. Systems like Trillian may reduce the number of applications needed, but the problem of status setting remains. The tangible, unobtrusive, small displays can act as mediator between physical and virtual world, as "switch" that is easily and quickly turned. Feedback about the current state can be given by the case design itself or by presenting text or icons on the display.

Electing Display

Imagine several people each having one of those displays. Using the web server capabilities described in a previous section, someone can send a question or statement to the other displays. The other users can now use their devices to give a particular answer to that poll. The answers of the other participants can be visualized by short lines or dots on the display indicating which way they have placed their displays. Thus, it is also easy to quickly see the result of the poll. One scenario would be the synchronization of some task: The moment all points are lined up on the same side, everybody is prepared to go for lunch, home etc. This implies that it has been agreed upon the meaning of each possible state of the display. This can either be done explicitly or implicitly by having the same feedback on the display for all users.

CONCLUSION

We have shown the design and implementation for small devices that incorporate just a display for simple output and two sensors to find out the current orientation. Their tangibility and simplicity promise to of value for different applications, in particular as awareness UI.

ACKNOWLEDGMENTS

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