RFID Tag Reader System Emulator to Support Touching, Pointing and Scanning

Timo Tuomisto[1], Pasi Välkkynen[1], Arto Ylisaukko-oja[2]

[1]VTT Information Technology, P.O. Box 1206, 33101 Tampere, Finland
{Timo.Tuomisto, Pasi.Valkkynen}@vtt.fi
[2]VTT Electronics, P.O. Box 1100, 90571 Oulu, Finland
Arto.Ylisaukko-oja@vtt.fi

Abstract. Integrated 13,56 MHz RFID readers are appearing in mobile phones, enabling the selection of tags and communication in a user-friendly way by touching. We have built a system emulating UHF tags, supporting other physical selection paradigms in addition to touching: pointing by IR or visual light, and scanning of nearby tags. The system is based on RF communication and sensing units, SoapBoxes. The system will be used to study the feasibility and usability of the different selection paradigms in the context of physical browsing, in the case where the tag contains directly a URL to a web resource.

1 Introduction

Integrated RFID readers are appearing in mobile phones. They enable user friendly interaction with the information and services associated with our physical environment. If the tags contain URLs, the tags with their physical environment form an analogue to a web page and its hyperlinks. Analogously to using mouse to click hyperlinks, we may select and read the tags with our mobile phones by (virtually) touching the tags. We call this activity physical browsing.

In physical browsing, touching is not the only imaginable physical selection paradigm. By using UHF RFID tags the reading range of passive tags can be extended to several meters, enabling scanning the environment for tags. Development is also going on to integrate sensors with UHF RFID tags (e.g. EU FP6 MIMOSA project [3]). Pointing of tags can be based on for example photosensitive sensors in tags. Thus it is foreseeable, that the tags may be selected using touching, pointing and scanning [5].

Other systems implementing similar concepts have been built by for example Want et al. [6] and Kindberg et al. [2]. These implementations have been very application-centric whereas we have focused on building a generic user interface for the different physical selection methods.

In this paper, we introduce a tag reader system emulator, which expands the selection concept from touching to also pointing and scanning of nearby tags. The prototype will be used to evaluate the different physical selection paradigms in physical browsing. Its functionality is demonstrated with a poster equipped with emulated tags.

The Physical Browsing System

The physical browsing system consists of a tag reader system (physical browser) and tag emulators, which both utilise RF communication and sensing units, SoapBoxes [4]. The functionality of remote sensor equipped RFID tags are emulated by remote SoapBoxes and the functionality of a reader by a central SoapBox and a PDA.

2.1 SoapBoxes

SoapBox is a programmable device with RF receiver/transmitter and wired communications. It is also equipped with a measurement board with optional selection of sensors.

A typical SoapBox network consists of a central SoapBox, which is connected to a terminal device such as a PC or a PDA by a serial cable, and one or more remote SoapBoxes that can wirelessly communicate with the central SoapBox. The communication range is about 10 meters. The maximum bit rate is 10 kbps.

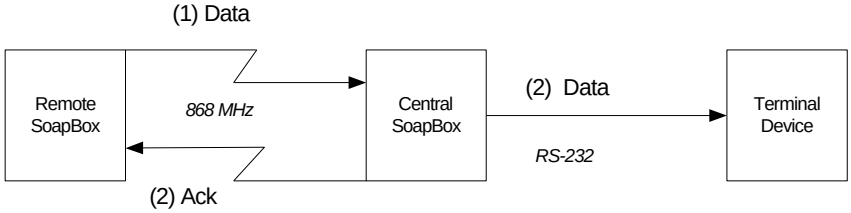

Fig. 1. Remote Soapboxes always start the RF-communication. The central Soapbox sends an acknowledgement message after reading the data.

The order of communication is shown in Fig. 1. Remote SoapBoxes can be programmed to send their data at regular intervals, or when a specific event occurs within the remote SoapBox.

The remote SoapBox sensor board is equipped with a light sensor to detect visible light, and a proximity sensor, which consists of an IR transmitter and receiver. The IR receiver in the proximity sensor is also used to detect the pointing signal emitted by IR LED of the central SoapBox. The remote SoapBox is programmed to regularly wake up from sleep mode, measure proximity, and detect the possible IR pointing signal.

2.2 The Physical Browser

The physical browser, i.e. the tag reader system, consists of a PDA (iPAQ 5400/5500 series) with a WLAN card and a central SoapBox with a laser beam unit. The central SoapBox is connected to the PDA by an RS-232 serial cable (fig 2).

Fig. 2. The physical browser components: iPAQ (left), central SoapBox (right) and a laser beam unit (middle). The SoapBox has a pointing button (shown in the middle of the SoapBox) to activate the laser unit and the IR-transmitter (visible in front of the SoapBox)

The user interface is managed by web browser (Internet Explorer), which is able to launch appropriate applications associated with different resource types depending on MIME type of the message, for example displaying video in a multimedia player.

The PDA has a lightweight personal HTTP server [1], which supports servlets. The HomePageServlet is used to construct and provide dynamic home page of available links when scanning, or when multiple tags are selected. The HomePageServlet also communicates via the SoapBox driver unit with the Java serial port driver for the PocketPC. The servlet can also invoke the default browser of iPAQ with a specific web resource (a URL) via system execute calls, if a unique tag (containing the URL) is selected. When presenting multiple links, the HomePageServlet launches the web browser with its own URL, so that the user may select the link from the PDA GUI, or try to select the tag again by touching or pointing.

3. The implementation of physical selection paradigms

The physical selection paradigms – pointing, touching and scanning – are implemented with remote and central SoapBoxes as follows:

For touching, the proximity sensor signal level is used to detect the proximity of objects. Whenever the measured reflected beam exceeds a certain threshold, the remote SoapBox data message is transmitted with low RF power to the central SoapBox. The range of low power transmission is about 10 cm. A flag indicating proximity is encoded in the data message. By using low transmission power, artefact detection caused by proximity of objects other than the reader can be eliminated.

Pointing by IR is initiated by pressing the pointing button (see Fig 2): initially the laser pointer is activated, and serves as a visual aid only. When the pointing button is

released, the IR LED pointing of the central SoapBox is activated. The IR signal is detected by the remote SoapBox, which then transmits the data message with normal RF power. A flag indicating pointing is contained in the data message. Different IR LEDs with different beam half angles ranging from +/-4 degrees to +/-12 degrees can be used. Extra nozzles attached to IR LED of the central SoapBox may further be used to reduce the pointing angle. Optionally, also pointing by laser and detection by illumination sensor can be used.

To mimic scanning, remote SoapBoxes work as beacons. They send regularly (programmable, typically every few seconds) their data messages to the central SoapBox. The HomePageServlet keeps track of available tags within the last 10 seconds. Scanning – presenting the dynamic home page with available tags – can be launched via one of the hardware buttons of iPAQ.

4. Discussion

The prototype presented is not truly a passive RFID tag system in the sense that reading is not initiated by reader device RF signal. Also proximity sensor signal is used in assistance to low power transmission to enable detection of touching. In real RFID tags the proximity signal may be omitted altogether. However, for the purpose of studying the user interface issues of physical browsing the user experience should remain intact. In usability studies we will for example test preferences between the different physical selection paradigms, whether a user wants to use a button for touching as well, and resolution preferences when pointing with different IR beam spatial angles or detection ranges.

References

1. Acme Java HTTP server, http://www.acme.com/java/software/Acme.Serve.Serve.html
2. Kindberg, T., Barton, J., Morgan, J., Becker, G., Caswell, D., Debaty, P., Gopal, G., Frid, M., Krishnan, V., Morris, H., Schettino, J., Serra, B. and Spasojevic, M. People, Places, Things: Web Presence for the Real World. Mobile Networks and Applications, Volume 7, Issue 5 (October 2002). 365-376. ISSN: 1383-469X.
3. MIMOSA, http://www.mimosa-fp6.com/
4. Tuulari, E. and Ylisaukko-oja, A. SoapBox: A Platform for Ubiquitous Computing Research and Applications. Lecture Notes in Computer Science 2414: Pervasive Computing. Zürich, CH, August 26-28, 2002. Mattern, F. Naghshineh,M. (eds.). Springer (2002). 125 - 138.
5. Välkkynen, P., Korhonen, I., Plomp, J., Tuomisto, T., Cluitmans, L., Ailisto, H. and Seppä, H. A user interaction paradigm for physical browsing and near-object control based on tags. Proceedings of Physical Interaction Workshop on Real-world User Interfaces. 2003.
6. Want, R., Fishkin, K. P., Gujar, A. and Harrison, B. L. Bridging Physical and Virtual Worlds with Electronic Tags. Proceedings of CHI 99, Pittsburgh, PA, USA. 370-377.