RFID TAG READER SYSTEM EMULATOR TO SUPPORT TOUCHING, POINTING AND SCANNING

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Abstract

Integrated RFID readers are appearing in mobile phones, enabling the selection of tags and communication with physical objects in a user-friendly way by touching. We have built a system that emulates UHF tags and supports other physical selection paradigms in addition to touching: pointing by IR or visual light, and scanning of nearby tags. The emulator is based on RF communication and sensing units, SoapBoxes. The emulator is used to study the feasibility and usability of different selection paradigms in the context of physical browsing, in particular when the tag contains directly a URL to a web resource.

1. Introduction

Integrated 13,56 MHz RFID readers are appearing in mobile phones. They enable user friendly interaction with the information and services associated with our physical environment. If RFID tags contain URLs, the tags with their physical environment form an analogue to a web page and its hyperlinks. Analogously to using a 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 metres, which enables scanning the environment for tags. Development is in progress to integrate sensors with UHF RFID tags (e.g. EU FP6 MIMOSA project [1]). Pointing to tags can be based on, for example, photosensitive sensors in tags. Thus it is foreseeable that tags may be selected using touching, pointing and scanning [2].

Other systems implementing similar concepts have been built, for example, by Want et al. [3] and Kindberg et al. [4]. These implementations have been very application-centric whereas we have focused on building a generic user interface for different physical selection methods.

In this paper, we introduce a tag reader system emulator, which expands the selection concept from touching to 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.

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2. The Physical Browsing System

The physical browsing system consists of a tag reader (physical browser) and tag emulators. Both use RF communication and sensing units, SoapBoxes [5]. 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

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

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

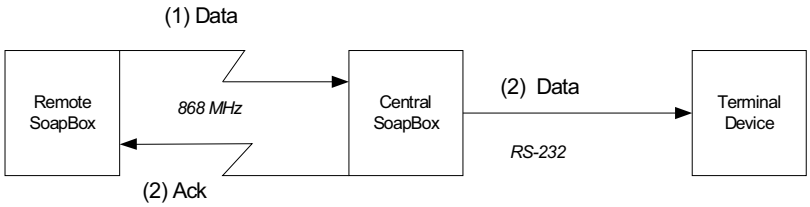

Fig. 1. Remote SoapBoxes always start the RF communication. The central SoapBox sends an acknowledgement message after reading the data.

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 the IR LED of the central SoapBox. The remote SoapBox is programmed to regularly wake up from a sleep mode, measure proximity, and detect any 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).

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

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 PDA has a lightweight personal HTTP server [6], which supports servlets. The HomePageServlet is used to construct and provide a dynamic home page of available links when scanning, or when multiple tags are selected. The TagReader engine communicates via the SoapBox driver unit with the Java serial port driver for the PocketPC. If a unique tag (containing the URL) is selected, the TagReader engine invokes the default browser of iPAQ with the specific web resource (the URL) as an argument. . When presenting multiple links, the engine launches the web browser with the URL of the local HomePageServlet as an argument. The user then selects the proper link from the PDA GUI, or tries to select a tag again by touching or pointing.

3. The implementation of physical selection paradigm

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 with 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 the 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 TagReader engine keeps track of available tags within the last 10 seconds. Scanning – presenting the dynamic home page with available tags – can be launched with one of the hardware buttons of the iPAQ.

4. Discussion

The prototype presented is not truly a passive RFID tag system in the sense that reading is not initiated by the reader device RF signal. Also a proximity sensor signal is used in addition to low power transmission to enable the 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 test for example preferences between the different physical selection paradigms, or whether a user wants to use a button for touching, and resolution preferences when pointing with different IR beam spatial angles and detection ranges.

5. References

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