Toolkit for Bar Code Recognition and Resolving on Camera Phones - Jump-Starting the Internet of Things

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ABSTRACT
Automatic identification technology such as RFID promises to connect physical objects with virtual representations or even computational capabilities. However, even though RFID tags are continuously falling in price, their widespread use on consumer items is still several years away, rendering large-scale experiments with such an "internet of things" difficult. Much more ubiquitous are printed bar codes, yet so far their recognition required either specialized scanner equipment or custom-tailored bar codes - an equally significant deployment hurdle. We have developed a freely available EAN-13 bar code recognition and information system that is both lightweight and fast enough for the use on camera equipped mobile phones, thus significantly lowering the barrier for large-scale, real-world testing of novel information and interaction applications based on "connected" physical objects. This demo presents our main contribution: A toolkit, consisting of a J2ME client for the barcode recognition on camera phones and a corresponding Java based server for linking the recognized product code to free and commercial databases on the internet, as well as two simple prototypical services (applications) based on this toolkit. With these tools, researchers can quickly develop full-fledged information and interaction applications based on EAN-13 product codes, and deploy them with a simple download to potentially large user bases in a much more effective manner than with the previously necessary special scanning equipment. We hope that this "low tech" version of bridging the gap will allow the community to quickly develop and try out more realistic and widespread applications, and thus gain real-world experiences for better jump-starting the future internet of things, today.

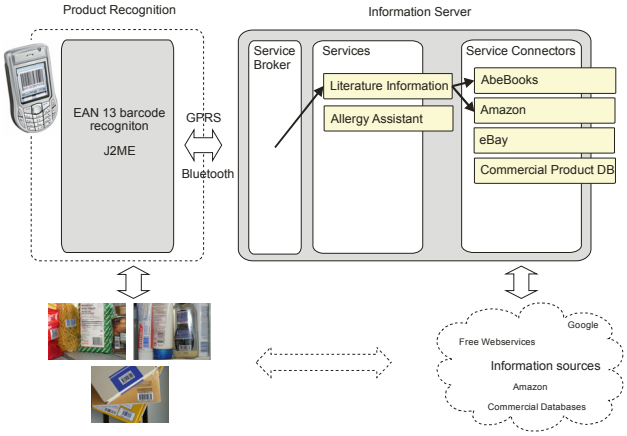
Keywords
Barcode recognition, mobile phones, Internet of Things

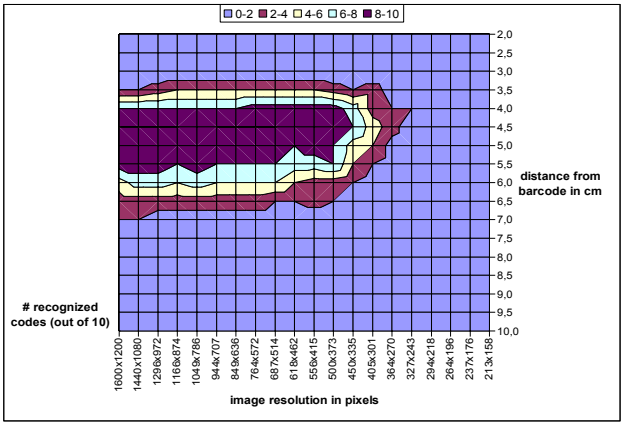
RELATED WORK
A number of algorithms have already been presented for the visual decoding of bar codes on desktop computers. Most of these are based on the transformation of the original image information into a decoding domain that simplifies bar code identification, like approaches based on the Fourier transformation or the Hough transformation as proposed by Muniz et al. [1]. Many of them are too "heavy" for the still restricted mobile phone platforms. While both Ohbuchi et al. [2] and Chai and Hock [3] have presented algorithms intended for mobile devices, these algorithms have not been implemented or tested on actual mobile camera phones so far.

Given the commercial potential of such a technology, it is not surprising that a number of commercial solutions exist. Scanbuy offers an application called ScanBuy Decoder (www.scanbuy.com/website/products_decoder.htm), which is capable of recognizing 1D barcodes. Similar applications can be bought from PaperClick (www.paperclick.com/) Gavitec (www.mobiledigit.de) and MediaStick (www.mediastick.co.jp), to name but a few. While informal trials with some freely available beta programs from the above vendors showed a comparable, sometimes even superior performance of our system, we explicitly abstained from conducting formal comparisons, as improving the recognition rate or speed is not our primary goal. Instead, we are trying to create a free, easily usable, and robust barcode recognition system for mobile phones, together with an open resolving framework that facilitates rapid prototyping and deployment. Commercially available systems, in contrast, not only restrict source-code access but also limit barcode resolving to vendor applications and/or a fixed set of lookup services.

TECHNOLOGY
Our EAN-13 bar code recognition and resolution toolkit contains two parts: the barcode recognition component running entirely on J2ME enabled mobile phones that support the Mobile Media API (MMAPI) extension and the Java based information server component, which is located on a separate server, to which the detected product code is transmitted via a GPRS (or for local demonstration a Bluetooth) connection.

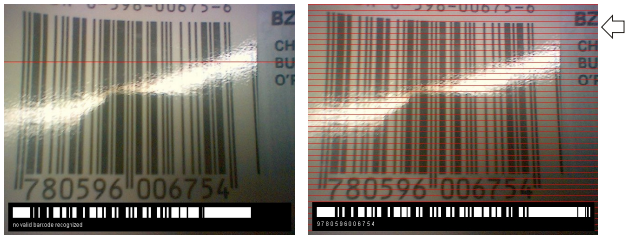
The information server uses a plug-in architecture, allowing us to quickly add various services and online information sources. Although this process could also be located on the phone itself, performing them on an external server provides us with greater extendibility, higher flexibility and better performance.





Recognition Algorithm and current Drawbacks

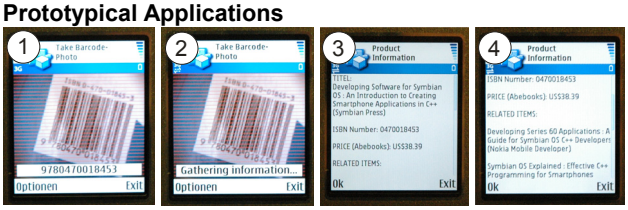
In general, our recognition algorithm is scanline based. In order to improve robustness, we decided to not only use a single scanline, but a set of multiple, potentially arbitrarily oriented scanlines. If multiple scanlines cross the bar code, each with a different sensitivity, we can increase the chances that at least one of them will result in a properly recognized code. Also, multiple scanlines can be combined in a majority voting fashion, were inaccuracies due to dirt or reflections on one line can be compensated for by two or more correct identifications on other lines. Last not least, by using a variable amount of scanlines we have a simple mechanism to adapt our algorithm to the processing power of the individual phone it is running on: The more computational capabilities available, the more scanlines and orientations we can try. Since the algorithm is scanline based, it cannot cope as well with image distortions as transformation-based algorithms that consider all available image data. However, as our analysis shows, our implementation is sufficiently robust even for lower image resolutions. Also, it is quite fast, has very little memory requirements and can be implemented relatively easy.



We have analyzed the recognition performance of our algorithm along two axes: focus and image resolution, as these are currently the two most important parameters influencing recognition accuracy on a mobile camera phone. The camera focus directly affects a picture's sharpness. Results indicate that focus remains a problem, while common camera resolutions are not critical.

In order to allow camera phones to scan a bar code from close-up, two options are available. Increasingly, camera phones are being equipped with auto-focus lenses that have been developed over the last several years. Models that still use fixed focus lenses need to be adopted to the required short distance with the help of a macro lens, a cheap accessory that should be carried by many mobile phone dealers. Ideally, our system would be deployed on auto-focus systems, thus eliminating the need for any specific hardware accessory. However, macro lenses are cheap and unobtrusive enough to make their use in a large-scale trial seem feasible.

Prototypical Applications



In order to illustrate the potential of services that are enabled using barcode recognition on mobile phones and to illustrate our toolkit, we implemented two prototypical applications. The first prototype represents a simple literature information system, providing information about scanned books, like their current price or a list of related items.

The second prototypical application implements a tool for checking ingredients in nutrition products that could trigger an allergic reaction. Using a retail goods database such as GS1 (see www.gs1.org) we can gain access to detailed allergen information of individual products, based on their EAN-13 code. Together with an individual shopper's allergy profile, the application is able to warn the user of potential allergic reactions to an item with a single click.

REFERENCES

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DEMONSTRATIONS DESCRIPTION

Title: Toolkit for Bar Code Recognition and Resolving on Camera Phones - Jump-Starting the Internet of Things

Project Description (100 words max):

We implemented a toolkit in order to foster the creation of applications that are based on the recognition of standard EAN13 barcodes using camera enabled mobile phones. During the presentation we are going to present the two main components of the toolkit, the J2ME client and the Java based server, the creation of own services and two already implemented prototypical services/applications based on this toolkit: “Book Information” and “Food Tester”.

Envisioned Interaction:

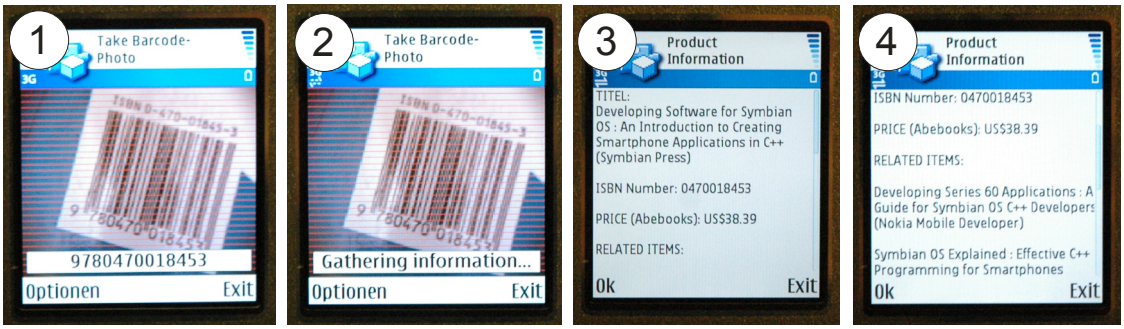
For the presentation we are going to use a Nokia N90 mobile phone with an attached macro lens and a standard Laptop, running the Java based information server. Both will be connected using a Bluetooth connection. The two J2ME demo applications will be preinstalled on the mobile phone.

1. Presentation of Existing Services:

There will be a table with the mobile phone, the laptop, several books and some food products on it. Users will be able to take the mobile phone, choose one of the two possible applications (Book Information and Food Tester) and try to recognize a barcode by positioning the phone in front of a product’s code and pressing a button. If the barcode has been successfully recognized, they will be able to observe the EAN13 code on the mobile phone’s display. After

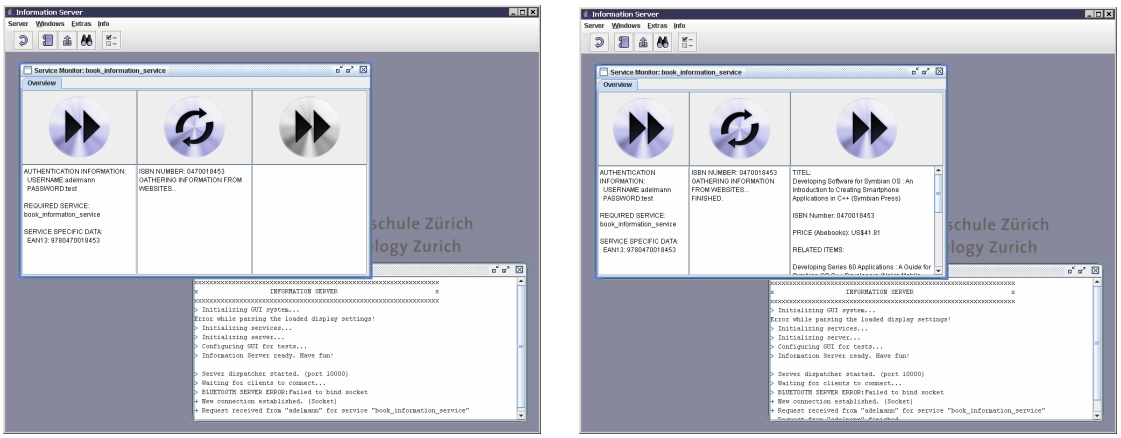
pressing another button, the recognized code will be send to a service running on the server (using either a Bluetooth or GPRS connection) and the returned information will be displayed on the mobile phone's screen.

When using the literature information system, information about the scanned book will be presented, including its title, current price and a list of related items. This information is obtained by querying several websites.



When using the food tester application, users can scan the barcode of a food product and will receive either a "warning", "ok", or "unknown" style message on the mobile phone, based on the substances contained in that product and a previously defined allergy profile of a person. Due to license issues, we are not going to directly access a commercial product database during this demo, but will instead provide a locally cached test set of product data.

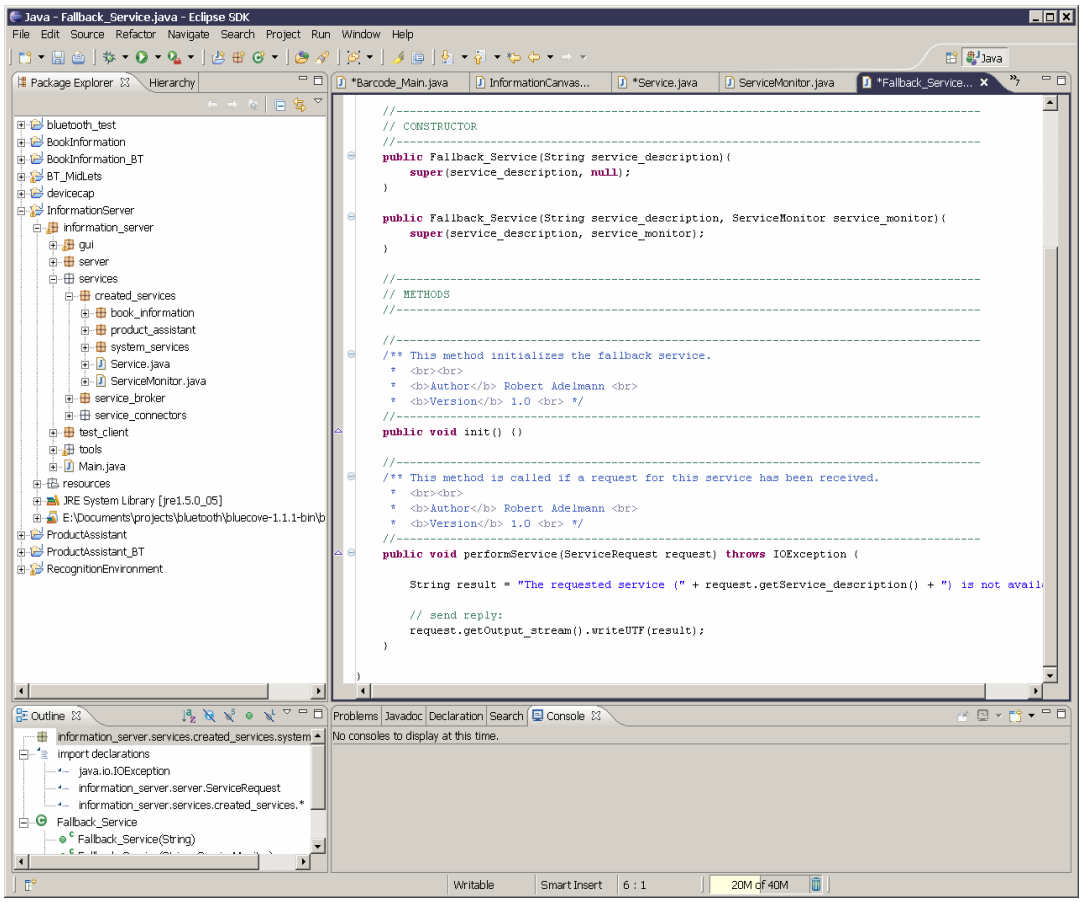
For both applications, users will additionally be able to observe the in- and outgoing data at the information server via a simple monitoring tool.



2. Presentation of Toolkit Usage:

Besides presenting the two example applications, we are also going to illustrate how easy it is to create new services, by demonstrating all steps necessary in order to create own services. If people are interested, we are also able to present the life creation and deployment of a simple service. We will use the Eclipse programming environment to write a small service for

the server, adjust and deploy the client application on the mobile phone and present the result. (This process will take about 10-15 minutes.)



TECHNICAL REQUIREMENTS

SPACE

We would only need a simple table with enough space to put the laptop, the mobile phone, 4-5 example books and 4-5 food products on it.

LIGHTING

In order to recognize the barcode, it would be nice if the place where the products are placed is not too dark.

TIME

One person is sufficient for presenting the demo. Presenting the example applications will require around 2 minutes of interaction. Presenting the creation of an own service will take approximately 10-15 minutes. It is sufficient if the demo is running only at the opening demo reception.

COMPUTATIONAL EQUIPMENT

We have no special hardware requirements and will provide the mobile phone and the laptop.

NETWORKING

In order to present the book information demo, we need to access the internet. Wired or wireless doesn't matter.

RADIO FREQUENCIES

During the demonstration we will use a Bluetooth connection from the mobile phone to the laptop.

POWER

Two normal power plugs should be sufficient. On for the laptop and one for the mobile phone's charger.