The Mobile Phone as the Enabler of an Internet of Things

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Today's Internet is largely limited to the virtual world linking computers and more recently mobile phones. At the edge of today's Internet, there remains a big gap where billions of real world objects including everything from appliances, logistical units and even everyday products are not "connected". In this article, we describe our research to bridge this gap between the physical and virtual world and in particular the important role the mobile phone can play. We showcase some of our latest research projects and describe how a PhD research project evolved into commercial software that today powers barcode scanning on millions of mobile phones around the globe.

Identifying Everyday Items

Over the past 40 years, barcodes have become a ubiquitous means of object identification. Hundreds of millions of barcodes are in use today to optimize supply chains and facilitate checkout in retail stores. Until recently, however, the scanning of barcodes required specialized scanner equipment that restricted the use of barcodes to the commercial sector and proprietary applications. Object identification via barcodes was not possible for the "masses" because cost and form factor of the scanners were prohibitive.

When the first mobile phones featured built-in cameras, this was set to change. The camera in the phone could turn every mobile phone into a barcode scanner. Leveraging the capabilities of the mobile phone such as the display, processor, networking capability, storage, and keyboard, the mobile phone could become a communication proxy for the millions of every day products without computing capabilities.

In our research group, we initially started developing mobile barcode scanning solutions for 2D optical codes because those codes were easier to decode than 1D barcodes with the early camera phones. While scanning 2D codes was easier, those codes were not common on everyday prod-

ucts. We, therefore, soon started the development of Batoo – a mobile barcode scanning technology for 1D barcodes.

Batoo – 1D Barcode Scanning for Camera Phones

The research project Batoo set out to investigate to what extent one-dimensional barcodes could be recognized using standard, off-the-shelf camera phones. This was no trivial task—mobile phone cameras often do not have autofocus, so barcode images are typically blurry. Even for phones with autofocus, motion blur, barcodes very close to the camera, lighting conditions, and warped product packaging make fast and reliable barcode scanning a challenge.

What started initially as the Batoo research project in a PhD thesis evolved into today's

fastest and most reliable commercial barcode scanning technology for mobile phones. The software known as "Scandit SDK" is being licensed via the ETH spin-off company Mirasense (www.mirasense.com) to mobile app providers around the globe. It has turned barcode scanning into a universal capability of mobile phones, with applications ranging from in-store price comparison or informing consumers about ingredients to the disruptive replacement of expensive hardware scanners in the entire supply chain. The Scandit SDK today powers for example popular Swiss mobile apps such as the Codecheck, Comparis and Ex Libris iPhone apps. ➔

BIT – A Browser for the Internet of Things

The recognition of barcodes with mobile phones is only one step towards the vision of an Internet of Things and the interaction with everyday objects. Once a barcode has been scanned and the underlying object has been identified, users often need to obtain information about the respective object or possibly interact with the object or its digital counterpart. Today's mobile apps with built-in barcode scanning only represent one, single information channel and this is limiting. You can either access Amazon reviews and prices, Codecheck's unbiased and independent product information, or Comparis' price comparison services. As the user you have to decide on one service before you scan the barcode or scan it again later with a different app. To address this problem, we are working on "BIT"—a universal browser for an Internet of Things where multiple information sources and different services are available to the user. He or she can scan an object once and see a list of third party services and information services at a glance.

What's next?

There is of course more to object identification than barcode scanning. Other image-based identification technologies and radio-based identification technologies such as RFID and NFC are alternative technologies to bridge the gap between the real and physical world. RFID has seen adoption in certain niche applications and in some supply chains, but has not seen significant consumer adoption beyond ski ticketing, building access and car immobilizers. Similar to barcode scanning, we believe that the mobile phone will play an essential role. Significant adoption of RFID in consumer applications

will happen once the corresponding reader devices are being integrated into mobile phones on a grand scale.

Getting involved

Do mobile computing and backend infrastructures fascinate you? Do you want to build a browser for an Internet of Things, design scalable architectures to store and analyze millions of barcode scans and RFID reads, or develop next generation product identification technologies? There are many ways to get involved. We offer exciting lab projects, semester and Master's theses on a continuous basis within the Distributed Systems Group or in the context of the spin-off company Mirasense. At Mirasense, we are also looking for talented software engineers to help us develop better product interaction technologies and services. For more information, contact us directly via email (rodunerc@inf.ethz.ch) or check out the projects at http://www.vs.inf.ethz.ch/edu/theses.html. We are also collaborating with the Auto-ID Lab at the Massachusetts Institute of Technology (MIT) which offers the possibility to do your semester or masters thesis abroad at MIT.   ✦

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