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Abstract

This paper describes an approach to using physical-digital appropriation for navigation, piggybacking off the humble, ubiquitous barcode to facilitate cheap, scalable indoor wayfinding. We illustrate the technique by describing a prototype interface for navigating to specific books within a library. Our design—BookMark—provides visitors to the library with a detailed map to any desired book by simply scanning the barcode on the back of any other book in the library. After describing in detail how our technique is achieved, we move on to show its effectiveness via an in-situ experiment in which we compare our design to standard methods of library navigation. We then present the results of a longitudinal evaluation where we deploy the BookMark application to library visitors for a period of 24 months. We conclude with a discussion of our overall results, what our design means for other pervasive infrastructures, and how best to design for the future of physical-digital appropriation.

Keywords: Appropriation, indoor navigation, barcodes, books, libraries

1. Introduction

With the rise of smartphones and cheap sensors, GPS-based navigation systems have expanded to become the standard routefinding option for drivers and pedestrians alike. In well-mapped environments, then, outdoor navigation is often considered a solved problem. Indoor navigation, however, is more complex – issues such as blocked or reflected signals, and error ranges that are often larger than the indoor spaces being navigated make GPS-based approaches unsuitable for these environments. Instead, indoor navigation most commonly makes use of dead reckoning, beacon- or sensor-based approaches. Each of these techniques have their relative pitfalls – dead-reckoning approaches, for example, suffer from accumulated error over time, whereas other techniques such as beacon- or sensor- based approaches require additional infrastructure.

In this work we aimed to develop a method for indoor navigation that does not require additional infrastructure, and instead uses existing markers and waypoints in the environment. Our focus was on libraries, where visitors require a fine level of granularity of positioning in order to help them find a specific book within collections of many thousands of items. There have been many attempts to streamline the process of locating books within physical libraries, but, as reviewed by Walsh (2011), these usually require some sort of specialist hardware or additional infrastructure within the library itself. Instead, we propose BookMark: a simple, cheap, scalable solution that makes use of existing infrastructure to facilitate precise navigation to specific books within a library.

Our technique relies on the ubiquity of the digital barcode – an easily recognisable marker that is visible on almost all consumer-level products, including the majority of printed books. Current uses of barcodes are rather unimaginative, and there are very few situations when these markers are used for anything other than their intended purpose. Researchers have previously tried to address this by making digital markers more appealing (e.g., Meese et al. 2013), using attractiveness to hide mundanity. In our view, though, the beauty of barcodes is not in their aesthetics, but in what their visibility and ubiquity affords. We take advantage of these pervasive codes by using them to determine where a user is standing in the physical space. By scanning the barcode on the back of any nearby book, BookMark can determine which book the user is holding, which shelf it was on, and, consequently, where they are positioned in the library. Using this information, and the details of the book they wish to locate, BookMark is then able to suggest a route from one location to the other, guiding the user to the correct shelf.

Other than a cameraphone, our approach requires no specialist hardware on the user side. Despite this, it is able to offer a very fine level of granularity, leading library visitors to the exact shelf containing the book they require. It also requires no additional infrastructure within the library itself, as the only information used for positioning is already printed on the back of most recent books. As a result, the approach is flexible, allowing librarians to

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