

ARLib: The Augmented Library

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Abstract

ARLib is a location-based application for a mobile Augmented Reality system based on a notebook computer, a head-mounted display fitted with a FireWire camera, and powered by Studierstube 2.0 software. The application aims to aid the user in typical tasks that are done in a library by augmenting a book's position on a shelf. The system utilizes an optical tracking approach, relying on ARToolKit for recognizing markers. Markers are attached to bookshelves and walls to determine the viewer's position, as well as to books themselves. A powerful multi-criteria search engine combined with an interface that supports graffiti text input grants a maximum of usability and speed.

1. Overview

ARLib can be thought of both as a mobile database for searching publications in a library, as well as a full-blown augmented reality tool that aids the user in actually finding the requested book (see Figure 1.). For every publication in the library, not only author, title, ISBN number, year of publication and additional keywords, but also category and physical position on the bookshelf is known to ARLib's database. Then it augments a book's position within the library shelves thereby providing a direct and intuitive interface to the standard task of searching for a book. The application features two main operating modes.

1.1 Assistance in searching for a book

In this mode, the user utilizes the book search engine to find the publication he intends to find on the shelves. This is performed by entering one or more search criteria using the text input widgets and then selecting one item of the result set. User input in general is done via a wrist-worn augmented tracked touch-pad. Before a search action can be started, one of the available search modes must be selected (see Figure 2.b).

Search by title - Returns books with matching title.

Search by author(s) - Returns books of matching authors.

Search by Keywords - Returns all books where the description string contains all the given keywords.

Search by single Keyword - Returns all books where the description string contains at least one of the given keywords.

Search by Year - Returns all books published in the given year or the given range of years.

Next, text can be input by using either a virtual keyboard or a graffiti pad. The virtual keyboard provides a trustworthy means of input for the user not accommodated to graffiti input (as on a PDA), whereas experienced users will find the graffiti pad handier (see Figure 2.c). The input type can be toggled at any time.



Figure 1. A user at work with the ARLib setup.

As soon as one of the search results that are presented in a list view is selected, the corresponding book's position on the shelf and the shelf itself are highlighted in the heads-up display to aid the user in finding the book (see Figure 2.a and d). Also, all available information about the publication is displayed on the wrist panel.

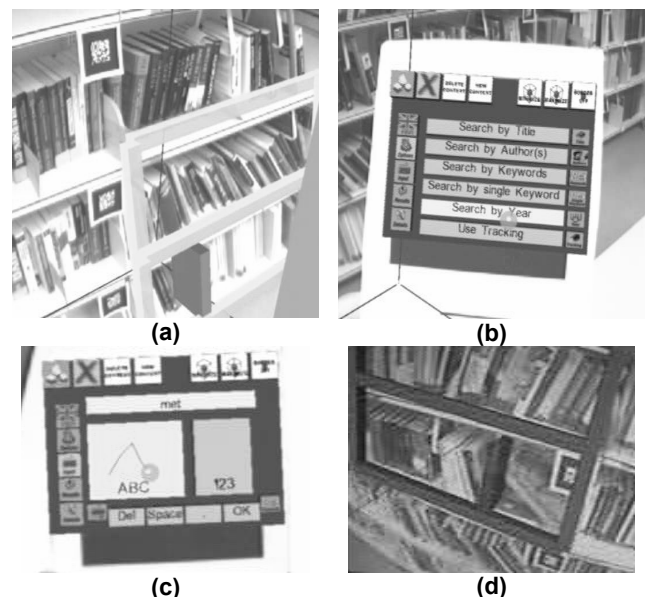


Figure 2. (a) Augmented shelf and book. (b) Search interface on the augmented touch panel. (c) Graffiti text input. (d) Another augmented shelf and book.

1.2 Assistance in returning a book to the library

In this mode, ARLib attempts to detect markers that are attached to books. If a marked book is spotted, all available information about the publication is presented on the wrist panel, and the book's designated position on the shelf is highlighted to aid the user in returning the book to its correct position.

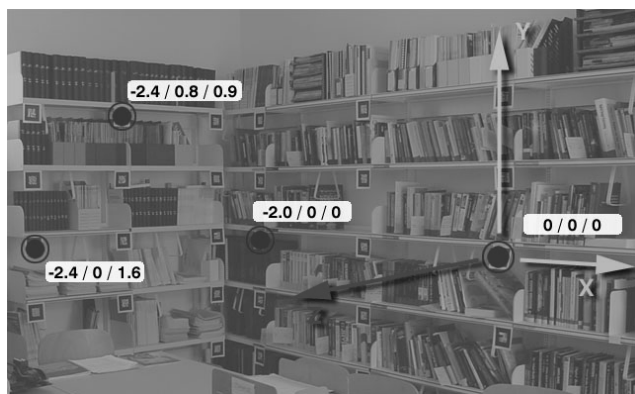


Figure 3. Example library with markers defining a coordinate system.

2. Technical Realization

2.1 Physical preparation

Before ARLib can be used with a real-life library, quite some preparation work has to be done. Most importantly, a database listing of the publications the library consists of is needed. A sufficient number of ARToolkit [1] markers must be created and attached to neuralgical points of the library (see Figure 3.). These are used to track the user's position with respect to the library rooms. Ideally, there would be always at least one marker in view. Finally, the shelf geometry and the marker positions must be surveyed and written to a geometry file.

The shelf geometry and marker positions register shelf information from the database with the geometric model. This can also be thought of as reverse-engineering the user's position in the library coordinate system.

In an ideal system, all the books would also have a marker attached to the cover so that they can be spotted by ARLib (see Section 1.2). The mapping of markers to books must be hand-coded into a separate file.

Once these prerequisites have been met, a specially-written converter utility transforms the specification files to an OpenInventor scene graph of the library database, including all geometry information that is used for the graphical representation of the library by the ARLib application.

2.2 Interface

The mobile AR kit consists of a PC notebook equipped with a NVidia GeForce2Go video chip. It is carried by the user in a backpack (see Figure 1.). As an output device, we use an i-glasses see-through stereoscopic color HMD. The display is fixed to a helmet worn by the user. Moreover, an InterSense InterTrax2 orientation sensor and a web camera for tracking ARToolkit markers are mounted on the helmet. The main user interface is a wrist mounted touch pad that is also equipped with optical markers.

The ARLib user interface completely relies on Studierstube 2.0 [2] standard UI widgets and the familiar augmented personal interaction panel, usually wrist-mounted along with the touchpad.

2.3 Database

Since the Open Inventor-scenegraph file that is generated for ARLib consists of custom nodes that contain geometry information as well as content information for books, no separate database is necessary for the book-searching algorithm. Instead, ARLibrary utilizes the standard Open Inventor node-searching function integrated in the API as a convenient way to browse through the scenegraph and come up with the search results corresponding to the user queries.

3. Evaluation

In practice, we used our in-house Institute of Computergraphics library to test ARLib, consisting of roughly 650 publications in 13 categories, stretching over 20 different shelves. One big question mark beforehand was how well ARToolkit would cope with a large number of markers, since we had a massive 62 of them and no idea whether ARToolkit could handle such an amount of data suitably.

52 rather small markers were placed at shelf joints and 8 on book covers. To enhance tracking quality in general and especially from a distance, we opted to attach two very large markers to the walls backing the shelves, which turned out to improve the overall usability of the system quite considerably.

4. Conclusion

The accompanying video demonstrates that ARLib is working very well even with several hundred books, and is really useful in locating books even in a single-room library. However, performance-wise ARLib's bottleneck clearly is not Open Inventor or Studierstube framework but the tracking process. Most interestingly, at a camera resolution of 320x240, most of the small shelf markers proved less useful for tracking than the large ones on the wall. Furthermore the application really pushes the limits of ARToolkit tracking in terms of precision and speed of tracking when on load with more than 60 markers, but it's nothing that faster CPUs and higher resolution cameras would not cure.

Future work on ARLib will include integration of the application into a wide-area general information service.

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References

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