Potential of Augmented Reality in the Library

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***Abstract*—Augmented reality (AR) applications are getting popular since they integrate the real world and the virtual world. This paper focusses on AR applications for public and scientific libraries. There exist some projects and sample implementations of AR apps specially designed for libraries, but they are seldom found in practice. To identify whether there is potential for AR apps to be applied in libraries, the results of a qualitative study that has been performed among librarians working in public and scientific libraries in Austria and experts in augmented reality are presented. Searching for media, navigating to the correct location and displaying ancillary information, like ratings, reviews, secondary media, links, etc., has the highest potential for users according to the experts. AR apps for maintaining the bookshelfs of a library provide real benefit for librarians and are awarded high potential as well. Guided tours through libraries using AR-based apps lightens the load of the librarians to introduce new users to the library. The feasibility of an AR app for a library is demonstrated by introducing a prototype that supports library users with additional information on media and the library itself.**

Keywords—library; public library; scientific library; teaching library; augmented reality

I. Introduction

Augmented reality (AR) bridges the gap between the real world and the virtual world – spatially and cognitively [1]. It allows to integrate the real world and the virtual world and presents information on mobile devices that directly corresponds to the physical environment. By selecting, filtering, and visualizing virtual objects context-based information can be displayed together with real world objects.

There exist several examples for various fields of applications, i.e., industry and construction, maintenance and training, the medical domain, personal information, or navigation [1] [2]. Although a number of successful applications can be found, AR is categorized by Gartner in its Hype Cycle for Emerging Technologies 2018 to be part of the *Trough of Disillusionment* [3]. Thus, it will take about another five years to reach the mass market.

Libraries are another field of applications that gets slowly into focus of AR. A few prototype applications exist that demonstrate the feasibility of augmented reality to support users and the staff of libraries. For example, the University of Applied Sciences Potsdam developed a concept and prototype for a complex AR-based app *myLibrARy* providing additional information and reviews to media as well as general information about the library [4]. LibrARi is an image-based AR app for mobile devices and AR glasses that supports users on finding their way to the desired book in the bookshelf [5]. The Miami University in Oxford, Ohio developed an AR-based app called ShelvAR that supports librarians to identify books in the wrong place and for inventory [6]. The Bavarian State Library Munich provides a location-based AR app that offers additional information to special locations, buildings, and monuments related to king Ludwig II [7].

Although there exist a number of augmented reality applications specially designed for libraries (i.e., especially for the users of libraries) their number is limited. None of them got ready for the market and some of them, like ShelvAR, even discontinued. This might be due to an immature technology, financial issues, a lack of acceptance among users or a lack of acceptance among librarians. To identify the potential of augmented reality apps in libraries we will focus on the point of view of libraries. Therefore, in this paper we will investigate whether there is a need for AR apps in public and scientific libraries, limiting the research view on Austrian libraries (section IV). To demonstrate the feasibility of an AR app for a public or scientific library a prototype supporting library users with additional information will be presented (section V).

II. Augmented Reality

A. Definition

Augmented Reality integrates 3D virtual objects in a 3D real environment in real time [8]. In AR virtual objects are superimposed upon or composited with the real world, but the user can still see the real world. Therefore, AR supplements reality, rather than completely replacing it like in *Virtual Reality* (VR) [8]. Instead of creating a completely synthetic world (i.e., virtual world) in which the observer is completely immersed, the *Mixed Reality* merges real and virtual worlds. According to Milgram and Kishino there is a reality-virtuality continuum that is related to a mixture of classes of objects. With the real environment (consisting solely of real objects) and the virtual environment (consisting solely of virtual objects) as the two opposite extrema, there is the *Mixed Reality* in between in which real world and virtual world objects are presented together within a single display [9] [10]. *Augmented Reality* is the part of the *Mixed Reality* more close to the real environment where real objects are more dominant than virtual objects.

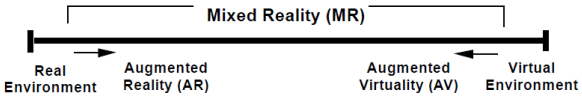

Fig. 1. Reality-Virtuality (RV) Continuum [10]

The most widely accepted definition that does not limit AR to specific technologies was proposed by Azuma in 1997 and defines Augmented Reality as "systems that have the following three characteristics:

1) Combines real and virtual
2) Interactive in real time
3) Registered in 3-D" [8]

B. AR Systems

A complete AR system requires at least three components:

- a tracking component,
- a registration component,
- a visualization component [1].

A fourth component is required to store information about the real world and the virtual world in a spatial model. The tracking component determines the location of the user in the real world. The real world model serves as a reference for the tracking component. The registration component is responsible for the alignment of coordinate systems between virtual and real objects since the virtual information has to be accurately registered with physical scene objects [1].

When using an AR system there is a feedback loop between the human user and the AR system (Fig. 2) [1]. While the user observes the AR display and controls the viewport, the system tracks this viewport and registers the pose in the real world with the virtual content. Then the situated visualizations are presented on the display [1].

Fig. 2. Feedback loop between user and AR system [1]

To be able to position virtual objects registered to real objects in 3D the relative pose – i.e., the position and orientation of the AR display relative to the real world – has to be known. Pose measurements have to be updated continuously since AR operates in real time. In AR 3D tracking refers to this process of constantly identifying the three-dimensional position or six-dimensional pose of real objects [1]. Tracking can be done using sensors exploiting physical phenomena like electromagnetic radiation (e.g., light, radio signals, magnetic flux), sound, gravity, or inertia [1] [11]. Mobile tracking uses magnetometer, gyroscope, accelerometer, or GPS. Optical tracking is based on cameras (visible light, infrared light). Optical tracking often uses markers: known patterns that are placed on the surface of real objects [1]. They are designed to make it easy to be detected in the image: square or circular shape, black border, high contrast [2]. In situations where no artificial markers can be applied, natural features of objects can be used instead, e.g., by identifying interest points, tracking edge features, or high differences in color or contrast [1] [11].

AR displays must be capable of combining the real environment and the virtual environment. An optical see-through display uses an optical element (partially transmissive and partially reflective) to combine the view of a user of the real world with computer generated images of virtual objects [1]. On a video-see-through display the real world is captured using a video camera and the image is modified electronically (using a Digital Combiner) to add the virtual objects. The combined image is then displayed on a screen [2] [1]. Based on those two fundamental principles different categories of displays can be found: head-mounted displays (e.g., smart eyeglasses), handheld displays (e.g., smartphones, tablet computer), and projective displays (e.g., head-up displays using the windscreen of cars or aeroplanes).

Additionally, users have to be able to interact with the virtual world: by movement (navigation), by selecting objects (e.g., physically grabbing a marker or pointing on a virtual object), manipulation of a virtual object (changing a parameter, e.g., turning, scaling, moving the object), input of symbols (e.g., using gesture or a virtual keyboard, or speech-driven) [2] [11].

III. Augmented Reality Applications in Libraries

There already exist a few AR applications dedicated to the use in libraries. However, most of them are prototypes ore specially designed for a certain library. This section provides an overview of the most striking AR projects for libraries. Different types of AR applications can be distinguished:

A) apps providing additional information on media for library users (including locating media in the library)
B) apps supporting librarians (e.g., for identifying books)
C) apps providing additional information on cultural assets associated with the library/archive
D) augmented books.

A. AR Apps Providing Additional Information on Media

In 2014 the University of Applied Sciences Potsdam started *myLibrARy*, a project to evaluate and explore the fields and scope of application of AR in public libraries [4] [6]. The main goal was the development of a user-oriented app for libraries with significant features related to augmented reality. Based on a user survey the app should provide features like

- managing media: search, reservation, extract, download
- navigation: finding the way to the media, virtual tour
- information on the library: opening times, contact, staff
- user service: user account, wish list, reminder, renewal
- interface to other services like bibliographic management, Wikipedia, book trade, exhibitions, events, etc.
- social media
- services outside the library like a literature walk

Some of these features are related to AR, some are classic features of library apps that could already be found elsewhere. The first prototype was developed by Metaio and was a channel in the Junaio app of Metaio [4] [12]. Media were identified by optical tracking and image recognition of the book cover. The second prototype was implemented as an independent app where media were identified by scanning the ISBN code. The main idea of *myLibrARy* was the development of Smart Libraries where smart technologies are an integrated part of the use experience. AR might be a key element that enables new knowledge due to semantic and visual contextualization of information [4] [12].

LibrARi is an image-based AR app for mobile devices and AR glasses that supports users on finding their way to the desired book in the bookshelf [5]. Since the AR app shows the direct way to the book on the display, the library can be explored interactively and users do not have to bother with classification systems any more. LibrARi offers searching, locating and navigating in physical space using a digital interface on a mobile device [5].

The University of Illinois Library developed a mobile recommender app with augmented reality features called Topic Space. By embedding optical character recognition software, the augmented reality app can recognize the signature on a book in the library and suggest relevant items that are shelved nearby. Additionally the app shows users media that are normally shelved at the location, but that are currently checked out [13].

B. AR Apps Supporting Librarians

The Miami University in Oxford, Ohio developed an AR-based app called ShelvAR intended to support librarians to identify books located in the wrong place in the bookshelf [6] [14]. Using the prototype librarians could aim the mobile device (e.g., smartphone or tablet) at the shelf and books on the wrong place will be marked accordingly (✓ or ✗). Unfortunately, due to a patent dispute the project discontinued [15].

C. Other AR Applications

The Bavarian State Library Munich developed the AR app "Ludwig II" that presents location-based services of cultural assets (e.g., special locations, buildings, monuments) related to king Ludwig II [7]. The multimedia content is either displayed on top of a map view or integrated in the live camera video.

Fig. 3. AR app "Ludwig II" [7]

By tracking the pose of the mobile device location-based and context-based information (e.g., historic images, maps, letters, audio clips of contemporary witnesses) can be identified and inserted in the live video. Figure 3 left shows the camera view of the app with information on nearby points of interest. Figure 3 right shows the real time simulation of the winter garden that had been torn down after the death of Ludwig II.

D. Augmenting books

The SCARLET project (Special Collections using Augmented Reality to Enhance Learning and Teaching) developed a marker-based app (using QR codes and book covers) to support students that have to consult rare books, manuscripts and archives within the controlled conditions of library reading rooms. The AR-based app enables students to experience the best of the real and the virtual world: students can enjoy the sensory delights of seeing and handling original materials, while enhancing the learning experience by enhancing the object with digital images, online learning resources and information on the items before them and on related objects held in the library and elsewhere [16].

Like in SCARLET markers can be embedded in various kinds of books (children's books, educational books), magazines or catalogues thus allowing the reader to access additional information (e.g., various multimedia content).

IV. Evaluating the Potential of AR for Public and Scientific Libraries

There are a few AR applications available for libraries and in some of the projects presented in section III a requirements analysis has been done prior to implementing the AR app. However, none of them got ready for the market and is available for other libraries. Therefore, we will investigate whether there is potential for an AR app in libraries. We will focus both on public and scientific libraries and derive whether there is a demand for augmented reality applications [17].

Research will concentrate on opportunities and challenges when libraries use AR apps to support their users. We would like to know which types of applications and which features are relevant for users in public and scientific libraries. Special focus will be on some of the core tasks of libraries – dissemination of information and conveying media competence – to identify whether AR has a positive influence on information literacy of library users [17].

There is a range of stakeholders related to a public or scientific library. In this research we concentrate on *users* of a library, i.e., regular readers and casual readers, who are searching for media (books, journals, etc.) – either print or electronic media – and want to lend these media.

A. Method

To investigate the potential of AR apps a qualitative research method has been chosen [18]. Structured guideline interviews have been carried out with twelve experts in three different domains (four experts in each domain): augmented reality, public libraries, scientific libraries. The four experts on augmented reality are professors at universities and COOs in

AR companies in Germany, Austria and Switzerland (DACH region) and authors of books on AR. The experts on public libraries are librarians and heads of public libraries in Germany and Austria. The experts on scientific libraries are librarians and heads of libraries at universities and universities of applied sciences in Austria.

The interviews were conducted in March and April 2018 and took about 30 to 50 minutes. A mobile audio recorder was used to record the interviews. Afterwards the audio was transcribed to provide written material [19].

A qualitative content analysis according to Mayring was then applied to identify corresponding statements in the interviews [20]. To be able to analyze the material, categories had to be defined, i.e., main categories and sub-categories [18] [20]. For example, the main categories were: current offerings in libraries, technology and digital offerings, reasons for utilization of AR, reasons for not using AR, information literacy with respect to AR, AR general, AR applications, AR benefits, AR challenges, AR considerations of users, and IT affinity [17]. The text was coded according to those categories using the software MAXQDA.

B. Results

Selected and aggregated results of the conducted interviews will be presented in this section [17].

1) AR General

The AR experts assume that AR will be applied everywhere in the future because it provides support in multiple ways. Users have to get acquainted to AR apps and realize their potential, but then the transformation to its utilization will be gradually and AR apps will be used everywhere. Data goggles will be the natural device for using AR.

Currently AR is mainly applied in navigation (head-up displays), sports broadcasting (lines faded in), industry (overlay of technical documentation), logistics, construction, medicine (insert extra data during surgery), military, and gamification. Although AR is still quite new to most companies, the AR experts think that in future AR will be heavily used to visualize a lot of different issues, e.g., in architecture, marketing, content combination, and in traineeship and education.

2) Advantages of AR for Libraries

Since the discussed applications of AR in libraries are fixed to the place of the library, users have to come to the library to be able to use the AR app. Although this seems to be a trivial fact, users will be forced to visit the library – and then they will get a lot of additional information. Since AR helps to better find the way in the library, media (i.e., books) can be found much easier and faster.

Ancillary information can be conveyed much simpler, more extensive and more context specific with AR. Using 3D, information can be perceived and imagined more easily. AR can be used whenever complex information in the library shall be presented to the audience. Added value arises when the physical holdings of the library can be combined with the virtual holdings. The librarians (of both types of libraries) would like to use such combinations much more often. AR can be used to link different types of the library holdings and to show all media since not everything can be presented in the catalogue of the library. By filtering and selecting content elements more precise results can be presented to users.

Five out of twelve interviewees (1 AR expert, 3 librarians of public libraries, 1 librarian of a scientific library) mentioned that AR will help to project a modern, attractive image of the library. Using a modern and innovative technology like AR the quality of the experience in the library will be increased. With the help of AR the libraries can offer better and demand actuated service.

3) Motivation, Attention, and Information Processing

All interviewees agree that AR apps can motivate users to visit a library. However, they added that the level of motivation depends on the target group (e.g., much better with young people or technogeeks). There must be a clear benefit, e.g., saving of labor, to motivate someone to use the AR app. Motivation can be increased by improving the quality of the personal experience, e.g., fascination of technology, a game, new opportunities, or the chance to discover and experience the library in a playful way.

The interviewees also agree that using AR heightens the awareness and in this way the offerings of the library are perceived more effectively. However, the opportunity to improve the awareness depends on the target group. Users can be motivated when there is an added value. The library may track all activities and related behavior and analyze the behavior of its users anonymously.

The AR experts and the librarians of scientific libraries think that with the help of AR information can be conveyed and processed much easier. They argue that more senses are appealed. However, the librarians of public libraries disagree. Two librarians of scientific libraries point out that the amount of improvement might depend on the type of service. The other two librarians of the scientific libraries hold the opinion that we have to be aware that the provided information might not be processed properly any more because of an overstimulation.

4) Preconditions of Augmented Reality in Libraries

All interviewees agreed that using AR has to make sense and generate extra value for users. Since there is still a lack of good applications, (library) users are not aware of the added value of AR.

There are external and internal factors that influence AR in libraries. External factors might be the interior design, lighting conditions, or the internet connection within a building. Internal factors like staff or overstimulation influence the utilization of AR as well. If the app shall be used indoors, good maps with high-resolution are needed. A WIFI/WLAN network connection would be practical as well. The rooms of the library should not be too bright or too dark and the walls should not be shiny.

There are many libraries that are run by a single person. Thus, the required know-how to run and further develop complex, technically sophisticated apps can not be assumed. Therefore, the staff of the library has to be trained adequate. The staff has to support the technical progress.

Libraries using AR have to be aware of overstimulation. Secondary issues like liability and safety have to be taken into account.

5) Considerations of Users

The interviewees where asked for their opinion whether users of libraries (i.e., readers) might have doubts when libraries offer AR apps. First of all privacy aspects have been mentioned. Users might fear that libraries use (tracking) data for personalization and services or even sell the data to third-party companies.

Five interviewees (members of all groups) take the position that using the AR app must not be compulsive. AR has to be an additional, but optional service that users might utilize if they like – and if they identify a benefit. Another group of five interviewees (2 AR experts, 3 librarians of scientific libraries) hold the opinion that users might perceive AR as disconcerting and not being a serious application. Furthermore, users may not be excluded because their mobile devices do not fulfill the required technological standards.

C. AR Applications for Libraries

The central question of the interviews is related to the relevance of AR applications for libraries [17]. There is no clear opinion whether there is a difference between public libraries and scientific libraries. However, several statements indicate that AR apps are relevant only for larger libraries. The experts where asked whether they consider the following applications to be useful and relevant for libraries:

- Augmented books
- Guided tours
- Searching for Media / Additional Information
- Gamification
- Shelf Maintenance

Table I presents an overview of their opinion [17].

1) Augmented Books

There already exist some examples of augmented book for children's books, reference books, and educational textbooks. Some libraries already offer augmented books. But even those libraries that do not offer augmented books yet, consider them as relevant. Several interviewees argue that it does not make sense to augment all books, but it is appropriate to augment some special books to provide added value.

2) Guided Tours

Six (out of eight) members of libraries consider augmented guided tours in the library or the building relevant. The AR app can provide virtual support while exploring the library which might simplify the utilization of the library.

However, three of the AR experts and two librarians did not expect guided tours as practical applications – above all due to the cost-benefit ratio. Especially for small libraries this kind of application is not practical. Classic, non-augmented tours shall not be eliminated since they provide personal contact.

TABLE I. AR APPS FOR LIBRARIES

Int.	**AR Apps**				
	Augmented Books	***Guided Tours***	***Searching for Media / Additional Info***	***Gamification***	***Shelf Maintenance***
AR1	✓	×	✓	Tend to ×	✓
AR2	✓	×	✓	Tend to ×	✓
AR3	✓	×	✓	Tend to ×	✓
AR4	✓	✓	✓	Tend to ×	Tend to ✓
PL1	✓	✓	✓	✓	✓
PL2	Neutral	×	✓	✓	✓
PL3	✓	✓	✓	Tend to ×	✓
PL4	Neutral	✓	✓	Tend to ×	×
SL1	✓	×	×	Tend to ×	×
SL2	✓	✓	✓	Tend to ×	×
SL3	✓	✓	✓	Tend to ×	✓
SL4	✓	✓	✓	Tend to ×	✓

Scale: Yes ✓ – Tend to Yes ✓ – Neutral – Tend to No × – No ×
Interviewees (Int.): AR = experts in augmented reality, PL = librarians working in public libraries; SL = librarians working in scientific libraries

3) Searching for Media / Additional Information

All except one interviewee think that searching for media in the library using AR is highly relevant and provides added value to users. Guiding the way to the book in the bookshelf and navigating the user with an AR app on a private mobile device is considered to be useful, especially for large libraries.

However, much more important – according to the interviewees – is the added value that is provided by additional information that can be displayed on the AR device. Additional information especially includes similar media, reviews, and ratings. Searching for a book might result in a list of, for example, four books. Then the AR app fades out all the other books and the four books of interest can be easily identified in the bookshelf. By providing additional information, like the abstract, a summary, or the first chapter of the book, users are assisted in their decision whether a book shall be lend.

Some interviewees (2 AR experts, 3 librarians of scientific libraries) mentioned the advantage of linking online and offline holdings. In addition to physical books in the bookshelf the AR app might display other books that are not available because another user has borrowed it or similar books that might be relevant for the lecture as well. Relevant media might be downloaded to the personal virtual library.

Three librarians argued that a disadvantage of this kind of AR app is its complexity and the amount of work on maintaining this app. The app has to be integrated with several databases in real time to access the additional information needed. The AR experts suggest that using this kind of app on a smartphone will be unsuitable and better for data goggles.

4) Gamification

The usefulness of gamification in the library using augmented reality is considered to be not very high – but it depends on the target group of users. Due to the profile of the users of scientific libraries gamification is hardly relevant. However, if a young audience shall be addressed by a public library AR-based gamification might be an appropriate approach with high potential. Visiting a library and exploring its offerings can be made more thrilling and exciting for young people with the help of games on a mobile devices. An integrated approach based on AR offers several opportunities – for fun, but also to communicate how a library works.

5) Shelf Maintenance

Support on maintaining the bookshelfs of a library using an AR app (like ShelvAR, see Section III.B) would be a real benefit for librarians. Most interviewees (4 AR experts and 5 librarians) agree on that issue. The biggest benefit is the saving of labor and making work much more easier in daily business. Three librarians (one working in a public library, two working in a scientific library) do not expect that an AR app might save much working time.

Shelf maintenance could be done using Internet of Things technologies as well, especially with RFID antenna [21] [22] [23]. Since approaches based on RFID are prone to errors and the implementation is expensive, it is seldom used. Therefore, AR-based approaches might be useful.

D. Findings

The central research question concerns the fact which AR applications are relevant for users of a library. The highest potential is awarded to searching for media and navigating to the correct location in the bookshelf. Searching for media and the display of ancillary information, like ratings, reviews, secondary media, links, etc., is most helpful for users. Using filtering and selection only relevant information can be displayed [17].

Maintaining the bookshelfs of a library with the help of an AR app is a real benefit for librarians. However, this requires a complex implementation and a complex infrastructure. Librarians are interested in providing guided tours through libraries using AR-based, custom designed apps.

Augmented books are an interesting offer for users, but providing augmented books is more in the scope of publishing houses than in the scope of the library. Gamification is the least relevant topic since is requires a very special setup and it is designed only for children and very young people.

Libraries offering AR apps to their users will benefit from improved image, improved quality of service for users, increasing time efficiency and making work easier for librarians.

The biggest challenges when implementing services based on augmented reality apps are cost-benefit ratio, technical issues (like display type, e.g., smartphone vs. data goggles; error rate of tracking), external and internal factors, overstimulation, and doubts of users.

V. Prototype of an AR App for a Scientific Library

To demonstrate the feasibility of an augmented reality app for libraries in practice a prototype app was developed for a university library [24]. The aim of this prototype is to ease the utilization of the library for students and university lecturers and to motivate students to use the library more often by providing additional benefits. The app shall be accessed by smartphones or tablet computer owned by the students. The *Augmented Reality Toolkit Wikitude* by Wikitude is used as the software development kit [25].

Following the fields of application demonstrated in section III two scenarios have been chosen:

- Presentation of additional information at special points of interest
- Display of additional context information to books

Visual triggers are used to activate the display of additional information [24].

A. Augmentations at Points of Interest

Augmentations are triggered by image markers attached to points of interest in the library. The markers consist of a common part identical to all markers (logo, icon) and an individual part including text plus custom icons that can be easily identified by the tracking software (Figure 4).

Fig. 4. Visual marker [24]

Each of the markers is assigned special virtual objects:

- *Welcome* (“Willkommen”) triggers a short video on the library. It is attached at the entrance of the library.
- *Library rules* (“Bibliotheksordnung”) will display the library rules as a PDF document. The markes is attached near the entrance and the library desk.
- *Operating instructions* (“Bedienungsanleitung”) triggers the display of step-by-step instructions on how to use the book scanner. Thus, it is attached on the scanner.

Typically, virtual objects are displayed when the camera of the mobile device is aligned to the marker. Since the information mentioned above is quite complex and requires some time to read, the information is presented in an extra browser window that remains open even if the marker is not identified any more (Figure 5).

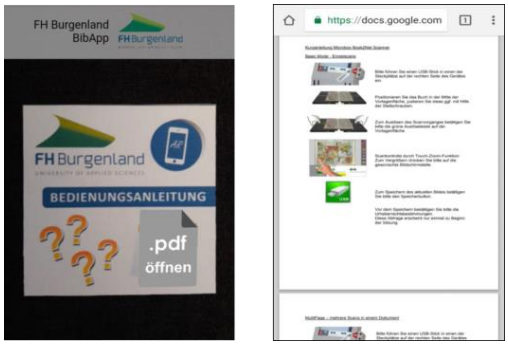

Fig. 5. Operating instructions [24]

B. Context Information for Books

Additional context-based information shall be displayed when the camera of the mobile device points at a specific book. Trigger may be either the book signature or the front cover of the book. The ancillary information is derived from *OPAC* (Online Public Access Catalogue) and the service *Syndetics Unbound* (e.g., summary, information on the author, reviews, ratings).

If the book of interest is in the bookshelf only the spine of the book is visible to the camera. The signature of the book is attached to the spine and can be used to identify the book. According to the signature, ancillary information like full title, names of all authors, language, year of publication, availability as ebook, summary, information on the author(s) will be displayed on the mobile device.

If the front cover of the book is visible, most of the relevant information is already visible and does not have to be augmented. Thus, the following information will be presented: language, year of publication, topic, availability as ebook, summary, information on the author(s) (Figure 6). Due to the length of the text of the summary and the information on the author(s) both types of information are displayed in an additional browser window. The size of the cover pictures used as markers in Wikitude should be minimum 500x500 pixels and maximum 1000x1000 pixels.

Fig. 6. Context information on cover trigger [24]

Because only a few reviews and ratings are available in the database this kind of information is not displayed in the prototype, yet.

C. Features

The prototype offers the following features:

- Recognition of specially designed visual markers for tracking
- Recognition of book covers for tracking
- Retrieval of metadata to identified books (cover marker) from the Wikitude cloud
- Display of text information related to books
- Display of virtual buttons on the touchscreen (Figure 6)
- Play a video
- Display of PDF documents

However, there are still some limitations. Character recognition of the book signature does not work properly in Wikitude. However, some plugins are available yet that might be used to integrate third-party text recognition modules. Since Wikitude works well on image recognition and not on text recognition, book covers that are monochrome and include only text can be hardly recognized. Book covers with high similarity (e.g., a series of books) can not be distinguished as well. They would have to be identified by their signature. Wikitude does not provide a database integration. Thus database access has to be implemented using an additional web service.

VI. Conclusion

A study based on qualitative interviews with librarians working in public and scientific libraries in Austria and experts in augmented reality derives which kinds of applications have potential for libraries. Searching for media, navigating to the correct location and displaying ancillary information, like ratings, reviews, secondary media, links, etc., has the highest potential for users according to the interviewees. AR apps for maintaining the bookshelfs of a library provide real benefit for librarians and are awarded high potential as well. Guided tours through libraries using AR-based, custom designed apps lightens the load of the librarians to introduce new users to the library. Augmented books and gamification approaches are awarded much less potential for libraries. This study provides useful insights on the relevant fields of application of an AR app.

Those insights have been the starting point for the development of a prototype app. It was designed for a university library to demonstrate how an AR app supporting readers (casual users and regular users of a library as well) might look like. The main focus of the prototype is on providing additional information to books that can be identified using visual tracking. The prototype has been designed to identify critical aspects and problem areas when implementing such a service.

VII. Future Work

The survey provided sufficient baseline information to start the prototype implementation of the AR app. However, we interviewed experts in the field (AR experts and librarians). We still have determine the requirements of readers who visit the library and will use this app.

The prototype has limited functionality that has to be enhanced in the future. More databases have to be integrated to provide real time data on additional information related to books. Visual tracking of the signature of books has to be improved to unambiguously identify each book in the library. Books in the bookshelf only show their spine including the signature as a text code. Our prototype does not provide proper character recognition yet which will have to be added in the future. Guiding users to the bookshelf where their book of interest is located has not been tackled yet since this a complex task to achieve in an indoor environment.

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