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Augmented Reality Navigation App and Metadata Icon Design for Children's Library

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Abstract:

Innovative services, digital technology, and quality information are increasingly required in libraries to meet the needs of digital natives (i.e., children). The information-seeking behaviours of children in the process of book selection, searching, browsing, and using a library differ significantly from adults. In this study, we have developed an augmented reality (AR) navigation app to help children find books and bring children a novel library experience.

Based upon the knowledge structure of children and how they perceive the thematic order of books, we designed visual interfaces for the AR navigation app, targeting children between the ages of 6 and 12. In order to align with their cognitive abilities and reduce their cognitive load, this study changed each subject category into a graphical icon. We also designed a corresponding monster icon for each user category, which will assist the children in navigating the positions of bookcases in the library. The interesting presentations not only evoke curiosity in children while allowing them to learn about the meanings of the subject categories, but our presentations also enable the children to explore the diverse range of physical books and abundant digital learning resources within the library.

The ability to navigate was achieved by constructing an indoor positioning system that combined iBeacon with our AR navigation app system while utilizing important physical markers and virtual visual icons within the library. The above app can be used to accumulate electronic records from various information systems and interfaces and thus allow children to better locate materials or books that they seek in a smart library. Furthermore, we employed big data to determine the correlation between "children of different needs or preferences" and "their information-seeking behaviours" in order to better understand the future development of smart libraries.

Keywords: Information seeking, Augmented reality, App, Icon design.

Introduction

Children's libraries in Taiwan use the metadata of books and the New Classification Scheme for Chinese Libraries to systematically store and manage books. Each stack has a corresponding subject classification number, and books are arranged in different areas of the libraries, depending on their subject classification numbers. Users must find the area corresponding to the subject category of books that they are looking for and then walk to said area; however, this search model is not suitable for children (i.e., digital natives). Aside from the fact that their cognitive abilities are still developing, their reading preferences and spatial experiences (such as the height of bookshelves) are very different from those of adults. The way that books are currently arranged makes it difficult for children to look for books, and consequently, librarians must often invest a lot of time and effort to physically guide children to look for books. Developing a smartphone app, which could incorporate mobile technology, smartphone platforms, augmented reality (AR) technology, and suitable icons for different subject categories, for young readers could enhance their autonomous learning abilities. Moreover, an app could also recommend other books of interest.

The objectives of this study were to (1) define the cognitive capabilities of children with regard to subject classification in learning to develop meaningful icons for corresponding themes, (2) explore the information-seeking behaviours of children in different scenarios and develop a smartphone AR visualization interface and information system to help children look for books, and (3) develop information system functions and integrate them with data analysis and book recommendations to enhance self-learning. We used digital technology to not only create a smart children's library but also to assist children in different stages of development to apply their informational skills.

Literature Review

Information technology can be used to shape new architectural spaces for libraries. In the past, automated systems were installed for library navigation and entrance/exit control at a single access point (3M detection). With the concept of smart living spaces and recent progress in mobile technology and the Internet of Things (IoT), many studies have explored how smart buildings can be applied to the development of libraries in the future (Hoy, 2016). Antevski, Reondi, and Pitic (2016) used iBeacon for indoor positioning and Wi-Fi to greet readers who had formed their own study groups in the library, thereby demonstrating the feasibility of the dynamic management of readers in libraries. Hahn (2017) stated that mobile technology and location-based services can be combined into an IoT; using the library at the University of Illinois Urbana-Champaign as an example, he developed the Wayfinder app and examined relevant security issues. Bruno (2015) listed the possible applications and case examples of wearable technologies from smart watches to Google Glass.

To apply mobile technology to assist children, we must first consider their spatial and cognitive abilities. Given that children are curious and like fun, Bilal (2005, p. 204) indicated that, "In the children's eye, the visual design of a successful portal is one with a fun name." Incorporating visualized navigation, such as virtual world (VW) information search interfaces (Beheshti, 2012), can motivate children and help them look for books and information.

Chase and Chi (1985) observed a close relationship between spatial knowledge and the cognitive process of wayfinding, and then divided spatial knowledge into route spatial knowledge and survey spatial knowledge. The former refers to the knowledge needed by an individual to execute a task or execute a task in the right order. The knowledge adopted is oriented towards wayfinding strategies using relative coordinates. The advantage of route spatial knowledge is that very little information is displayed on a navigation interface at any given time. The images and functional configurations are simpler and there is no information overload. In contrast, the survey special knowledge refers to the knowledge that an individual has regarding the overall network architecture of an organized activity or task, and the knowledge adopted is oriented towards wayfinding strategies using absolute coordinates. In a virtual spatial interface, the advantage of survey spatial knowledge is that all of the functions and configurations can be seen at a glance. However, the disadvantage is that the display of too many functions or too much information at the same time may contribute to user information overload. Wu et al. (2017) employed a smart watch and a map (survey spatial coordinates) for navigation in a children's library, which piqued the curiosity of children to use these devices to find books. Nonetheless, no AR smartphone navigation app based on route spatial knowledge at present has been developed in coordination with the mentality of children to create game-like mixed-reality environments to meet the needs of children searching for information or books.

Methodology

This study employed the database at the children's library of the National Library of Public Information in Taiwan to classify books by subject and to create a different theme icon for each subject category. Using big data, we analyzed reader statistics with regard to book-borrowing and learning background to recommend books and monster icons (user profiles) to children. With an AR function, the monster icon leads children to the locations of books. Children can comprehend connections between the monster icon (children location) and the theme icon (book location) and thus navigate their way to book locations. The guidance from the monster icons can also create an interest in learning and reading in the children and promote self-learning.

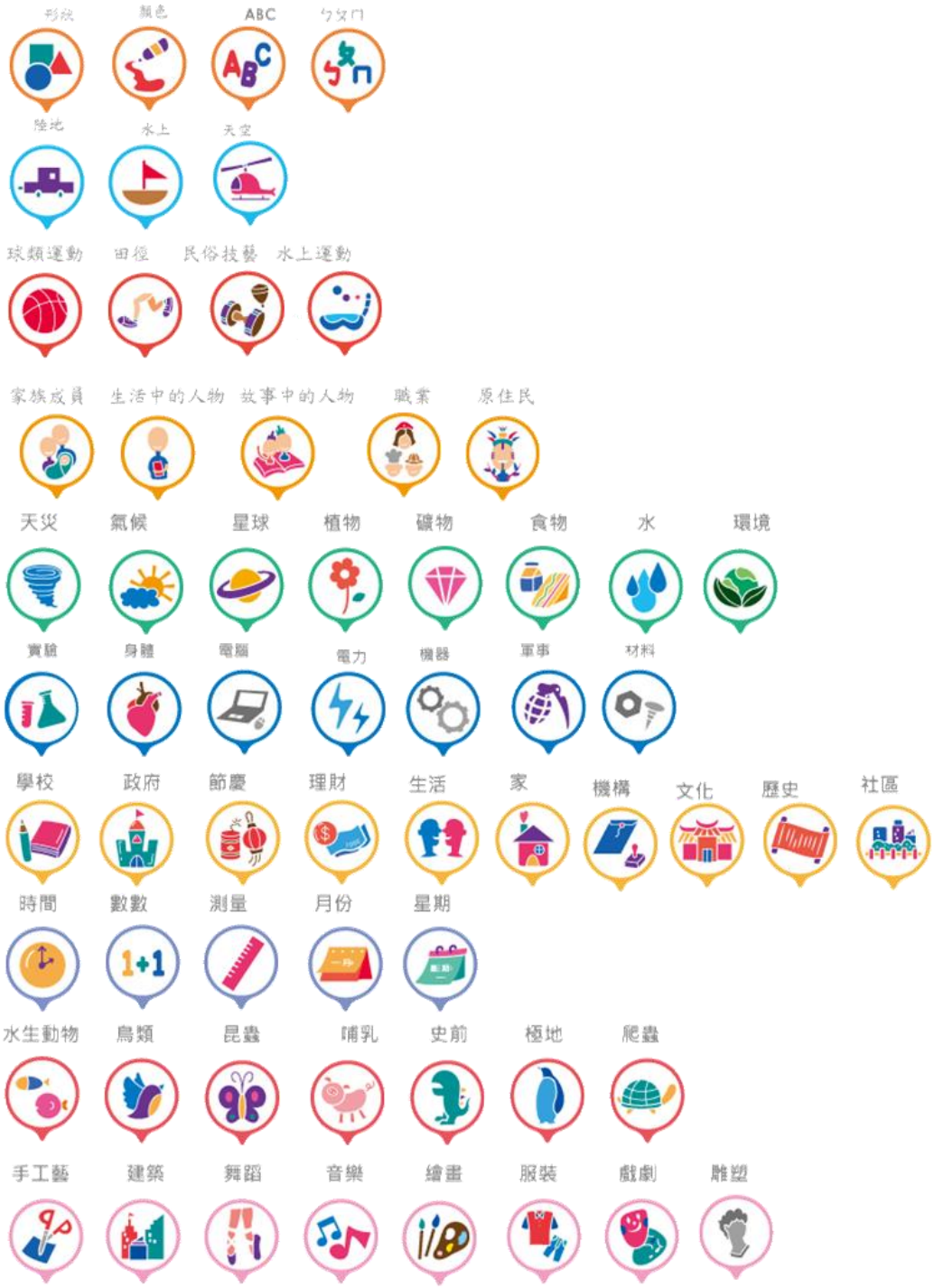
Result

(1) Children subject classification framework, keyword extraction, and icon design

The dual-coding theory explains that humans use different cognitive methods to process the information content of images (intuition) and text (comprehension). Libraries house numerous physical books and are thus have been defined as treasures of knowledge. The book search functions of automated systems are also mainly based on the manipulation of words and an understanding of the meaning of metadata. However, the massive amounts of information on the internet are not classified based on convention by subject; therefore, digital natives, who are accustomed to browsing information online, are unfamiliar with conventional library classification systems and often misunderstand them. Children in the concrete operational stage prefer intuitive knowledge and have difficulty using the New Classification Scheme for Chinese Libraries. In view of this, we employed a folksonomy approach to develop iconized subject categories, which are better for children to use, as well

as icon designs with a reasonable subject classification framework (as shown in Fig. 1) for the app interface.

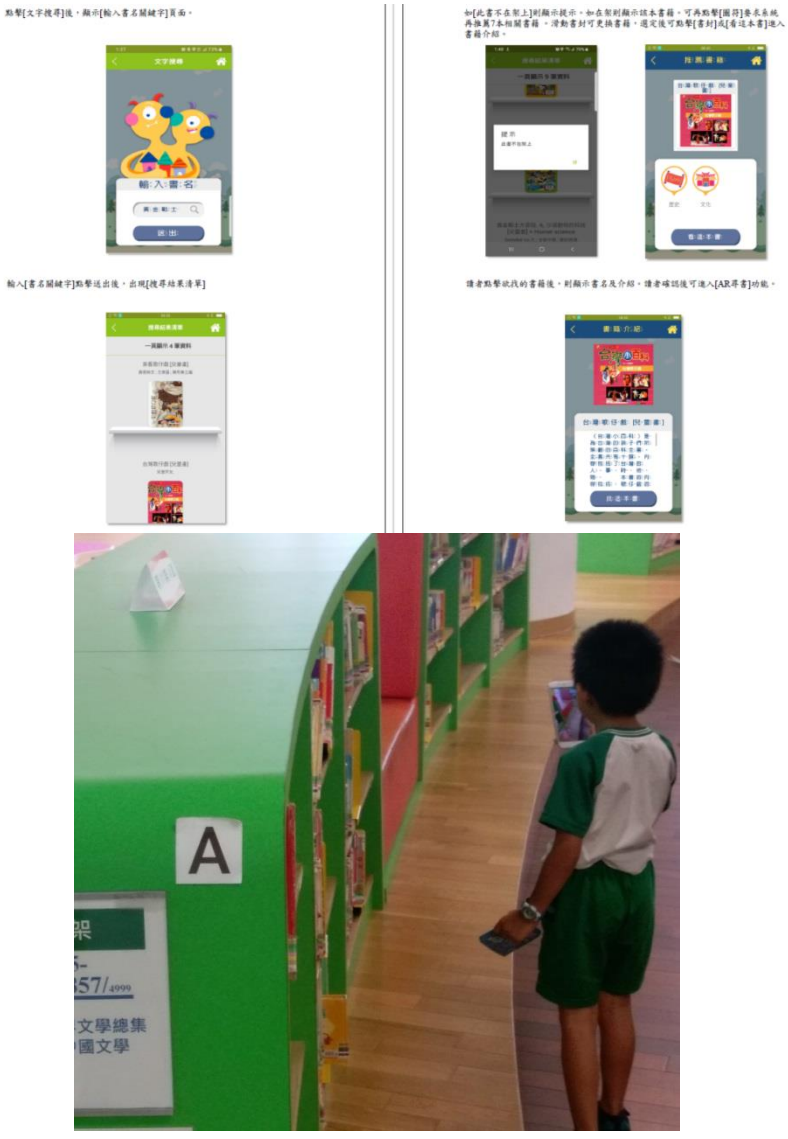
Figure 1. Subject Categories and Their Corresponding Theme Icons



(2) AR visualization interface on smartphone

Game-based learning in libraries can prompt children to explore and learn on their own. We thus developed a visual, game-based learning software and application interface that fits the cognitive abilities of children so that the interface is also easy for them to use. The smartphone app interface can use AR technology to mark important physical markers in libraries. Theme icons corresponding to subject categories and the cognitive abilities of children guide children to the locations of books without subjecting them to significant cognitive load yet giving them the chance to explore the wide variety of books and e-learning resources in the library at their own pace (see Fig. 2). The National Library of Public Information currently uses UHF RFID in its books, which coordinates with its automated circulation system. The location-based services in the library use iBeacon to mark the locations of areas and stacks. Whether a book is in the library is confirmed via the automated information system and, if available, the shelf it should be on is determined based on its subject category. The interface then uses an arrow (with the location of the child being the origin of the polar coordinate system) to guide the child to the book.

Figure 2. Design of Book-Searching Interface and Actual Navigation Conditions



(3) Enhancement of library information system and children self-learning mechanism for book recommendations

The objective of game-based learning is to use games to generate interest and increase motivation for learning. However, motivation is not equivalent to effective learning which requires correct learning content and continued stimulation. Applying game-based learning to the static reading environments in libraries is somewhat different from the use of serious games in museums, which are a passive way of evoking interest and enhancing learning in a short period of viewing time. Because the primary function of libraries is to support learning, asynchronous learning methods are often used so that children can control the progress of self-learning by themselves. This study set up initial data architecture to set the suitable parameter weights of data feedback groups. With the book-borrowing history of readers and book summaries, word segmentation and data mining are performed, and then books are recommended to different readers based on suitable patterns of word segmentation. Furthermore, the results can be used to analyze the information-seeking behavior of children in smart libraries.

Discussion

(1) Research on development of navigation and book-searching models for digital natives to promote reading literacy

Improving the reading literacy of children has always been the primary mission of public libraries. Using mobile technology apps to help children navigate and search for books in smart libraries is in line with the habits of digital natives with regard to using computer technology to search for information and to learn. For the development of innovative services in smart libraries, it also means a new opportunity to study the utilization of digital information. Conventional automated library systems with books as the unit of management and records are being expanded to encompass smart spaces, digital units with thematic metadata, and information-seeking behavior of readers, thereby becoming a probe to further understand the human application of digital information. During the process of system development, the book (digital information)-seeking patterns of children are processes of dynamic development and repeated corrections as well as case examples for action research. They are also cross-disciplinary research attempting to combine human-computer interfaces with librarianship.

(2) Verification of the National Library of Public Information's pioneering practical achievement and its promotion to public libraries

The National Library of Public Information plays a supporting role for public library services throughout Taiwan and holds the promotion of reading and the use of library resources to children (and the public) in high regard. The AR navigation smartphone app developed in this study highlights that the application of mobile technology to libraries is a chance to begin a trend for the use of digital resources in libraries. After the National Library of Public Information successfully developed and implemented a smart watch navigation system for their children's library in 2017, they employed a similar model to develop a smartphone navigation system for the entire library. This study proposes the incorporation of AR into the existing navigation system of the National Library of Public Information to promote system maturity. With the scalability of smartphone platforms, opportunities to develop navigation systems suitable for all public libraries throughout Taiwan are possible as well as to demonstrate the application of mobile technology and development of information education.

Conclusion

Our research team developed an app with AR navigation and book recommendations for a children's library. We conducted the following: (1) developed meaningful icons for corresponding themes in a library, which involved defining the cognitive and memory capabilities of children with regard to subject classification in learning, (2) developed an AR interface on a smartphone to help children look for books, which involved exploring information-seeking behaviors in different scenarios, and (3) developed a library book recommendation system to enhance self-learning, which involved integrating data analysis regarding readers, the library's collection, borrowing, and space, as well as the library book recommendation system for children self-learning. In this era of information explosion and diverse resources, the app can attract digital natives to the innovative service models and quality information content of smart libraries, enhance their reading literacy, promote self-learning, and lay down the foundation for future lifelong learning.

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