QR codes in library - does anyone use them?

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Abstract - Although they were initially intended exclusively for use in shipping industry, Quick Response code is gaining popularity with widespread use of smartphones and has began to be used and implemented in various types of libraries for engaging and assisting patrons. Absolutely free, allow access to more data than standard bar-codes, can be read with almost all types of smartphones and with great potential to bridge the gap between digital and physical objects. Sounds good, but is it? In this paper we will overview current usability and future applications of QR codes in libraries.

I. INTRODUCTION

Today it is clear that the most widely used device in the world is the mobile (smart)phone. Phones are mostly voice-centric devices, but a wide range of mobile devices now exist on the market offering multiple services and functions. The term smartphone is now used to characterize a mobile phone with special computer-enabled features. Despite the mobile phone evolution, one of the main disadvantages of these devices is that they still have insufficient input capabilities, providing tiny keyboards to do manual entries. Fortunately most smartphones are now equipped with several sensors that can be used to enhance and create new users interfaces. This is the case for integrated cameras that can be used to read visual codes, like Quick Response (QR) code as well as other sensing technologies such as Radio Frequency Identification (RFID) and the associated Near Field Communications (NFC). The use of these technologies does not only facilitate entering information, but it also allows using mobile phones for interactions with people, places and things, enhancing the usability and usefulness of these devices. The use of QR codes and RFID tags has significantly evolve in the last decades, they were first used to track products in the industry, but now they have contributed to develop several new concepts that integrate the physical world with the virtual one [1]. Essentially, QR codes are a low-threshold technology, convenient way to add the virtual to the physical and to provide useful content, often at the time of need [2]. But are they actually useful?

In this paper we will review possible implementation methods of QR code technology in libraries from aspect of usability and convenience. As this technology is low-cost, easy to implement and easy to use there is no doubt that in the future it will be even more in libraries, but it is difficult to predict if it will ever get wide acceptance by library patrons.

II. ABOUT QUICK RESPONSE TECHNOLOGY

Quick Response code or QR code is a two-dimensional (2D) bar code developed in 1994 by Denso Wave Corporation; QR code got this name because it was developed to improve the reading speed of complex-structured 2D barcodes. This type of code was initially used for tracking inventory in vehicle parts manufacturing. QR code is established as an ISO standard, it has been defined in the Information technology — Automatic identification and data capture techniques — QR code 2005 bar code symbology specification (ISO/IEC18004). QR code is free to use and the technology is open since its specification is disclosed and the patent right owned by Denso Wave is not exercised (Denso Wave Incorporated, n.d.).

The main characteristic of a QR code compared with a traditional bar code is that it contains information in both the vertical and horizontal directions, while a bar code contains data in one direction only. For this reason QR code holds a considerably greater volume of information. In addition it can encode several types of data including symbols, control codes, binary data, and multimedia data. The typical barcode holds a maximum of 20 digits, while the maximum data capacities of a QR code are 7,089 characters for numeric data, 4,296 characters for alphanumeric data, 2,953 bytes for binary data, and 1,817 characters for Japanese Kanji and Kana data.

FIGURE I. Comparison of QR code and Bar code [3].

QR code is faster to read than other two-dimensional code, because it contains three large square patterns in the corners that are used for position detection. Additionally, the patterns are used to detect the size, the angle and the outer shape of the symbol. When a reader scans a symbol, it first detects these patterns. Once the position patterns have been detected the scanner can rapidly read the inside-code in all directions. The inside code consists of several blocks where the information is encoded [1]. As suits something developed for demanding, fast moving environment, they included generous error correction

capabilities and QR codes can be set up to still work even if 30% of the symbol is damaged or obscured [4].

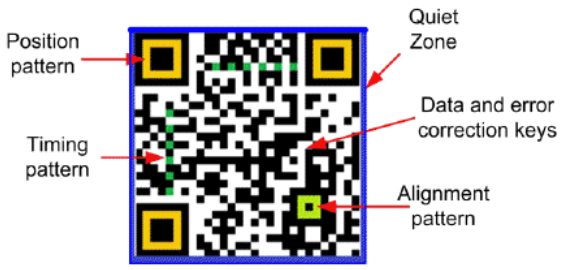

FIGURE II. Structure and components of QR code [1].

The elements contained in a QR code are the following:

- Pattern. Three big squares in the corners used for detecting the position, the size and the angle of the QR code.
- Alignment Pattern. A pattern used for correcting the distortion of the QR code. These distortions could occur for example when attaching the codes onto a curved surface.
- Timing Pattern. It consists in white and black modules arranged alternately and placed between two position patterns. It is used to determine the central coordinate of each cell in the QR code.
- Quiet Zone. A margin space that makes easier to detect the QR code. At least four cells are required for the quiet zone.
- Data Area. The area in the QR code that contains the data (for example a URL) encoded in binary numbers. The data area also includes Reed-Solomon codes to provide error correction functionalities [1].

III. COMPARISON WITH SIMILAR TECHNOLOGY

The Internet of Things (IoT) enabled users to bring physical objects into the sphere of cyber world. This was made possible by different tagging technologies like NFC, RFID and 2D barcode which allowed physical objects to be identified and referred over the Internet. The emergence of Internet of Things has provided an initiative to link our cyber lives with the physical ones by exploiting low-cost embedded tags, i.e., RFID, NFC, 2D barcode. Due to less complexity and low development and deployment cost of 2D barcodes, they have become the primary tool to create a linkage between physical objects and their cyber representations [5]. There is widespread assumption that the increase of NFC enabled mobile phones will replace the use of QR codes, but it is more likely that both technologies will coexist for some time.

The best definition of Virtual Reality (VR) is when participants are completely immersed in a fictitious world that can take some properties of the real world but that replaces it with a simulated one. The road from the real world to a virtual one may include other environments where the participants are still connected with a real world while enhancing it with other contents, merging both worlds in some way. This concept can be referred as Augmented Reality. Augmented reality (AR) refers to augmenting the real-world with content generated with a computer or another device. This content can include sound, video, graphics, and other data [1].

RFID uses radio waves to store and retrieve data from an identification chip. These chips are known as RFID tags and they provide limited information, but connected to the wealth of information that our libraries hold on our stock and our users and thus they become smart objects, acting as mobile connectors to a world of usage and behaviour information. RFID is now widely used in the industry for several applications including security, access control, transportation and tracking of the supply chain. Also in libraries they are primarily used to label stock and have tended to be used in much the same ways as barcodes previously. They have made it easier for library users to issue and return items through self service equipment and some libraries have used them to aid stock taking. There is so much more that we could do with them though, using them to display some of the data linked to our physical items that is normally inaccessible to users [6].

Usually an RFID system requires three main components: the reader/writer, RFID tag and application software for processing the information. The RFID reader comprises an antenna, a transceiver and decoder. The reader periodically transmits signals to search for tags in their vicinity. When it captures a signal from a tag, it extracts the information and passes the data to the processing subsystem. An RFID tag or transponder consists of an antenna, a radio transceiver and integrated circuit for storing and processing information. There are several types of tags. A tag contains writable memory where data is stored to be transfer later to RFID readers. The internal memory capacity of a tag depends on its model and varies from tens to thousands of bytes. RFID technology is classified into the short-range wireless communications, which are systems that cover distances of less than 100 meters [1].

Near Field Communication (NFC) is also a short-range high frequency wireless communication technology which enables the exchange of data between devices at distances fewer than 10 cm. This technology is an upgrade to RFID technology; it was designed and marketed by the NFC Forum. The International Standard Near Field Communication - Interface and Protocol, ISO/IEC 18092 (NFCIP-1), defines communication modes for NFC interface and protocol. According to this standard, NFC can operate in active or passive mode. In active mode, the devices generate their own electromagnetic field independently, while in passive mode only one of the devices is capable of generating an electromagnetic field and the other extracts energy from it to operate and transmit the required information. One of the key elements of NFC enabled devices is the ability to read different types of tags. This facility of NFC technology is a key enabler for many applications. NFC tags are passive devices with no power of their own. In order to read a tag

the users almost touches it with an NFC-enabled device. A small amount of power is taken by the NFC tag from the reader/writer to power the tag electronics. The tag is then enabled to transfer a small amount of information to the NFC reader [1]. NFC could maybe have knocked QR codes aside if Apple had decided to include NFC in its mobile devices. NFC is less maligned but more precipitous. Being kept off Apple's devices has effectively kept NFC from penetrating the mainstream technology market.

Augmented Reality has not seen the pick-up predicted by its potential, though that may change with the growth of some types of wearable computing technology [7]. AR is another means of integrating the digital and physical world, though in a much more interactive manner than with QR codes. AR is best defined as an overlay or augmentation of the physical environment with sounds, graphics and perhaps location-based information (geolocation) [8]. A person uses applications, such as Google Goggles or Layar, that use a mobile device‟s camera to identify objects and provide more information on the object, layer information over the view from the device‟s camera or locate the device and provide information based on the user`s location, and thus provide more interactive experience and enhance perceptions of reality [9].

IV. ANALYSIS OF QR CODE USE IN LIBRARIES

It is safe to say that library patrons in social driven world want to feel connected to and involved with the information, they are more social now than ever before. We need to encourage this type of interaction between information the library provides and the users. So, QR codes are recognized by many as means of encouraging this type of interaction. Of the examples we reviewed, the most useful and successful implementations are those that provide some value-added service for the users. Adding value means that using the QR code is better or easier than using the existing service or that the library is providing a service that is uniquely useful via QR codes [10].

Some reasons for implementing QR codes in libraries are:

- to dynamize relationship with patrons,
- to give an extra access point to website,
- to improve the image of the library [11],
- linking from print to electronic journal holdings, on the boxes containing back copies of print journals, together with the display stands holding current copies, QR codes took users to link resolver, searching electronic holdings and linking to the appropriate electronic journals where available,
- library exhibits that include a QR code link to songs, videos, Web sites, surveys, etc. or other information that augments the exhibits,
- linking to library audio tours for orientations,
- added to print handouts for additional information on mobile friendly sites,
- QR code with text that loads the library's text message reference service and other contact information into the patron's phone,
- art shows or permanent art in libraries with a QR code linking to the artists Web sites,
- in catalog record to offer patrons basic info about an item, including the location and call number, users can scan the code and head to the stacks rather than writing or printing,
- taped to video DVD cases, linking to mobile-friendly video trailers,
- code placed on audio book cases for author interviews or books for reviews,
- code placed on study room doors connecting to room reservation forms [2],
- providing an electronic alternative to physical books,
- promoting online audiovisual materials,
- embedding video help,
- bringing external resources into the library,
- QR codes displayed across the library that linked to help desk, prompting the users phone to ring IT help; library help; or send an SMS to our "text a librarian", whichever was appropriate for the location [6], and
- to embed QR codes in the physical space, people can scan the codes and instantly engage with the library via social media.

One of the initial uses of QR codes has been within library catalogue records, and also one of the most popular, including the University of Ryerson Library and Archives in Toronto, San Diego State University Library and the University of Bath and Huddersfield Libraries. The codes are embedded in each item record, and, when scanned, send shelf location information to the user`s mobile device. Such information can vary, but typically includes basic bibliographic information such as title and author, as well as call number, floor and library building. By using QR codes, library users do not need to record the exact location information as this data has been stored on their mobile device, and they are certain to have all of the necessary information to find the item in the library`s collection [9].

The University of Bath is the predecessor of applying QR codes in education. They have incorporated this technology in several aspects related with the learning process. For instance, they use QR codes in the library to provide information about the books. They have also developed an enhancement for Moodle which automatically includes the QR code for the page that has been printed. The QR code contains the URL of the page on that particular Moodle course. They have also added QR codes on posters that can be found around the campus,

on Websites and service blogs for bookmarking, in handbooks linking to activities, and in marketing materials from departments.

According to Susono and Shimomura [12] in Japan almost 100% of college students have mobile phones, for this reason they are commonly used for education purposes. In their work they reported the use of mobile phones and QR codes to conduct surveys during class, this with the intention of providing feedback to the teacher at the middle of a long class (i.e. 90 minutes). With this project students answer a survey using their mobile devices and QR codes to choose from different options. They send the answer to a server and the teacher can have immediate feedback in order to improve his/her class if needed.

However, there are certainly some downsides to implementing QR codes in libraries that we have to mention. QR codes are only one application among many on devices that are relatively new, they are not well known. Users need to be educated about what the codes are and their use. Scanning in poor light or off a computer screen can be troublesome, as some camera phones cannot read the code properly and it becomes blurry. Furthermore, the more information stored in a code (for example, a long URL), the more complicated (or pixelated) it will be, and thus harder to scan. Thus, the inconvenience associated with scanning a QR code (downloading an application, opening the application and then scanning the code) may be too great, depending on the situation. The difficulty associated with the installation of a third-party application to a mobile device (the QR code reader), as well as needing to open the application on the device, scan the code and then load the information contained within the code is still a barrier (real or perceived) that can inhibit their use.

Another barrier is convincing users that scanning the QR code will provide them with valuable information or an enhanced experience. In most of projects that implemented QR codes in libraries there is huge disappointment with the actual usage of new service. In the analysis of pilot project carried out in the Eda Kuhn Loeb Music Library of the Harvard College Library Wilson [13] states that "none of the three on-line resources were viewed via QR codes more than five times each over the course of the entire semester, and the actual utility of those page views was minimal, at best. Of the three sites, only the "Finding Concert Reviews in Periodicals" appears to have been accessed for use, as the other two research guides had only single page-views, and no recorded time on the sites themselves. Legacy and current usage statistics indicate that the sites are being used, with anywhere from 31 to 53 site visits over each of the past two academic semesters, but once the data is examined at the platform level, mobile usage was negligible in comparison to conventional on-line access." Among the likely reasons for the lack of acceptance of QR codes in this pilot project are a wider than previously believed misunderstanding of what QR codes are and what they can do. Despite their ubiquity in the public space, a significant portion of the population appear not to know exactly what they are, or even what the term QR code means. Abuse of the QR code technology to gather information on users is another potential negative. While QR code generators may be downloaded for free, it has been reported that some generators collect data about users before redirecting the user to the desired web site, and there is also a possibility of linking to malicious websites, and providing new ways of luring people into phishing scams [14].

V. CONCLUSION

When planning implementation of QR codes in library it is necessary to pay attention on potential short-falls that include: real world usage, their reliance on the scanner being stable and steady, size and distance sensitivity, but much of the argument in favor of QR codes in the library comes down to a simple cost/benefit analysis. And in this case, as long as a few simple rules are followed, the cost of employing QR codes is so low that any benefit derived from them outweighs the minimal effort involved.

There is a reason that QR codes have become so ubiquitous in print advertising, points-of-sale, and other venues: they are so easy to use, and cost so little in terms of resources, time and money, that despite low acceptance by the public, it is a technology simply too easy to ignore [13].

Bearing in mind that QR codes should not be used just for the sake of the technology, we need to ensure the learning design focuses very much on the appropriate use of QR codes where it adds value to the learning experience over and above other delivery methods.

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