Implementation of an Inventory Control System for a Computer Center Using QR Codes on Android Mobile Devices

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Abstract—This paper presents the design and development of a mobile application that uses QR codes for the inventory control of a computer center. This application was developed to support the administration of the computer center of the Multidisciplinary Unit Tizimin, with the aim to reduce costs and time of searching for articles when making an inventory, by leveraging the capabilities of smartphones and tablets. The implementation of the system was carried out using free software.

Keywords—Inventory Systems, QR Codes, Mobile Applications.

I. INTRODUCTION

Cellular telephony has become a service of great importance for the general population since it allows to establish a ubiquitous and timely communication, besides of being the technology with greater penetration and the one with less regional inequalities. INEGI states that two out of every three cell phone users have a so-called "smart" cell phone (Smartphone), that is, capable of establishing an Internet connection [1].

The speed with which smartphones have advanced, the combination of innovative interfaces and the wide range of software applications developed for them, have positioned the same as compact tools capable to perform many tasks that were previously reserved for desktop computers.

With the appearance and popularization of smartphones and electronic tablets, the QR (Quick Response) codes have been spreading and have become more important in everyday life. These two-dimensional codes are capable of storing many information, and to perform the reading from them only is needed a device with an integrated camera. The main objective of this work is the design and construction of a mobile application that implements QR coding as a support tool in the management of the computer center of the Multidisciplinary Unit Tizimin, in order to reduce the search time of articles during the realization of inventories.

II. STATE OF THE ART

The most important concepts related to this work are defined and some contributions from other authors are presented below.

Inventory System

An inventory consists of the registration of physical products that are stored in a determined place and time [2]. Some of the most popular methods to make inventories are of manual type, where each of the sales and purchases is annotated in some notebook or sheets, later the technology was involved in these methods and the software Excel was a great tool to register the information in a more agile way, later the technology based on bar codes improved the process, despite the additional costs implied, including from the lector device to even the computer and software focused on the bar code reading [3].

QR Code

A QR code stores information in a matrix, that can be visualized in printed format or on screen, and are interpreted by means of a camera and a specific software [4]. A QR code (quick response code) is a kind of two-dimensional bar code designed to be read by smart phones. This code consists of black squares arranged in a bigger square pattern over a white background. The encoded information can be text, an URL or any other kind of data [5].
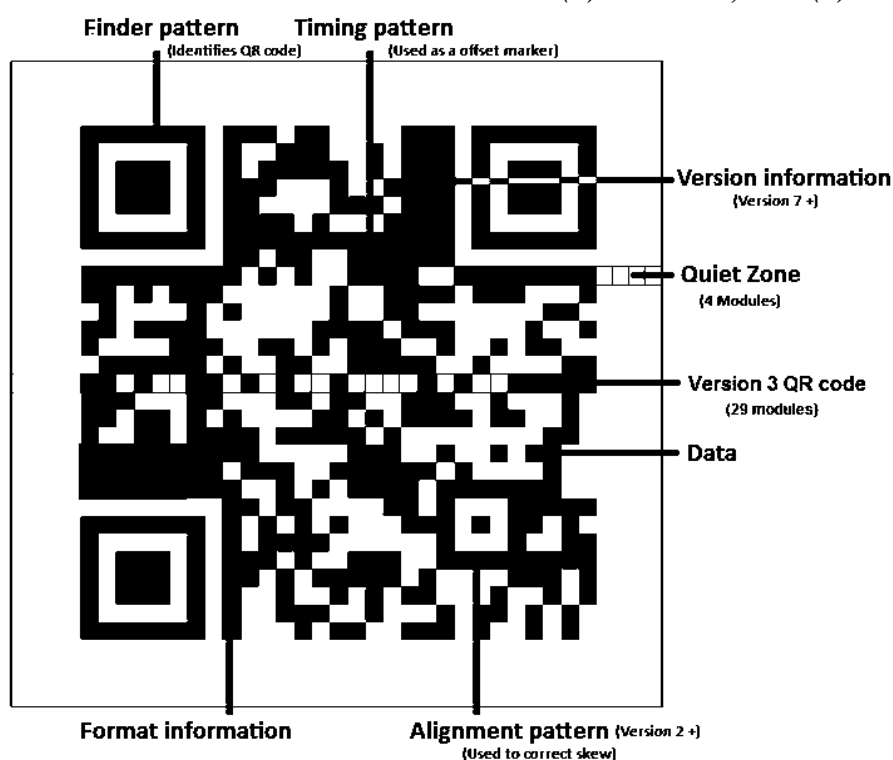
Figure 1 shows the structure of a QR code.

Fig. 1. Structure of a QR code [6].

Mobile applications using QR codes

QR codes are employed by the main advertising and marketing industries, as well as by inventories administrations of a wide variety of industries. Likewise, web addresses (URL) are becoming more frequent in magazines, newspapers, papers, etc. [5].

According to Graván [7], among the main uses and functions of QR codes are:

- To access an Internet address or web page (URL).
- To access an Internet address to download a program from the App store and install it in a smartphone.
- To store the information of a contact: first name, last name, phone number, web page, email, postal address, etc. (Vcard).
- To connect automatically and by means of a security code to a wireless network (only for terminals based on Android operating systems).
- To manage inventories in a wide variety of industries [5].

Related works

Some investigations related to this work are presented below.

In [8], the authors developed an iterative book (Magibook) as a teaching strategy whose objective is to give students virtual scenarios related to the theme using augmented reality with markers printed in the book. The software of augmented reality was made for Android devices, Vuforia was used to generate markers based on QR codes, Blender was used to make the 3D modeling, and the audios in mp3 format were generated from text using the application DSpeech.

In [9], the author addresses the concept of what is a QR code, its origins and operation, then provides some ideas of how this technological tool can be integrated as an educational tool in the classroom. At the final part, the author concludes that although QR codes were not designed for educational environments, by being available to all students, without incurring into additional expenses, they offer to teachers the opportunity that with a greater effort of integration and restructuration of classes, can be achieved an effective insertion of QR codes in the educational field, thus providing more resources for traditional classes.

Finally, in [10] the author proposes a prototype that manages the electronic laboratory elements of a university achieving a reduction in the time to lend those elements compared to the manual registration way that has been carried out till the date. For the implementation of the prototype the operative system Android and the iterative cascade model were selected, in the same way a client-server architecture and a relational database with MySql were designed. Besides, the prototype includes a module for web management where it is incorporated the creation of QR labels needed for the addition of new elements.

III. DEVELOPMENT OF THE APPLICATION

The most important concepts related to this work are defined and some contributions from other authors are presented below.

Methodology

For the design and implementation of the mobile application, five stages were considered. Initially, the analysis stage was carried out, where the user's requirements were obtained and classified using a participatory approach, that is, including in its entirety the directly impacted population, such as those in charge of the computer center. At the same time, the appropriate literature on the functionality of QR codes [4] and methodologies for the development of mobile applications were reviewed [11] y [12].

Subsequently, the design stage was carried out, where the technological scenario was defined and the solution was structured by means of a use case diagram, integrating time and other resources. Below is the general use case of the application (Fig 2).
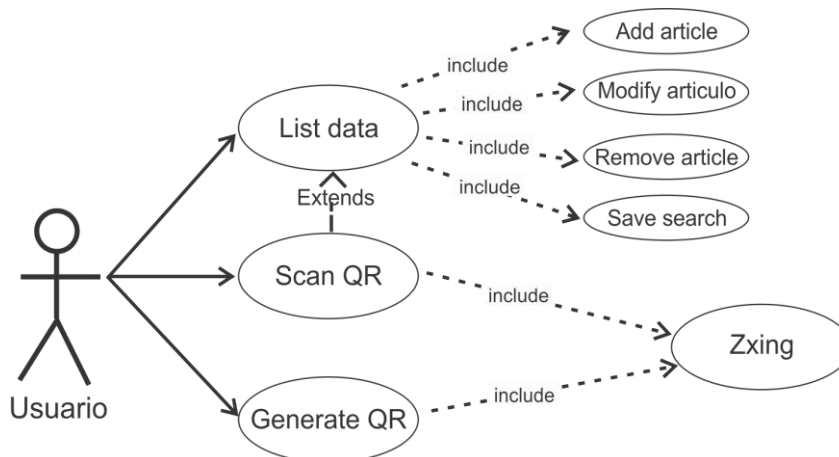

Fig. 2. Use case diagram.

User: It is a single user that interacts directly with the mobile application, performing all the actions of the use cases.

Name	Generate QR
Actors	User
Description	It generates QR codes from a string provided by the user and saves it in the memory of the mobile device.
Preconditions	The user must have written a string or word to process, and have clicked the "Generate QR" button.
Main Flow	1. The system will ask to enter a word to generate.
	1.1. If the entered word is empty, go back to step 1.
	1.2. If the word is not empty go to step 2.
	2. The QR code is generated in a new window, it can be saved or canceled.
	3. If "save" is selected, it will be stored in a folder created automatically in the internal or external memory of the mobile device.
	4. The QR code can be canceled simply by pressing "back" on the mobile device.

Development tools

The following tools were used to develop the application: Eclipse, which is a free software IDE, used for the development of Android mobile applications; ZXing (Zebra Crossing), which is an open software library for multiformat image processing written in different programming languages, whose main purpose is to use the camera of mobile devices to encode or decode QR codes on the device itself [13].

Functionality of the application

In the development stage, a main menu containing the main functionalities of the mobile application was coded based on the application design:

- The list of articles or equipment that the computer center has.
- Module to perform the scanning of QR codes used for the search of inventory articles.
- Module to generate the QR codes used for new or modified articles.

- Next are shown some of the more important screens of the mobile application.
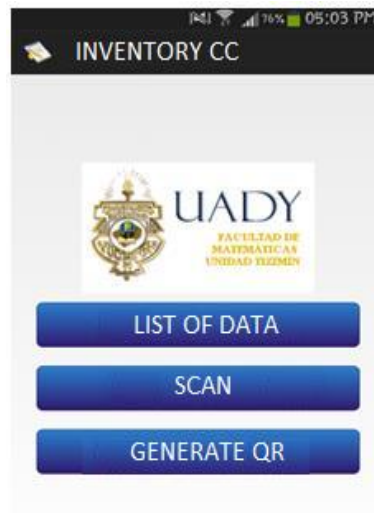- In the following figure, the main interface is shown.

Fig. 3. Main menu window.

One of the main tasks of the application is the reading of QR codes, which is used to search for the article and present its data, as well as to add them into the database of inventory control. An example of scanning for an article is found in Figure 4, which shows the view generated after searching and finding an article in the database.

Fig. 4. Window to capture articles.

Figure 5 shows the interface for the generation of QR codes from a specific string.

Fig. 5. Window to generate the QR code associated with each article.

IV. TESTS AND RESULTS

To evaluate the efficiency of the developed QR mobile application, a bar code reader mobile application was selected, so that a comparison could be made.

The selected application is called Barcode Scanner, available without cost, valued by users with four and a half stars and with positive comments [14].

Continuing with the test environment, 3 smartphones and 1 tablet all with Android were selected. Likewise, a sample of 26 articles was selected, which corresponds to 10% of the total inventory, thus constituting a valid and sufficient sample. The list with the selected mobile devices and its characteristics is shown in Table 1.

Table I Characteristics of the Android Cellular Telephones

Name of the device	Characteristics
Samsung Galaxy S3	Model: SGH-I747M Android Version: 4.3 Jelly Bean Main Camera: 8MP-Auto focus
LG G2 Mini	Model: D625 Android Version: 4.4.2 KitKat Main Camera: 13MP-Auto focus
Samsung Galaxy Ace	Model: S5830L Android Version: 2.3 Gingerbread Main Camera: 5MP-Auto focus
Samsung Galaxy Tab 4	Model: Tab 4 10.1 Android Version: 4.4.2 KitKat Main Camera:3.15MP-Auto focus

V. CONCLUSIONS

Based on the performed tests, the following observations are made.

All the selected devices worked properly with the developed mobile application regardless of the version of the Android Operating System, and performed a fast and efficient scanning of the QR codes.

The application to read bar codes worked too on all devices, but it showed dependency on the resolution of the camera, the auto focus and the physical state of the bar code label.

The bar code reader application was not very efficient in some cases where the bars were with a low color and with a black background, in contrast with the cases in which the bars were dark and the background white, besides, it showed dependency on the size and position of the bar code label.

It was verified that any device obtained the data within one or two seconds, significantly improving in time and effort with respect to the manual control of the articles of a computer center.

The barcode application has high dependence of the auto focus of the camera as well as of the resolution of the same.

The developed application does not depend strongly on the resolution of the camera, but still requires the auto focus, besides the reading is much faster than with the bar code.

The implementation of the QR mobile application developed for the administration of the computer center of the institution exceeded the expectations of the person in charge of that department, reducing the search time of the articles and making the work of inventorying the computer center more efficient, which is the main objective of the development of this mobile application.

The tests carried out in this project have helped the institution to verify the potential of QR codes and suggest the development of more tools using it, like those for the management of academic and administrative tasks.

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