QR-code based Hospital Systems for Healthcare in Turkey

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***Abstract*—Our system consists of QR-codes placed in various places of the hospital and QR-code reader applications, installed on smartphones or tablets, which scan the QR-codes in order to obtain vast amount of information. Moreover, several copies of the QR-code are produced for patients admitted into the hospital. The QR-code is used wherever the identification of the patient is required. Furthermore, we introduce the system accessing the medical information network in Turkey by utilizing QR Identity Tag. The QR Code Identity Tag allows its members to be able to control their own Emergency Health Record such as carrying the information on themselves or editing them. We chose QR-code because it is a cost-efficient solution, which is of importance for developing countries such as Turkey.**

Keywords— QR-code based Hospital Systems; Healthcare in Turkey; QR Code Identity Tag

I. INTRODUCTION

A tool that has recently become very popular in meeting mobile information delivery demand while keeping the resource investment relatively low is the Quick Response code, or QR code. QR codes are found everywhere. Whether in the pages of magazines, printed on flyers and posters, or added to web pages, they serve to lead customers to more information. Airlines are using them as electronic boarding passes. Retailers are providing links for customers to access detailed comparisons and make well-informed purchases. Librarians are delving into this method of information access by designing services that deliver information directly to the user's device.

The real value of QR code access is the speed and convenience with which the information is delivered. No more struggling to enter a long URL or contact's name and phone number on a tiny optical keyboard, just snap the code and go.

SoftTech [1], through the mobile payment system "Parakod" developed by them for İş Bankası [2], used the QR Code for payment purpose for first time in Turkey. Hence, without any physical credit card, it became possible to purchase by scanning the QR Code in display of the POS device via customer's mobile device through Parakod application in IşCep. This technology also allows us to avoid from entering our personal and financial information such as name-surname, credit card number, expiration date or security code in internet shopping. SoftTech aims to make it available to pay the bills via scanning the barcode or QR Codes on the bills.

Developing mobile applications, Pozitron [3] prepared a project of "withdrawing money from ATM via QR codes" for Türk Ekonomi Bankası (TEB-Turkish Bank of Economy) [4]. Thanks to this feature that is first in both Turkey and world, the users can withdraw money from ATM through the code they created with their iPhone.

Thanks to QR Code application started by Divriği Ulu Camii and Darüşşafaka, listed in UNESCO's "World Culture Heritage" and accepted as "El-Hamra of Anatolia", the visitors are offered the opportunity of the presentation in 4 languages via smart phones and tablet computers without need for any guide [5].

Türkiye Newspaper [6] delivers its important news, photo portfolios, and news videos to its readers via QR code. Linking the newspaper pages to internet via smart phones, Türkiye Newspaper connects from paper to digital media for the first time in Turkey. Readers scanning the QR Codes of the important news within the papers of newspaper via the cameras of their smart phones will be able to reach the rich photo content and the video of the news within seconds.

Via the Mobile-Life application developed by Pierre Cardin [7], the first for Turkish textile industry, and it eliminates the obligation of carrying the credit card physically. Customers can use fashionality card number in purchasing from Pierre Cardin stores, they don't need to carry the card. They can display bonuses from purchases, can use bonuses in purchases via QR code without needing the card etc.

The most significant advantage of the utilization of QR codes from the aspect of patient identification originates from its simpler technology. QR code-based technology is much more easy-to-access for the users since it doesn't need any special tags (such as the RF tags). Alternatively, the QR codes are created very easily, and printed on any surfaces such as paper or plastic labels, or on any other surface, they don't require utilization of any special equipment other than any printer [8].

Since the smart phones are widely used in any domain of our lives, reading and decoding the QR codes has become much easier in proportion to complex technology-based

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systems. This system has also another advantage in proportion to radio frequency-based systems. Since reading the QR code requires closer contact, it is almost impossible to read an undesired code. From this aspect, the QR code reading is unambiguous because it only requires close proximity of the reader device to the patient's bracelet in order to read the code [8].

This technology is in use in many medical facilities, mainly in the Asia-Pacific domain, in patient process and accessing and controlling the patient data. The health care centers located in Japan and Singapore (Soon 2008), and also ones in Hong Kong, have established the system known as Unique Patient Identification (UPI), that, in year 2008, achieved full technology transition from barcodes to QR codes [8].

Addenbrooke's Hospital in Cambridge also utilizes the QR codes in accordance with its policy about the patient safety [9]. Besides the other personal information, the QR code is printed onto a bracelet, and that bracelet is carried by the patient on wrist. Initially, the system was in use only for tracking blood transfusions and for controlling the coincidence between patient and blood type. But nowadays, the QR codes are utilized much more widely in order to minimize all types of failures observed in medical area [9].

An update of Houston's Methodist Hospital KBMA 1D code-based ID system has been proposed, consisting of migrating its old barcode-based patient identification to a QR code-based system [10].

In this paper, we present QR-code based Hospital System for healthcare in Turkey.

II. QR CODE

A. What is QR code?

In year 1994, the QR Code has been developed by Denso Wave [11], [12]. Example of QR Code is depicted in Figure 1. That version was a 2D Code, since it has been coded in vertical and horizontal directions. Through that design, it was possible to store larger amount of information into the code. There are also other types of 2D Codes available on the markets. Each of them has unique advantages and disadvantages.

Some of the features, which are thought to be useful for clients, of QR Code are listed below:

- First its Data capacity, QR Code can contain up to 4296 Alphanumeric data or 7089 Numeric data or 2953 Binary data. It means in clear that you can write a text long of 4296 character within your code that will be readable by any translating software.
- In order to translate the barcodes, there are many price-free applications in online application stores. Through these codes, you can not only code the important product info into the code, but you also can provide your clients with direct interactive links.
- This code can be used in textile forms, and it will still be able to be scanned and read.
- Should the code be smudge or partially damaged QR Code system has an error correction capability up to approximately 30%.
- In order to keep the same amount of data stored by a traditional 1D Barcode, the required space is only 10% of the space that is required in case of Barcode.
- It can also encode the Kanji Characters (漢字) .
- It is capable of 360 degree high speed reading.
- In this system, 1 Code can be divided up to 16 smaller codes. This feature is useful when it is needed to print on smaller surfaces.

B. How does it work?

There are many free QR code applications that can create a code from the data. User enters the data to be embedded into the code, and then the application creates the QR code that can be used in digital form or in printed form. In order to decode the data embedded in the code, the camera of any mobile device such as smart phone or tablet PC that includes QR Code scanning application can be utilized. After the user scans the code, then the application decodes it [13].

QR codes are capable of storing significantly complex information into a small matrix. The common denominator glue is the mobile phone. The new social interactions generally make use of various sources such as face to face meetings, voice calls, SMS, email, IM chat, social applications such as Twitter & Facebook and many others.

III. QR CODE HOSPITAL

Our systems consists of QR-codes placed in various places of the hospital and QR-code reader applications, installed on smartphones or tablets, which scan the QR-codes in order to obtain vast amount of information. We chose QR-code because it is a cost-efficient solution, which is of importance for developing countries such as Turkey.

A. General Information

Doctors:

QR-codes are placed on the office doors of the doctors and next to the names of the doctors listed on the walls in corridors and in the lobby of the hospital. When QR-code is scanned the web page containing the information about the doctor is provided containing his/her background, specialties, etc.

Maps:

QR-codes with "Are you lost?" tags are placed in different locations in the hospital. When QR-codes are scanned the map and the current location become available.

Posters and brochures:

Posters or brochures containing information about various issues are usually available in the lobby of the hospital or in the waiting rooms. In our system QR-codes are placed on the

posters and brochures. By scanning the QR-codes a web page containing the detailed information is presented.

B. Admitted Patients

Patients:

In order to get treatment each patient has to first register to the hospital system. An online profile, a password, a unique identification number and a unique QR-code are generated for each patient. A bracelet containing the QR-code is placed on the wrist of the patient.

Moreover, patients are required to provide a detailed medical history. In most of the hospitals patients fill the hard copy of the form. In our system patients are encouraged to use on online form, which can be accessed by scanning the QR-code available on the identity bracelet. The form that has be filled includes a phone number of the person to be contacted in case of emergency, addresses, telephone numbers, blood type, contact information of the person with the same blood type, allergies, illnesses, special conditions, current medications etc.

Several copies of the QR-code are produced for patients admitted into the hospital. The QR-code is used wherever the identification of the patient is required. One copy of the QR-code is placed on the door of the patient's room, one on the bed, another on the chart so that medical personnel can quickly identify the patient, obtain the medical history and the status of treatment. QR-codes are scanned by the doctors before the surgeries to identify the patient and to avoid patient or surgery mix-ups. QR-codes are also placed on the patient's lab samples to prevent mix-ups and to keep information private.

Doctors: Doctors can obtain the patient information by scanning the QR codes placed on the doors of the patients' rooms or by scanning the QR codes placed on the patient charts.

QR-codes are scanned by the doctors before the surgeries to identify the patient and to avoid patient or surgery mix-ups.

C. Out patients

Some patients may always wear the QR-code identity bracelet. This will be useful for the patients with allergies, asthma, unusual blood types, AIDS, diabetes, Alzheimer's etc.

When the QR code read by any reader such as smart phone or any similar device, the general information about the patient including name, address, and emergency point of contact is shown, as illustrated in Fig. 1.

The system will allow the medical personnel to reach the emergency contact, and receive the security code. Once the security code is received, the healthcare professionals will be able to receive the information such as the detailed medical history, current and past medications, family contact information, their healthcare proxy, and their service provider.

Fig. 1. Smartphone and QR Identity Bracelet.

The QR Identity Tag can be placed on any object including a necklace, bracelet, keychain, identity card, or it can be even tattooed on the skin.

We prefer the utilization of QR Code identification because the QR code-based tag technology, when utilized with smart phones for reading and decoding the code, is considered the most useful and cost-efficient alternative for automatized patient identification, besides the quick remote-access to health records by medical professionals in public health care systems having limited budgets.

IV. Implementation

We have developed a QR Identity Tag system, the system mechanism as depicted in Fig. 2 containing of a web site, database containing the medical records and a mobile application using PHP [14], MySQL [15] and Java [16].

A. Web Application

Some screenshots of the web pages of the QR Identity Tag web site are listed below. First a new user has to become a member by clicking Become a Member (Üye Ol) button, refer to Fig. 3. As shown on Fig. 4, on the next page user has to enter the information. To update the information user first should login then update the information as depicted on Fig. 5.

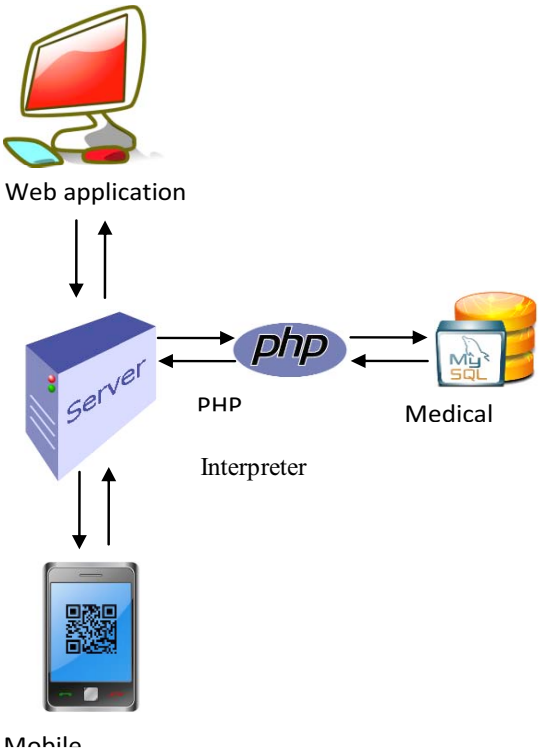

Fig. 2. System model of the QR Code Identity Tag.

B. *Mobile Application*

Some screenshots of the mobile application follow. Fig. 6 shows the application icon. Fig. 7 depicts what happens when the QR Code Identity Tag is scanned by the police or doctors. After the scanning process is completed the initial information which includes the phone number of a person to be contacted in case of emergency is presented, as illustrated in Fig. 8.

Fig. 9 presents the complete information after obtaining of the secret code from the emergency contact.

Fig. 3. Main page.

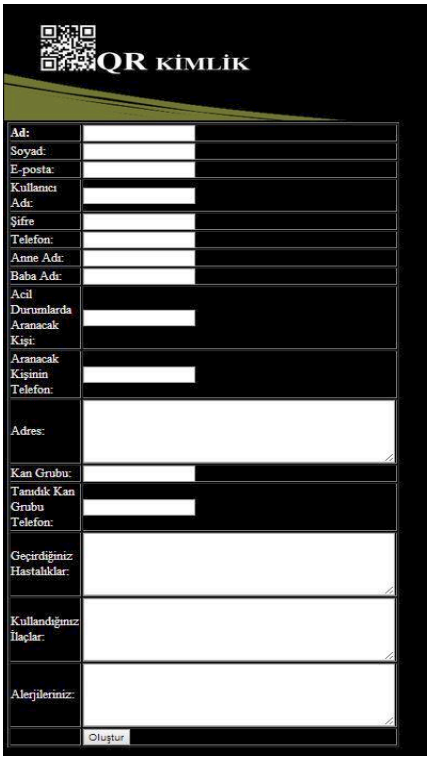

Fig. 4. Entering information.

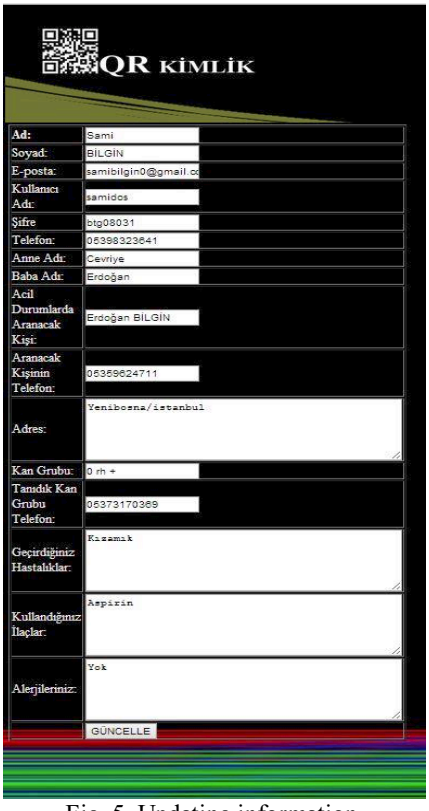

Fig. 5. Updating information.

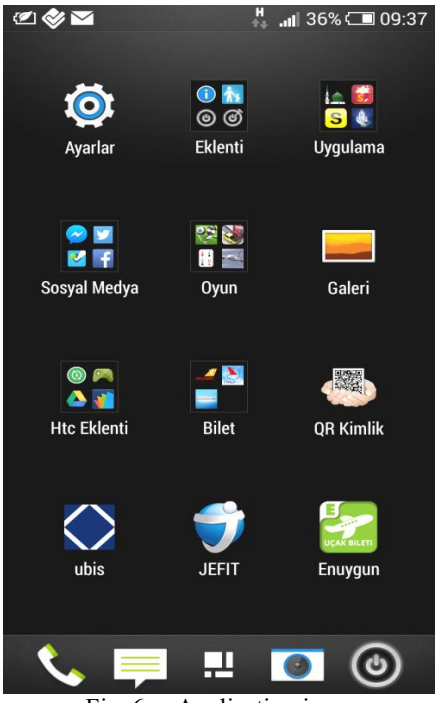

Fig. 6. Application icon.

Fig.7. Scanning QR Code Identity Tag.

Fig.8. Showing the initial information.

Fig. 9. Showing the complete information.

V. Conclusion

QR codes are a simple, effective way to distribute information. They are quick and convenient for mobile device users. As mobile devices become more ubiquitous, it is in the hospital's best interest to attempt to accommodate the users of these devices by creating services that are well suited to them. QR codes have the potential to facilitate this shift and require minimal resources to implement. Some of the generators and their features are subject to change, but not the codes themselves. The stable nature of QR code technology is an argument in favor of maintaining an adaptable approach when it comes to features that might change in the future.

We have implemented a QR Code Identity Tag system for Turkey. QR Code Identity Tag offers smooth access to vital medical information. Once the QR code is read by the reader such as a smartphone or any other electronic device being capable of scanning, the general information about the patient including name, address, and emergency point of contact will be demonstrated.

QR codes are the most practical alternative for establishing the automatized patient authentication capabilities in public health care facilities having limited budgets. Consequently, we think QR Code Identity Tag service should be integrated with the currently evolving healthcare system in Turkey.

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