Mobile Application of Drug Follow-up Information System with Data Matrix Reader

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Abstract: The number of products that simplify people's lives are increasing with the enormous development of the technology. Mobile devices have a great importance for the provision of communication which is one of the most significant need of human beings. Mobile devices have gone beyond to be used originally as a mobile phone purposes and they have begun to be used as a smartphone by taking in charge of computers. They are not only used for communication but also they are used like camera, photo camera, notebook, television and reminder. Google's Android platform is a widely anticipated open source operating system for mobile phones. Google's Android Operating System (AOS) in mobile phones are still relatively new, however, AOS has been progressing quite rapidly. The increasing number of smartphone users has prepared the ground for the emergence of new ideas to make life easier. Recently, especially some applications in health sector have reflected one of the most important samples. Some of the mobile applications in this field used by humans are about hearing test, vision test, diabetes, pregnancy, and doctor appointment. This paper focuses on following of drugs, taken by patients, through mobile phones. The application running on the AOS provides the use of drugs on time with the alarm system. In addition to this, the application gives information (time, dosage, and name) about drugs by reading data matrix located on the medicine box. Thanks to visual and understandable interface and easy usage, many difficulties experienced in drug intake can be eliminated with this application. Finally, the percentage of drug intake on time can be increased in the future.

Keywords: Android, data matrix, web service, drug alarm, prospectus, smartphones, mobile programming.

1. Introduction

Mobil devices (tablet PC, smartphone, and etc.) are rapidly increasing and they are becoming an essential part of human life due to its efficient and useful properties. Mobile users can benefit rich experience of various services from mobil application like google maps, which runs on the devices. Emerging technology is becoming widespread in the field of health as it is in every field of our life. In this context, providing access to health records with the communication networks and mobile devices from the desired location has been suggested as a growing business value in the health field[1]. The drug which is one of the most important thing in the field of health disorder is one of the most effective methods used for immunity. For this purpose, following of the medicine becomes more difficult and it reveals a dangerous situation in terms of health for patients. All these problems have emerged the idea of mobile drug tracking system. The main purpose of drug tracking is to prevent disease by providing medicine taking in the right time.

Positive impacts of the market of mobile applications in the health sector are increasing day by day. Elderly population has led to increase the health expenditures in a remarkable way. Until 2030, health spending is expected to absorb %15 of the gross domestic product of developed countries. These countries such as Brazil, Russia, India and China anticipate that 175-200 billion dollars will be saved in the management of chronic diseases using mobile health applications actively. This means that the area of the mobile health will gain more importance in the future.

There are some systems for tracking up chronic illnesses developed by mobile operators such as "Turkcell Health Monitoring Service" and "Avea Patient Status Tracking System with Chronic Illnesses" in Turkey.

In literature, there are numerous examples of mobile applications. Hacer and Kürşat[2] developed a web based mobile application of child tracking system. In their study, GPS (Global Positioning System) technology was used to provide location data. Another mobile application developed by Yuce et. al. [3] focused on asthma, a chronic disease which can be controlled with patient-doctor cooperation involving frequent medical review and regular self-monitoring by basic indicators. In their study, they proposed to help patients by keeping their asthma under control and enable doctors to reach their patients. There are some mobil applications which are used for education of childen. One of them which is carried out by Kural and Kilic[4] is an intelligent mobile drawing platform. In their study, basic steps were explained by using SVM (Support Vector Machine) and mobile platform.They aimed to develop basic education skill and hand-eye coordination of the children with supportive feedback. Finally, Kato and Tan[5] reviewed the six 2D barcodes and then use an extra metric - a first-read rate - to quantitatively verify our earlier results and better gauge reading reliability.

The rest of this paper is organized as follows: In this section, some mobile applications used in different fields are briefly reported with their basic properties. Then, some fundamental concepts about barcode and data matrix standards are given in Section 2. In Section 3, we introduce our mobil application in terms of how does it works with important functions. Moreover, screenshots of the mobil application is presented to make the application more umderstandable. Finally, we summarize and

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conclude this study in Section 4.

2. Barcode and Data Matrix Technologies and Standards

Barcode technology is one of the information coding standard. They are interface elements that provide access to encoded data via optical reader. As seen in Figure 1, barcodes, consisting of vertical lines and spaces of different thicknesses, is a method used to transfer data automatically and error-free manner to another environment.

Figure 1. Sample barcode labels

The use of barcode system has provided great advantages in daily life and business. This technology provides fast and accurate data reading. In addition to this, it provides time saving in the processes such as data update.

There are many types of barcode which have the serious areas and development process from past to present. Generally, the basic characteristic that distinguishes species from each other is the amount of information that the code can hold. Figure 2 demonstrates the types of barcode used in literature.

In this paper, data matrix is preferred because of its use in the pharmaceutical industry. Some basic information about data matrix is given as follows.
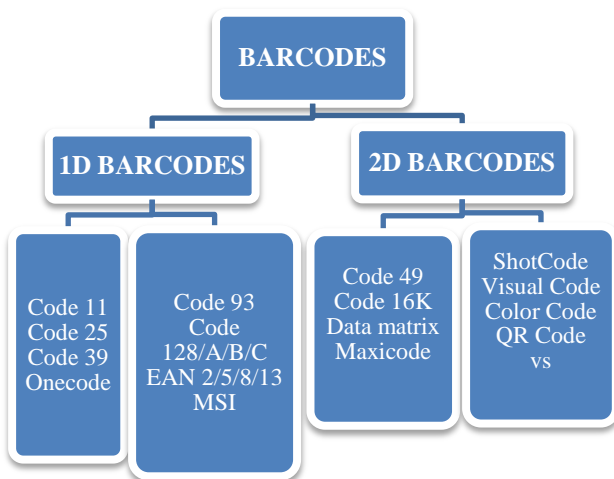

Figure 2. Some barcode types[6]

Data Matrix: Data matrix code is a two-dimensional matrix barcode consisting of black and white "cells" structured in either a square or rectangular pattern. Encoded information on the data matrix can be text or numeric. The number of cells in the matrix determines the length of encoded data.

Data matrix which can save 3116 numerical or 2335 character can hold more data than one-dimensional barcode. On data matrix, while each black cell refers "1", each white cell refers "0" mathematically.

One of the most fundamental characteristics of QR code is that it accelerates the sharing of information. Instead of keeping information in mind or taking notes about the things that you see in a magazine, website link or contact information (map, phone, and etc.), you can record the information immediately and use it whenever you want thanks to a simple application in your smart mobile device. From this point of view, QR code is one of the most effective visual element of accelerating information to share in the digital world.

3. System Architecture

In this study, we propose a system which consists of an application to be installed on the mobile device with Android operating system, a database where the drug information is stored, and a Windows Communication Foundation (WCF) service which provides the data exchange between them.

3.1. Database

SQL Server Express is a database system developed and distributed by Microsoft, which can be used to provide a basis for the applications running on desktop and small servers. Microsoft's Azure cloud infrastructure and application platform provide easy way of moving SQL Server databases to Azure. The database is designed to be moved to cloud in the future.
SQL Server serves the majority of the database and management tasks. Because of such facilities SQL Server has been the preferred database server for our application.

3.2. WCF Service

The main objective of WCF is to enable the communication between applications on the network or internet. Representational State Transfer (REST) is an architecture to provide the data transfer between client and server via Hyper-Text Transfer Protocol (HTTP). REST services are platform-independent, language-independent and easy scalable, so this architecture is preferred in our system. The return types of REST Services can be used as Extensible Mark-up Language (XML), JavaScript Object Notation (JSON) based on the need. JSON is preferred in our application because it can transfer smaller pieces of information while transferring data in the application, and it is easy to use on the mobile platforms. As an example, the barcode number and drug information which is sent to the service is illustrated in Figure 3 in JSON format. Likewise the database system, the service is also designed to be moved to the cloud.
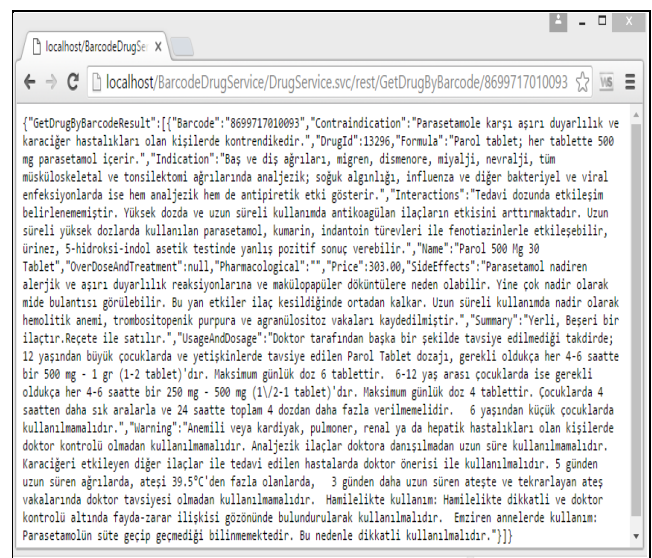

Figure 3. JSON Format

3.3. Mobile Application of System

In the design phase of the mobile application, it is important to specify which operating system will be used for running the application. According to operating system, it is necessary to make custom design and coding. Android, the open source operating system, is used and Android Studio is preferred as an editor. The purpose of this mobile application is to let the users doing medication tracking via Android mobile devices. One of the most important features of the application is to notify the user when it is medication time and to let the medication is taken on time. The medication alarm can be set manually as well as via the QR code on the drug. In addition to this, multiple alarms can be set.

The QR code on the drug is created to enable drug tracking. The QR code consists of the barcode number for the drug (GTIN: Global Trade Item Number) and a Serial Number (SN). By integrating the Batch Number (BN) and the Expiration Date (XD) to this unified record system, the obtained information is written on the drug.

In this mobile application, information about drugs can be gathered not only by their names but also by their barcode number. For this solution, application needs a barcode scanner. There is a library for barcode scanning on mobile devices called Zebra Crossing (ZXing). In order to read the QR code, ZXing library is used. ZXing is an open source, multi-format 1D/2D barcode image processing library implemented in Java. This library enables users to scan and read the QR code on the drug, utilizing the camera on the mobile devices.

On the opening screen of the mobile application, the list of tracked medications takes place, as shown in Figure 4. To add a new record to this list, we press the "Plus" button. In the screen which is seen in Figure 5, a drug reminder can be set through entering the activeness, title, hour, repeating days of the medication reminder, the ring tone, and whether the vibration is on or off, or by reading the QR code in Figure 6, and clicking the "SAVE" icon. After this stage, the application is redirected to the screen in Figure 4.
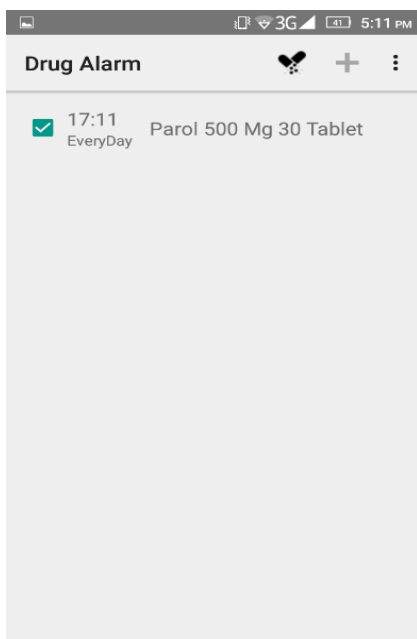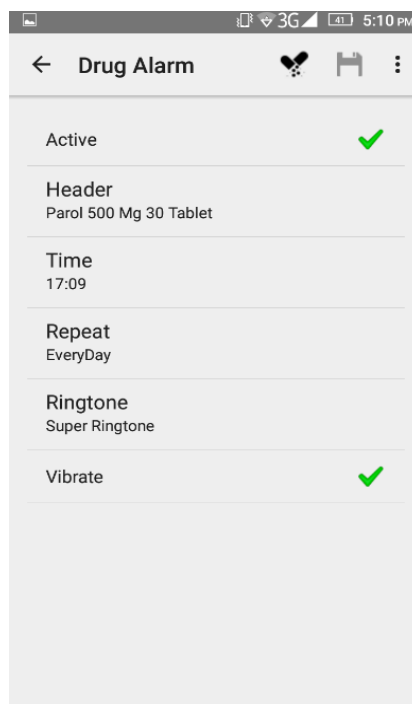

Figure 4. Home Screen

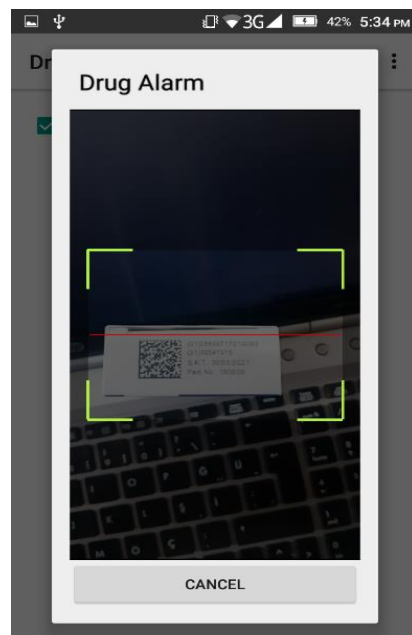**Figure 5.** Drug Addition Screen

Figure 6. Data Matrix Reading

In case of the drug is wanted to be deleted or the drug information is wanted to be updated, the deletion or update can be accomplished by selecting the item from the list in the opening screen and using the screen in Figure 5. In order to delete the record easily, the item is pressed and hold for a while in the opening screen.

Either by clicking the "DRUG" icon on the opening screen or through the QR code reading screen shown in Figure 6, the information about the drug can be seen as demonstrated in Figure 7.

Figure 7. Drug Information Screen

Figure 8. Notification for the drug time

Finally, notification is received when drug time is approached as seen in Figure 8.

As it was presented visually in the previous parts, the mobile application of drug follow-up information system with data matrix reader has a simple interface, therefore all the world and his wife can experiment it easily.

4. Conclusion

With the increased use of mobile devices, mobile applications have made a quick entry into our lives in many areas such as education and health. Health applications attract the interest of both health workers and patients.

Application makes possible to add up to the required medication reminder record. The reminder of each drug is shown separately and when desired a reminder notification can be added for each drug. The most important benefit of this application is that nearly almost problems about drug intake (dosage, time interval, and etc.) will disappear. As a result, receiving time of the overall drug percentage will be raised by this application.

Acknowledgements

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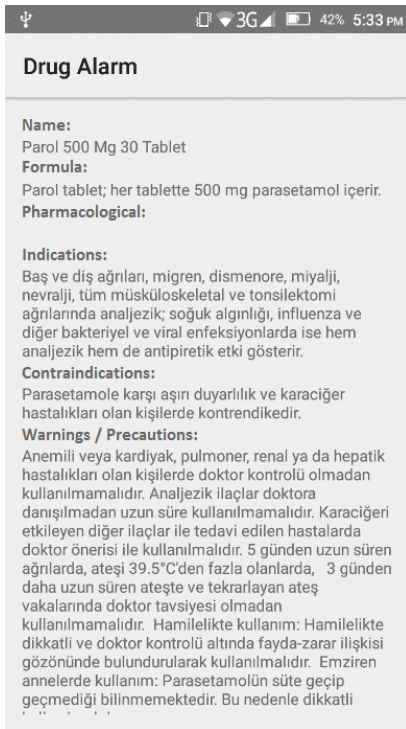[6]   Cakir, A., Kaygısız, H., *Wireless Student Attendance Control System.* 6.International Advanced Technologies Symposium, Fırat University, Elazig, in turkish, 2011.