

# Improving HealthCare using Smart Medical Refrigerator Barcode Reader System

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## Summary

Humans suffer from health problems due to pollution and diseases, especially in the Middle East and African countries. So citizens need safe medicines to help them with a safe, speedy recovery. In turn, a medical refrigerator can monitor storage temperature, expire dates, and quantity to keep drugs, vaccines, and blood donations useful and safe for them. The study has proposed and enhanced a new applicable and fast "Medical Refrigerator" system to help pharmacists to easily keep medicines with safety without the need for regular inventory to check expiry and quantity, which costs effort, time, and money. Pharmacists and lab technicians have issued with the medicine and other staff that need a refrigerator. The main issue is they may expire without any indication about the expiry date. Another issue is the quantity which may out suddenly. Besides, there is a problem in the store's temperature system (refrigerator) where they kept their medicines and medical solutions at a cold temperature to prevent infection.

The proposed smart fridge uses a barcode scanner that scans the expiry date products while keeping in the refrigerator. The refrigerator alerts the users with emails when any product in it is expired. The fridge's embedded camera can see the fridge's contents on the user's smartphone application from a remote area.

## Keywords:

*IoT, Healthcare, Medical Refrigerator, Arduino, Android, IShield.*

## 1. Introduction

Smart technology becomes urgent in this field to prevent loss and keeps everything recorded, which means that you can have many details and graphs about each medicine through this system. Also, the order's data can be used in future decisions and analyzing [1].

The main research idea is how to help many people who work in the medical field. So the objective of this proposal is to improve a system that can read a barcode and save some data (quantity and expire date) based on that code, then analyze it and make an iPhone Notifications based on the barcode with its data. The notification will be sending an email with the required details about the medicine. Also, the proposed smart system does the following:

- Notifying the Pharmacists by email when the medicine is near the expiry date.
- Notifying the Laborer (Pharmacist) and the medicine store when a targeted medicine quantity may be out or a shortage in the remaining amount.
- Notifying the Laborer when the temperature changed in the refrigerator and the new fan will start working.

Based on an overview of the proposed model, it will facilitate people's work in the medical field by alarming the users' information instead of searching or daily routines about inventory or the different products [2].

Different applications, in addition to hardware, will be used to manipulate the system. The hardware devices are Arduino Mega board and an iPhone and IShieldPlus that will be used between the iPhone and the board. Software applications are the barcode reader (IShield) [3].

IShield is a new shield configured for the Arduino microcontroller. It is connected to a mobile application to allow all Android smartphones' capabilities into the Arduino sketch such as LCD Screen, LEDs, Wi-Fi, GSM, GPS, Gyroscope, Switches, Accelerometer, Magnetometer...etc. [3].

The IShield consists of two parts: The first part is a physically connected shield to the Arduino board and acts as a wireless middle-man, piping data between Arduino and Android smartphones via Bluetooth. The second part is a software platform and application on Android smartphones that manages the communication between the shield and the smartphone. IShield can be used as an input or an output from Arduino and enable all sensors and peripherals on the Android smartphone instead of buying the actual shields. The advantage of using the IShield is to provide faster and cheaper ways of prototyping for Arduino [4].

Smart Technologies have become worldwide in different devices such as T.V., Mobiles, and Lighting system at Homes. However, it is less used in governmental associations because they have complicated and costly equipment that cannot be upgraded to smart effortlessly.

The presented system may be used in a small device, a medical refrigerator in the health ministry. That means

the implementation in the future can be done at a lower cost. This system can be upgraded into a bigger one by implementing an application that can be downloaded over the different phone operating systems, saves records about the product, and does some analysis.

The remainder of the paper is structured as follows: the related work and background on IoT technology, including a discussion of the role of IoT in Smart Refrigerator Systems and especially the medical one system architecture design, is provided in Section 2. System Development is discussed in section 3, and In Section 4, a discussion on the system implementation is given. The paper concludes with a summary of this research's main findings and possible future research lines to be explored in Section 5.

## 2. Literature survey

This paper focuses on A" Smart Medical Refrigerator" that uses the Arduino Mega board in addition to the system software ISheeld. The following research papers where found, which is worked on the same system idea.

Jessica Velasco & Leandro Alberto [5] have presented an inventory monitoring system that monitors the home refrigerators' stocks wirelessly by combining a conventional refrigerator with microcontrollers and smartphones. The proposed refrigerator used a sensor network system that transmits data to the microcontrollers, Arduino Uno. All images and data were processed on IoT based on the cloud-based website Temboo to send data to the Dropbox where a smartphone is connected to. The user can monitor the stocks or contents of the refrigerator wirelessly using an Android Application. The proposed system has some disadvantages in the installed camera zoom out rate, and there is no distance-measuring sensor that can stand the refrigerator freezing temperature.

M. K. Sangole et al. [6] have programmed a module to remotely notify the Smart Refrigerator user about the low contents of food items inside the refrigerator. The module responds on a one-touch button on a mobile application to send SMS to the shopkeeper. This module's advantages are power saving, smell detection, ice-ready indication, and other features.

J. Shwetha & S. N. Prasad [7] have provided and developed an advanced refrigerator stalk management module that can advise the user remotely about the low amount of items inside the fridge and facilitates buying of the rare things from the vendor through online operation. The system outputs to the user an email and SMS. It makes life simpler, effective, and quick that there is no time is spent on organizing objects in the refrigerator. In this way, it will save the cash wastage quantity.

M. P. Mahajan et al. [8] had gained an intelligent, cost-effective refrigerator capable of sensing and monitoring contents and remotely notifies the user about scarce products via an android application. It also facilitates the purchase of items by using the online vendor of items. The information and notifications are sent to the user via an android application.

In reference [9], a Medical Refrigerator is proposed to comprise sensors and used comprehensive area network protocol based on LoRaWAN.

T. Kwon, E. Park, H. Chang [10], they have developed an intelligent electronic kitchen smart refrigerator. When the stored food in the fridge is over, the user receives notifying over information. Then, the quantity of stored food is reduced. By using this technology, consumers will be updated with the online state of their Food Smart Refrigerator, and companies will survive quickly.

Deepti Singh & Preet Jain [11] introduced health enabled smart refrigerator applications. Their smart refrigerator manages items stored in it, performs dietary control and eating routine analysis, etc. Such types of intelligent lockers will be applicable and essential in future smart home life.

A smart refrigerator was proposed in that paper of I. Kim [12]. It helps users to know the remaining quantity and count of food items. The fridge is attached to inexpensive large LCDs through the Internet or smartphone. When the users click the cooking thing which they want, it automatically orders the required amount of food items.

D.Vinodhan & A. Vinnarasi [13] had described how to develop a smart home, not only the refrigerator based on the Arduino Mega board. An android application was built to control different devices that are connected to the Arduino board. Also, the Sensor is used to manage the home, such as the temperature sensor. This paper's results turn on and off a couple of devices but not fully control them. This is a comprehensive system that uses Arduino mega, which helps present system implementation and design.

S. Prapulla, G Shobha & T. Thanuja [14] described how to implement a smart refrigerator that can read the product barcode and have sensors to search for the product inside the fridge. Then, it provides an online schema for the missing products to buy them online without having to go to the market. The paper does not implement medical staff. It does not have any phone application to connect directly to the refrigerator; the computer is connected to the fridge through the software and interface circuit.

T Kwon et al. [6] developed a smart refrigerator that uses artificial intelligence techniques to classify different products and notify the user with the missing fruits or vegetables based on a build-in sensor inside it. It is an

algorithm based study that is using sensors and Arduino mega board that test the humidity and temperature. Also, it tests the expiry date for the products and notify the user through an android application. Also, this system is connected directly to a server to save and store the data in addition to the product images, see Fig. 1.

The reviewed papers were introduced and supported to build an overview of the targeted system.

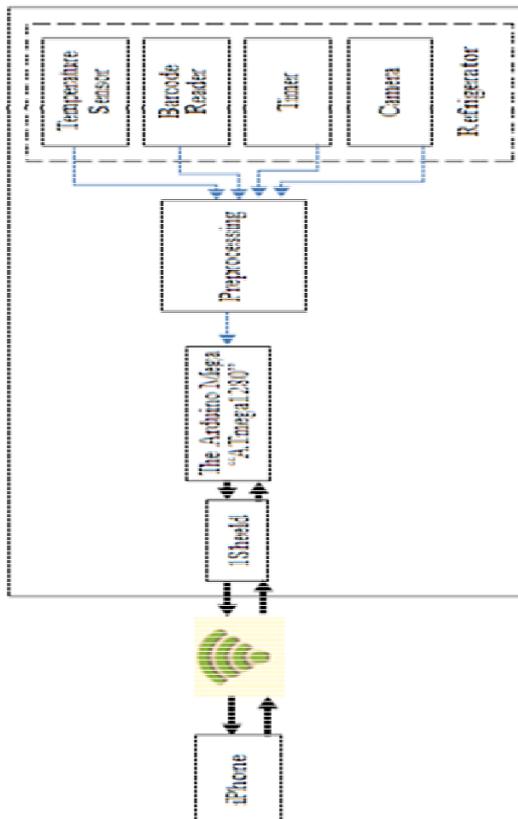


Fig. 1 The Proposed IoT Based S. Refrigerator Block Diagram

Many other researchers recognized in literature on IoT applications such as [15-27] studied the importance of IoT application in our lives.

### 3. Proposed system design

The system consists of hardware and software parts; they will be introduced based on a scenario. The scenario is that medicine was added to the refrigerator. Firstly, the iPhone will scan the medicine barcode through the OneSheild iPhone application. Data will be recorded based on the barcode, such as the expiry date and the medicine quantity. Secondly, if the medicine drops out,

then it will also scan. Thirdly, when the medication expiry date is near its expiry, an email will notify the pharmacist. Fourthly, when it reaches the out, it also carries two emails, one for the pharmacist to inform him of the refrigerator's inventory level and one for the medicine inventory store to send the targeted medicine. Finally, when the temperature has some issues, it will send an email to its admin and turns on the other fan because medicine needs to be placed on a specific temperature, or it will be damaged.

1Sheild interface is used to create communication between the iPhone and the Arduino code to manage the inputs and outputs. The system inputs are the barcode that defines each medicine with the expiry date in addition to the quantity of it. Moreover, updates were made when the user drop out a drug with the amount to see the refrigerator inventory.

The system outputs are varied. The first output is email notification to the pharmacist if the medicine is close to the expiry date. Secondly, an email notification will send to the pharmacist details about the inventory when a medication is out. Moreover, the same email in the inventory level will be sent to the store to prepare an order with the needed medicines, which reduces the time and effort in this process.

Finally, the fans will turn on when the temperature inside the refrigerator becomes above the average level; the system will also send a message to the pharmacist notifying him of this issue. The processes that came from the refrigerator can be summarized in the following Fig. 2.

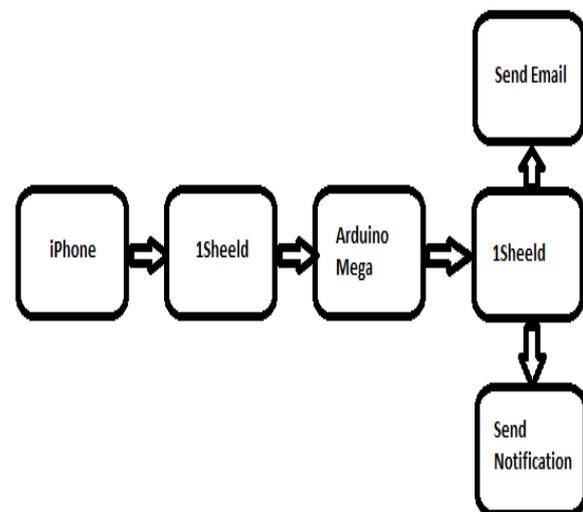


Fig. 2 The Proposed Medical Refrigerator Reactions System

### 3.1. System Structure

The Arduino Mega board (ATmega1280) used in the system consists of 54 digital input/output pins; it can also be powered through a USB port or power cable, as shown in Fig. 3.

The 1Sheeld have a mobile application and advice connected directly to the iPhone and the Arduino Mega Board. This microcontroller creates a direct connection between these two devices.

As described in Fig. 2, the iPhone is connected directly to the 1Sheeld software, which sends a signal to the Arduino mega board. The outputs from that board will be formatted to the 1Sheeld microcontroller connected with its software and then the needed signal through a Bluetooth.

The 1Sheeld mobile application has a friendly and easy way to use its interface, in addition to its functionality, by sending direct signals to the board. e.g., to use the barcode reader, the iPhone must be turned into a "Barcode Scanner shield" for Arduino. Barcode Scanner library will allow the phone to scan various types of barcodes (1D/2D) and return the data to the microcontroller to do specific actions.



Fig. 3 The Arduino Mega Board Attached to the Refrigerator

### 3.2. Limitations

Each system design has its drawback that may be cleared from the beginning or may be faced during the implementation. One of the problems that affect the proposed system would be the Bluetooth limitation if the order were using an internet connection instead of Bluetooth that can be a great advantage for us. Due to the current research for excellent equipment to work with, a targeted controller could not be found.

The system reads only medicine that has a barcode on it. So if any essential solution needs to be saved in the refrigerator without having a barcode, it will not be added directly.

## 4. Results and Discussion

The system results are completed to keep medicine cold and dry, and an Arduino Mega board that reads the different system processes such as adding and dropping medicine to make different alarms and changes in the system like turning the fan on when the temperature becomes higher than usual. This system will also use an internet connection to send different alarms as an email message to the specified users.

Advantages of the proposed system are:

- No need for any human intervention that performs all functions automatically.
- Program and system installation are in one-time only.
- Low maintenance cost.
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The smart medical refrigerator concept is far more reaching than notifying the user about the available contents of the fridge. It should give importance to maintaining a healthcare lifestyle by providing the nutritional value of safe medicines.

The following figures are extracted from the final result as shown in Fig. 4 till Fig. 11:



Fig. 4 Open Application 1sheeld to Select



Fig. 5 The Arduino Mega Board Attached to the Refrigerator with Selected Shields



Fig. 7: Help to Check Expire Date



Fig.8 Email Address to Send Emails When One Certain Action Happens



Fig. 6 Barcode As an Input From The Medicine



Fig. 9 Camera to capture user for security

The actions when an email is sent:

1. Input & output medicine.
2. When an expiry date or approaching to expire date.
3. Exhaustion of quantity or quantity less than required
4. When temperature more than suitable.



Fig.10 Capture Terminal to see the processes that are performed

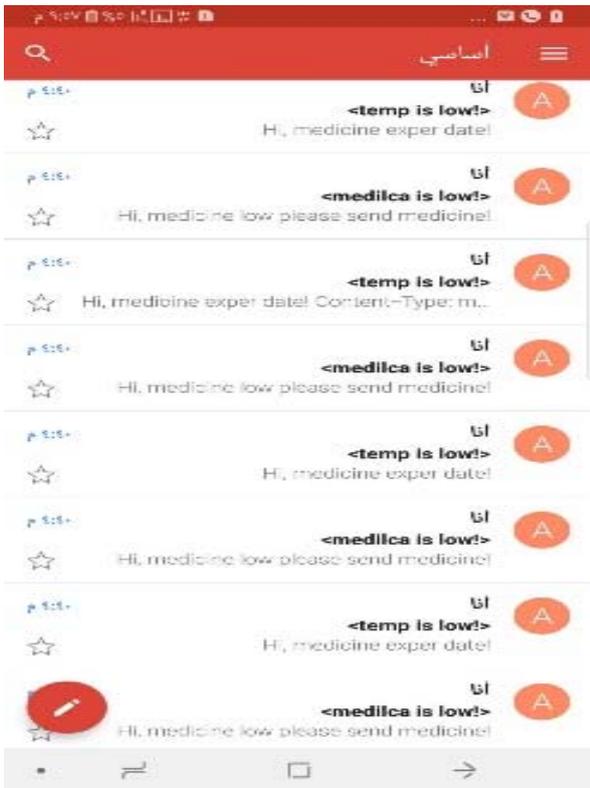


Fig. 11: Some samples of emails sent by executing the system application

## 5. Conclusion

This research aims to develop a system that can be added to most of the medical laboratories and pharmacies refrigerators available for the medicine and products that have a barcode. It facilitates the work in the labs. This system can also have many improvements to make it works on other refrigerators located at home and supermarkets.

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