Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Developing modern system in healthcare to detect COVID 19 based on Internet of Things

Muataz Haqi Ismael, Abeer Tariq Maolood

Department of Computer Science, University of Technology, Alsina'a Street, 10066 Baghdad, Iraq

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ABSTRACT

In this paper, a medical platform has architecture that depends on middleware and database supports people with Coronavirus, and this platform mainly relies on three users. The first person is the administrator, who is separated into two groups of users: the doctor and the patient. The doctor has an app that questions through the patient so he knows the patient that is being visited and extracts the health identity from him, and he questions the patient for sending him an OTP in the event that the patient does not have a mobile screen or an Internet connection. Alternatively, if QR asks him if his laptop is smart and wired to the Internet, the person will be able to access the system after the doctor has examined them. The patient will examine himself through the devices he has, and the system will provide him with the results of his doctor. The doctor can write a prescription every time he sends new readings. If the prescription is correct, then the patient can keep it and increase the dose. Doctors will work on the prescription console that sends the prescription for cloud authentication and obtain an encrypted QR that will then be issued to the recipient of the drug. The patient has the privilege of studying medication details via the recipient's app. The privilege of viewing QR encrypted cloud data is for life. The drug issuing outlet can decode and issue the drug only as prescribed until the expiration date of the QR. The scheme is designed to promote and provide access to care facilities for both patients and physicians, and it complies with General Data Protection Regulation (GDPR).

Selection and peer-review under responsibility of the scientific committee of the Emerging Trends in Materials Science, Technology and Engineering.

1. Introduction

Following the success of the Internet in linking people all around the world, it is now the turn of the things around us to join the international intelligence network known as "the Internet" [5]. The Internet of Things or something Known by the acronym: IoT is a group of cabins or devices that have connectivity that can interact with each other (machine with machine) or interact with a human being (machine with human) for a day. It was the first appearance of this term the twentieth, precisely in the year 1999 CE, by the British scientist Kevin Ashton, whose idea was to complete connecting some devices that are around us, such as electrical and home appliances, which allow us to know their status; living by self-controlling the ratios of lighting, temperature, and humidity inside the home and help by remote controlling various devices. As well as monitoring the health of human beings through monitoring the health symptoms that may arise and the prediction of diseases that may occur, especially those diseases that it may lead to serious health problems. In addition to its various applications in the field of industry, as a monitoring devices and equipment in factories, predicting faults that may occur, releasing losses, and helping in Availability of spare parts on time. The medical sector has benefited from digital transformation and modern communication technologies and is likely to be adopted more and more. On the trends of the Internet of Smart Things in the coming years thanks to the continuous development in communication systems and artificial intelligence tools that have contributed to drawing innovative features of a methodology that sustains health care services [6]. Since it can reduce costs, improve service efficiency, and have advanced consumer interfaces, the Internet of Things is rapidly becoming a critical technology in healthcare monitoring [4–7]. The Internet of Things is expected to explode in healthcare due to its immense capabilities, which includes mapping, recognition, verification, and data collection [2,8]. After the outbreak of the influenza pandemic in 1918, COVID-19 has become the greatest global public health epidemic [9]. According to the World Health

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Organization's (WHO) most recent survey, the number of confirmed COVID-19 cases had surpassed 31 million people as of September 2020, with an estimated 960,000 deaths [10]. Fever, cough, and nausea are flu-like signs that must be recognized in order to diagnose the illness early [11]. COVID-19 takes anywhere from 1 to 14 days to incubate. Surprisingly, even though a patient has no symptoms, the COVID-19 virus might be transmitted to others [3]. This is when isolating these individuals is needed [12]. Furthermore, the recovery time for this disease varies and it depends on the patient's age, underlying causes, and other factors, but it will extend anywhere from 6 to 41 days in total [13,17,18]. Although this disease has a high capacity for rapid dissemination as opposed to other Coronaviruses, there are many attempts and experiments being conducted to limit the virus's spread. IoT technology has proved to be a secure and successful way to combat the COVID-19 pandemic in this sense [14–16]. Fig. 1 shows the model of Internet of Thing (Figs. 2 and 3).

2. Literature review

In this paragraph, previous studies based on medical science has been done using the Internet of Things to monitor patient health. Table (1) shows several studies of IoT based on healthcare monitoring. Table (1) Healthcare Monitoring in IoT.

Author	Independent	Dependent	Methodology
B. Thaduangta et al. [19]	Device sensor	relied on basic health checkups, which included testing body parameters on a daily basis and reporting the results to physicians. A web application's outcome info.	Technology Acceptance Model
Trivedi et al. [20]	Not to use other devices for the transfer process and to use a Bluetooth device that does not cover a large area.	Analog values are registered and translated into digital data. The physical qualities were transmitted to the established system through Bluetooth.	Arduino-based health parameter monitoring was regulated by a mobile computer.
Kumar et al. [21]	Not use other devices for many sensors cannot be treated properly.	In the control section, a DS18B20 sensor was used to measure body temperature, and a pulse sensor was used to measure pulse. The Wi-Fi module and the Ethernet shield on the transport layer were used to load data from Arduino into the cloud.	Ethernet, Wi-Fi, and Arduino
Tamilselvi et al. [22]	No specific performance measures are described for any patient.	Heartbeat, SpO2, Temperature, and Eyeblink sensors were used as capturing components, with the Arduino-UNO serving as the processing unit.	As a microcontroller, the ARDUINO-UNO module and cloud computing
Prajoona Valsalan et al. [23]	----	Body temperature, heart rate, and room humidity and temperature were all tracked using sensors, which were all reflected on an LCD.The sensor data is then sent to a medical server via the internet Connection over the airwaves	WLAN, LCD,wireless communication.
Acharya et al. [24]	The major drawback of the system is that no interfaces for data visualization are developed.	Pulse sensor, temperature sensor, blood pressure sensor, ECG sensor, and Raspberry Pi are all included here. Sensor data was gathered and sent to a Raspberry Pi for analysis before being sent back to the IoT network.	BP sensor, ECG sensor, and raspberry pi.

3. Backgroung theory

3.1. The General Data Protection Regulation (GDPR)

The General Data Protection Regulation (GDPR) is a European Union (EU) and European Economic Area (EEA) regulation on data protection and privacy (EEA). It also addresses personal data transfers outside of the EU and EEA. [No. 201] The GDPR, whose primary goal is to give individuals control of their personal data while also simplifying the regulatory environment for international business, has been in effect across the European Union (EU) since late May, [200] and is widely regarded as the single most significant change in data protection law in two decades, affecting a countless number of organizations around the world that collect and process personal data. This covers those in charge of online authentication [26].

3.2. One-time password (OTP)

On a computer or other digital interface, a one-time password (OTP), also known as a one-time PIN or dynamic password, is a password that is valid for a single session or login transaction only. OTP avoids some of the drawbacks associated with traditional (static) password-based authentication; Many apps often provide two-

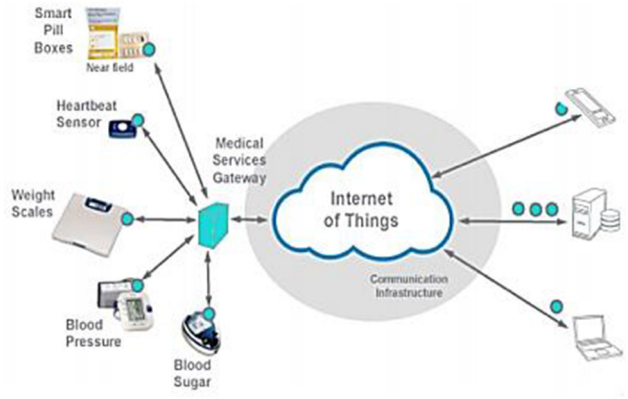

Fig. 1. Internet Of Thing.

Fig. 2. OTP massage.

Fig. 3. QR message.

factor authentication by ensuring that a one-time password requires access to both something a person owns (such as a mini vob with a one-time calculator, a smart card, or a specific cell phone) and something someone has (such as a device small key-chain with built-in one-time calculator, specific smart card or cell phone) plus something (like a PIN). Pseudo randomness or randomness are often used in OTP generation algorithms, making it impossible for an attacker to anticipate successor OTPs, as well as cryptographic hash functions, which can be used to retrieve a value but are difficult to reverse, making it difficult for an attacker to access the data used for the hash. This is important since it would otherwise be simple to forecast potential OTPs by looking at the past ones [25].

3.3. Quick Response (QR)

Two-dimensional codes, such as Quick Response (QR) codes, are made for more widespread implementations than one dimensional codes because they store more data. The QR code was created by the Denso-Wave Company in Japan and has since been adopted as a universal standard specification [1] by ISO [27]. QR codes are found in a multitude of situations in everyday life, including data collection, online connections, traceability, verification, and authentication. Furthermore, since QR codes offer a contactless information transmitting channel, the online-to offline mode of QR codes represents an exciting new trend. A QR code, according to [1], is resistant to segmental loss or symbol effect. QR codes are unsuitable for keeping classified data since anybody may access the information they contain. Many attempts have been made in recent years to put and secure hidden messages in QR codes [28–31].

4. Proposal system

The proposed system consists of two phases, the hardware phase, and the software phase, where the hardware part represents the devices used in this system to examine the person with COVID-19, this devises heart beats, temperature, oxygen rate. Raspberry Pi4 is the most powerful device to be released for this purpose, an incredible improvement on previous boards. The software part consists of three phases that represent the interface used through the mobile, frontend, and backend. All the parts used will be explained below. Figs. 4, 5 shown proposed system for the software phase [32–34].

4.1. Hardware phase

In this part, the types of devices that were used in the health care system to examine a patient with coronavirus will be explained.

a. Contactless Temperature Sensor Module GY-906 MLX90614ESF

This non-contact infrared thermometer can be used for Arduino or some other microcontroller that has an I2C device. This sensor comes with a breakout board that includes all of the required components as well as two types of pins. They have not been soldered. Please specify whether you like one or the other soldered. The I2C interface has two solder jumpers that can or may not need to be soldered depending on your use, but they will not in most cases. Fig. 6 depicts the GY-906 MLX90614ESF Contactless Temperature Sensor Module.

b. Heart Rate (Pulse)

Sensor for Microcontroller open source hardware development sensor whether are planning a workout regimen, studying your fitness or fear levels, or just want your shirt to blink in time with your heartbeat, heart rate data can be extremely helpful. The issue is that measuring heart rate can be difficult. Fortunately, the Pulse Sensor Amped is here to help! Fig. 7 Microcontroller open source hardware development sensor for heart rate (pulse).

c. Pulse Oximeter (SPO2) Heart-Rate Sensor Module MAX30100

The MAX30100 is a sensor that combines pulse oximetry and a heart rate monitor. It detects pulse oximetry and heart rate signals

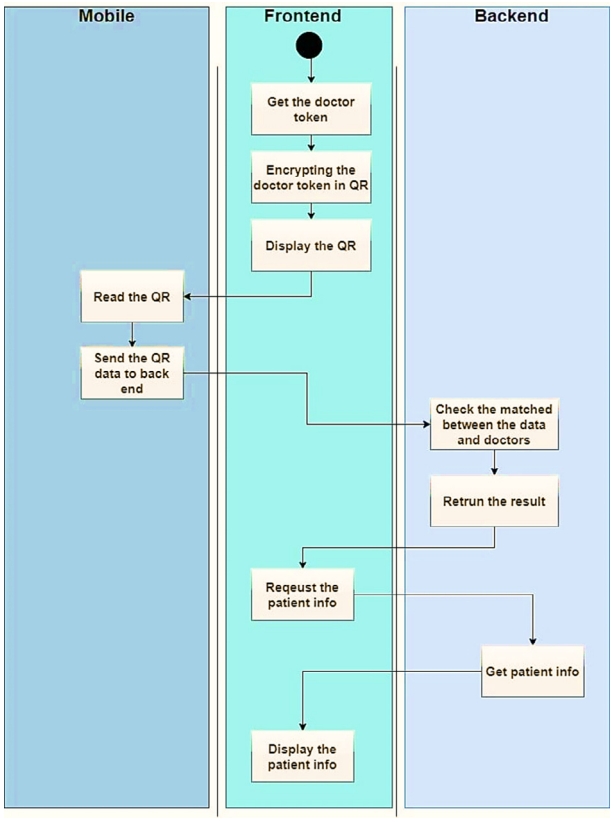

Fig. 4. Proposal System for patient support QR.

using two LEDs, a photodetector, calibrated optics, and low-noise analog signal processing. The MAX30100 uses 1.8 V and 3.3 V power supplies, and it can be shut down by software with very little standby current, allowing the power supply to stay connected at all times. Fig. 8 MAX30100 Pulse Oximeter (SPO2) Heart-Rate Sensor Module.

4.2. Software phase

The system includes a central token issuance system that issues and verifies encrypted tokens that form the basis of this proposal to secure prescription data that helps a patient with COVID-19. Prescriptions are stored as document objects in the cloud and the unique identifier issued by the cloud storage is encrypted and coded into a mapped QR code with some validity.

a. Players of the platform

The platform has three types of customers, the highest authority is the system admin, who has the highest privilege in terms of managing users (Adding users and editing permissions) with a rich dashboard that includes statistics for all medical centres. As for the doctor, his privileges are limited to adding a new visit with the patient's approval, (the second development of the letter), and he also has a dashboard that is specialized in his own patient's statistics. Finally, the subscriber of the medical platform who owns the authority to authorize the doctor by the mobile application through (QR) or by the (OTP), the customers and references are detailed. In order to ensure the privacy of the patient's data, although there are powers for the doctor to detect and add the treatment, the patient must be authorized to access the data. To

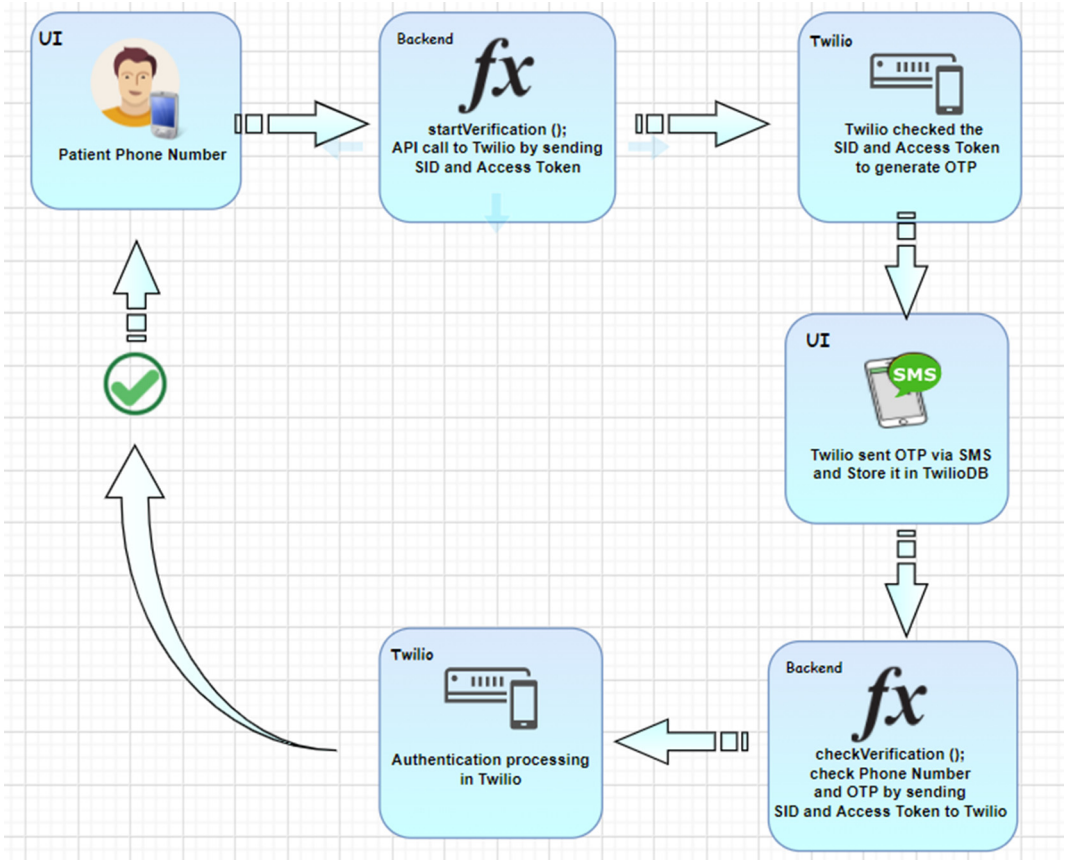

Fig. 5. Proposal System for patient support OTP.

Fig. 6. Contactless Temperature Sensor Module GY-906 MLX90614ESF.

Fig. 7. Heart Rate (Pulse) Sensor for Microcontroller open source hardware development sensor.

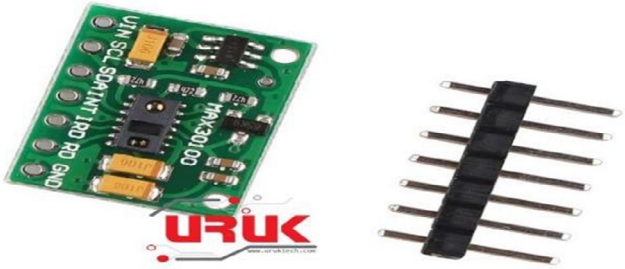

Fig. 8. Pulse Oxmeter (SPO2) Heart-Rate Sensor Module MAX30100.

provide this mechanism, an encrypted QR is used to check the doctor's presence in the system first and then give him access to the data. In case of the phone is not connected to the network or is not intelligent smart, the OTP by Twilio will be used. This will be illustrated by the following algorithms (1) (2).

Algorithm 1. OTP Using Twilio Messages.

Input: Phone Number
Output: Twilio Messages
1. GET Patient Phone Number
2. START Verification
3. CALL Twilio using API
4. SEND SID
5. SEND Access Token
6. GENERATE OTP
7. SEND OPT via SMS
8. STORE OPT in Twilio Database
9. IF (Phone Number is valid AND OTP valid) DO
10. Receiving Massages via API
11. ELSE
12. Authentication Failed
13. ENDIF

Algorithm 2. QR Code.

Input: Access Token
Output: Patient Information
1. GET ENCRYPT Doctor Access Token
2. DISPLAY QR Code
3. READ QR by Phone
4. SEND QR
5. IF (QR Doctor exists in Database) DO
6. REQUEST Patient Information
7. DISPLAY Patient Information
8. ELSE
9. Authentication Failed
10. END IF

b. Design Front layer

The first part, which is the " raspberry pi 4 " device, is responsible for transmitting data through the medical sensors which are connected within it, as mentioned in the second chapter. Where it sends data to databases as a final stage, details of data transfer will be detailed in the next paragraph. As for the second part of the front layer, its mobile and web; for mobiles, only the user has access to his or her readings, as well as to the doctor's authorization, as mentioned in the previous paragraph.

c. Backend layer

Within the backend layer there are 3 stages of processing; the first one starts with the authorization of all people that are authorized to enter the system by relying on token that is generated by the system. The second stage is concerned with dealing with the process, which includes validation and verification where the data is ready to analysis and visualization. The last part encrypts the data before storing it through the proposed algorithm (the first development of the research).

5. Experimental result

In this part, the interfaces obtained through the medical platform will be explained as well as dealing with this interface, starting from the system interface used by the admin to the patient interfaces as shown below. The main interface through which the doctor controls as shown in Fig. 9.

1. The patient's interface from which the doctor requests information, which is to send a code (QR) if he is connected to the Internet and his computer is smart, or to request (OTP) if he is not connected to the Internet and his device is not smart. Fig. 10 depicts the patient's interface post (Fig. 11).
2. The doctor records the patient's visit, the examination and the medication in the figure below (11).
3. A form in which the patient's visit information can be filled in as shown in Fig. 12.
4. A comparison is made of the databases entered for the patient and details of this comparison are presented as shown in Fig. 13 below (Figs. 14 and 15)
5. An interface that shows the number of users in the system, meaning how many doctors have used the platform to follow up on their status.
6. An interface that shows the number of infected and sick people who entered the system.

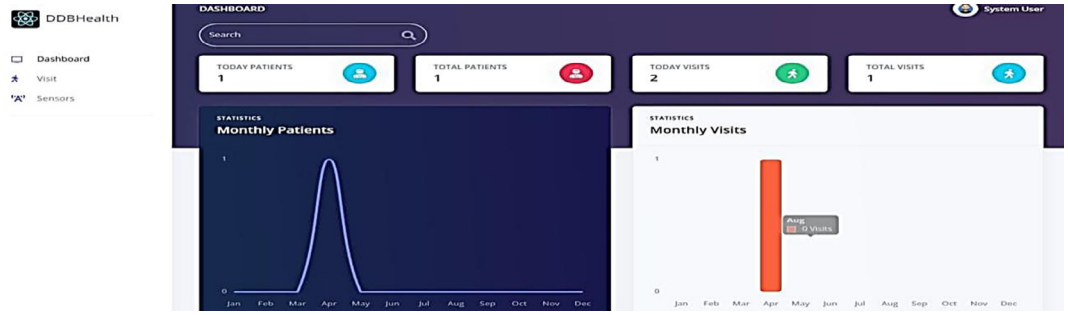

Fig. 9. Dashboard of the Doctor.

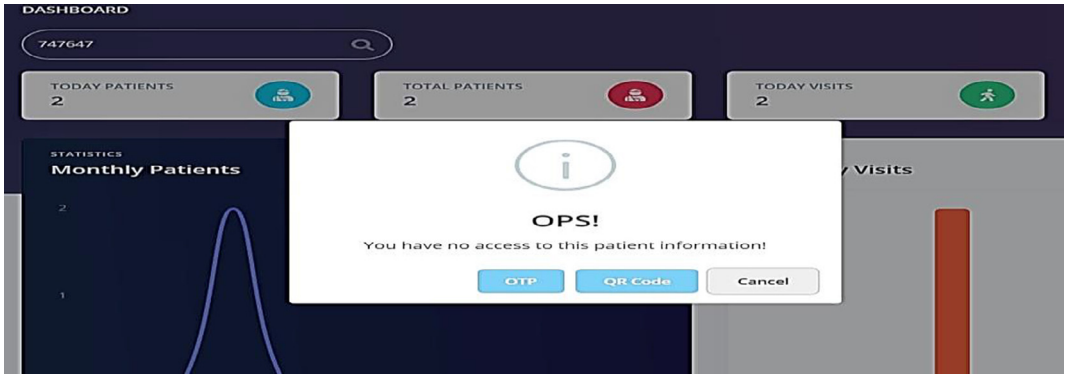

Fig. 10. Authentication of the Patients.

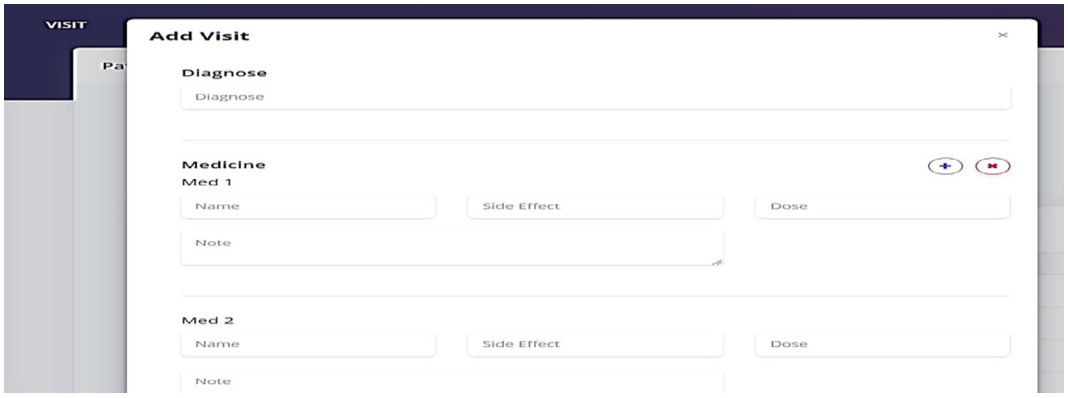

Fig. 11. Adding a New Visit.

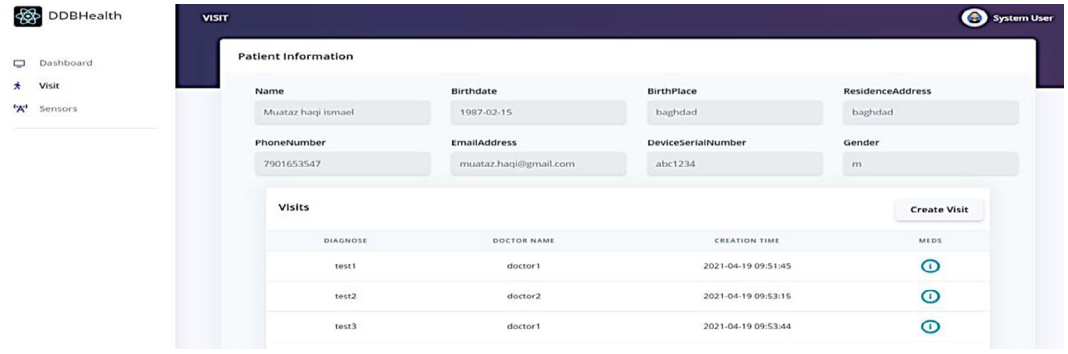

Fig. 12. Re-try of all previous visits.

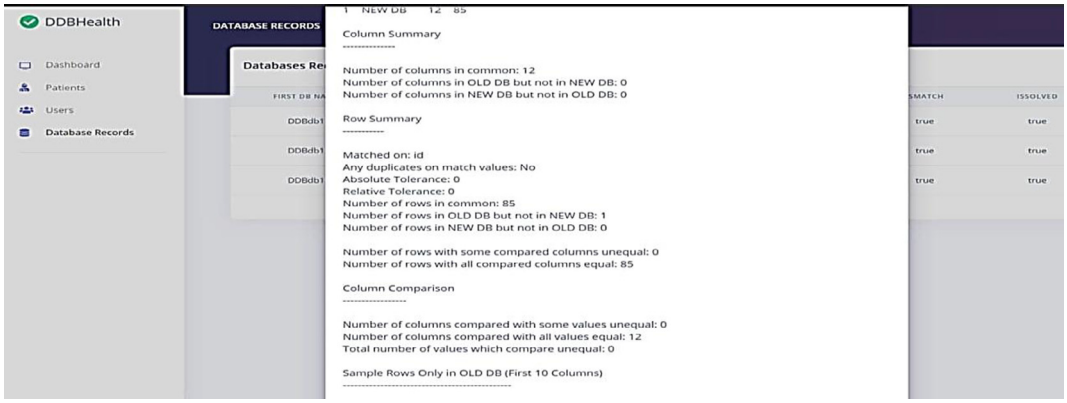

Fig. 13. Log File Showing Data Comparison with Each Database.

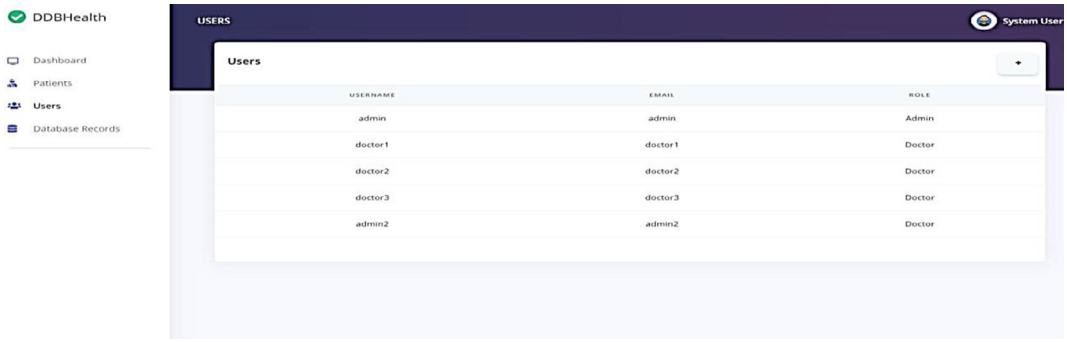

Fig. 14. Panel to add user.

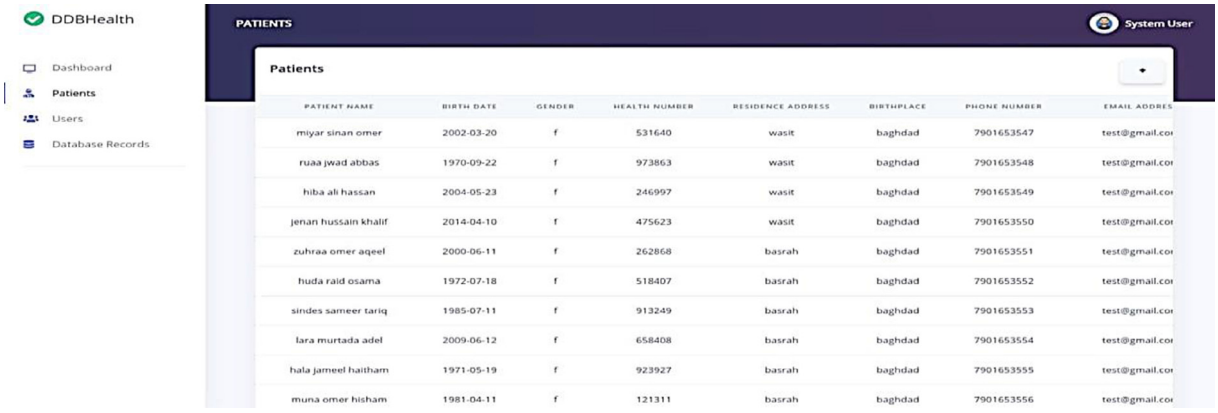

Fig. 15. Patient user panel.

7. Samples of the system interfaces used in the mobile phone will be presented and how the patient can use them to reach the doctors and follow up on their condition, and send the results to the doctor of temperature, pressure and heart rate, which change every time. Fig. 16 Sample of interface of mobile application.

6. Conclusion

In light of the crisis experienced by all countries of the world from the COVID-19 epidemic and due to the scarcity of hospitals and the difficulty of accessing places through which the injured person is examined and followed up on their case, so there was an urgent need to have a system that addresses this problem, so a medical system was designed based on the Internet of things. Where a group of devices that an individual can use to follow his/her condition through temperature, heart rate, pressure, and if it is outside the threshold degree that represents the natural degree of a person was used, and it is sent to the concerned authority, i.e. the doctor, to follow up his case through the QR code features used to make this system safe. This system was developed to eliminate all these kinds of illegal and harmful activities by digitizing and applying prescription restrictions using a QR code to limit the use of incorrect prescriptions. This system also provides medication port information to anyone using android app. By eliminating traditional methods, this system brings about a revolutionary change in the field of prescribing.

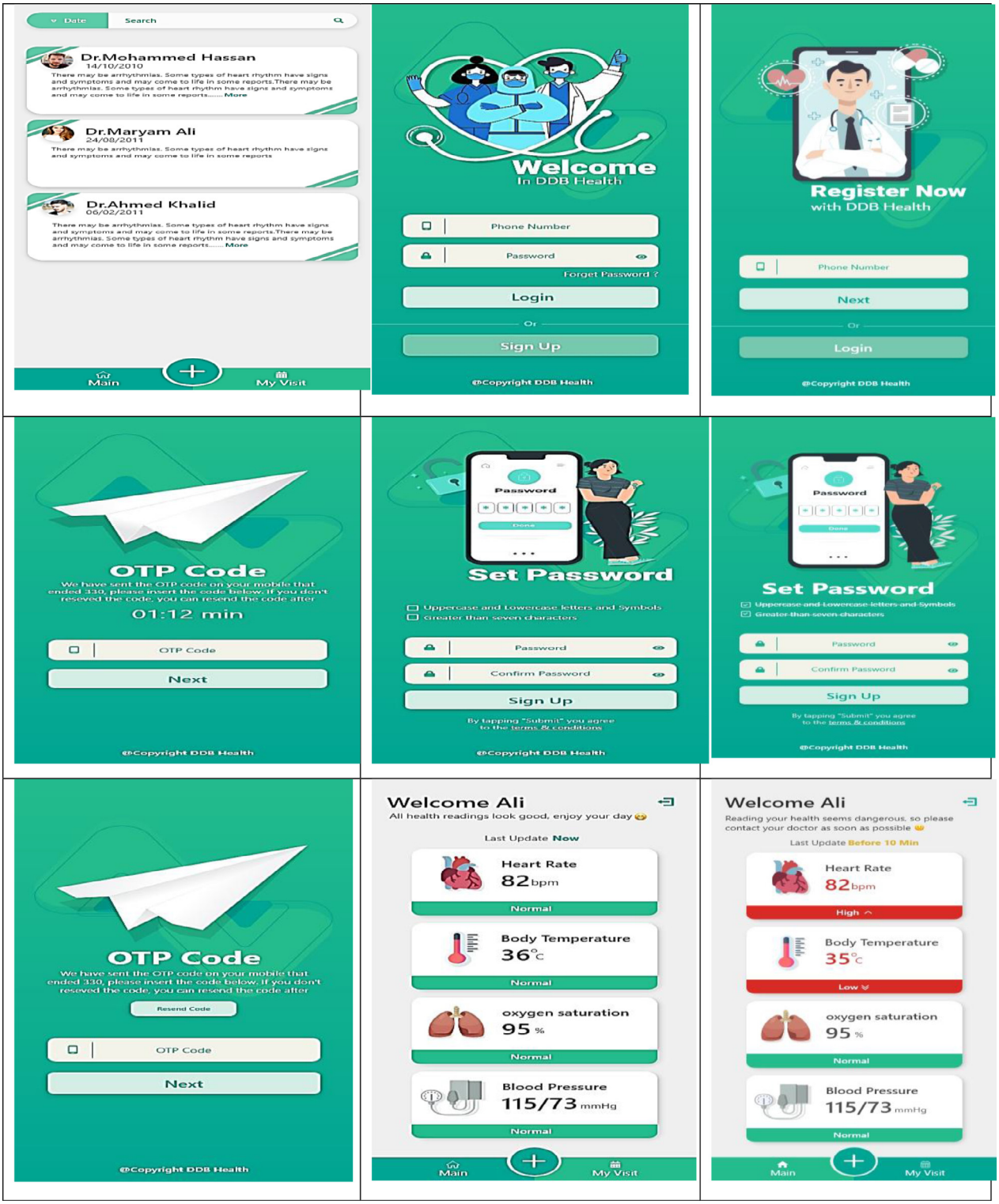

Fig. 16. Sample of Interface of Mobile Application.

CRediT authorship contribution statement

Muataz Haqi Ismael: Writing - original draft, Visualization, Data curation, Investigation. **Abeer Tariq Maolood:** Conceptualization, Methodology, Software, Supervision, Software, Validation, Writing - review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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