

# **INTERNET OF THINGS (IOT) ENABLE SMART MEDICAL CONSULTATION SYSTEM FOR ELDERLY CHRONIC DISEASE PATIENTS**

LI SANCHUAN  
MOHAMMAD KAMRUL HASAN  
*Fakulti Teknologi & Sains Maklumat, Universiti Kebangsaan Malaysia*

## **ABSTRACT**

Treatment of chronic disease is a long-term process that requires the cooperation of patients and doctors. And regular follow-up visits. The traditional online medical system lacks effective check-ups. To solve this problem, a Web-based online medical consultation system for elderly patients with chronic diseases has been developed. Patients can make appointments with their doctors and video chat with their doctors online. They can track personal health data collected by IoT wearable devices in real-time. The method used in this project is incremental development. PHP Laravel framework was used during development. The system is designed for elderly chronically ill patients who are inconvenient to travel to the hospital in person.

## **1 INTRODUCTION**

In today's world, both developed and developing countries are increasing population aging. Aging is a long-term risk factor for the development of many chronic diseases. On the other hand, there is an increase in the number of young chronically ill people who lack physical activity or have bad habits such as drinking alcohol, drugs, and smoking. Chronic diseases usually require long-term treatment and medication and regular hospital visits. This greatly increases the pressure on patients and society.

With the outbreak of the coronavirus disease (COVID-19) in 2019, countries have implemented different travel bans to control the epidemic. In this situation, most healthcare practitioners believe that since the outbreak of COVID-19, changes in medical services have had a certain impact on patients with chronic diseases. On the other hand, chronic diseases increase the risk of viral infections such as COVID-19. Therefore, some patients with chronic diseases dare not go to the hospital. These conditions increase the possibility of their disease recurrence or even death.

Online medical consultation systems can reduce the above cases. This kind of system transfers the process of patients seeing a doctor from offline to online. The patient will consult with the doctor through video.

## **2 PROBLEM STATEMENT**

The treatment of chronic diseases is a long process, usually requiring long-term medication and regular follow-up visits. Regular visits to hospitals are time-consuming and laborious for patients.

In China, some patients choose to go to famous hospitals in nearby big cities for treatment. This requires several days and additional accommodation and travel expenses, which increases the burden on patients. Especially during the epidemic period, since patients' immunity to chronic diseases is worse than that of healthy people, that is why visiting high-risk areas such as hospitals will increase the risk of cross-infection. Due to the epidemic and travel ban, some well-known hospitals and doctors are no longer able to receive frequent visits from patients as before.

Another problem is that traditional medical care is usually accompanied by various checkups and laboratory tests. A survey shows that 67.69% of patients believe that online medicine lacks effective checkups and laboratory testing and question the accuracy of online medical diagnosis results. For the elderly, the main population of chronic diseases, the backwardness of thinking and body is a challenge to the use of online medical care. One study concluded that older patients are less willing to use online medicine.

### **3 OBJECTIVES**

The objective of this project is to create an online medical system to provide services for patients with chronic diseases.

- a) To study the existing web-based medical system, and designs which unique functions that provide consultations for patients with chronic diseases
- b) To design and build a new system with a web-based application that solves the real-time video consultation and accessibility problems.
- c) To test and validate the proposed system connecting the patients and doctor for real-time consultation performance evaluation.

### **4 METHODOLOGY**

The method used in this project is incremental development. The idea of this model is to develop an initial implementation first. Then expose it to users for review and comments. Finally Refining it through many versions until complete.

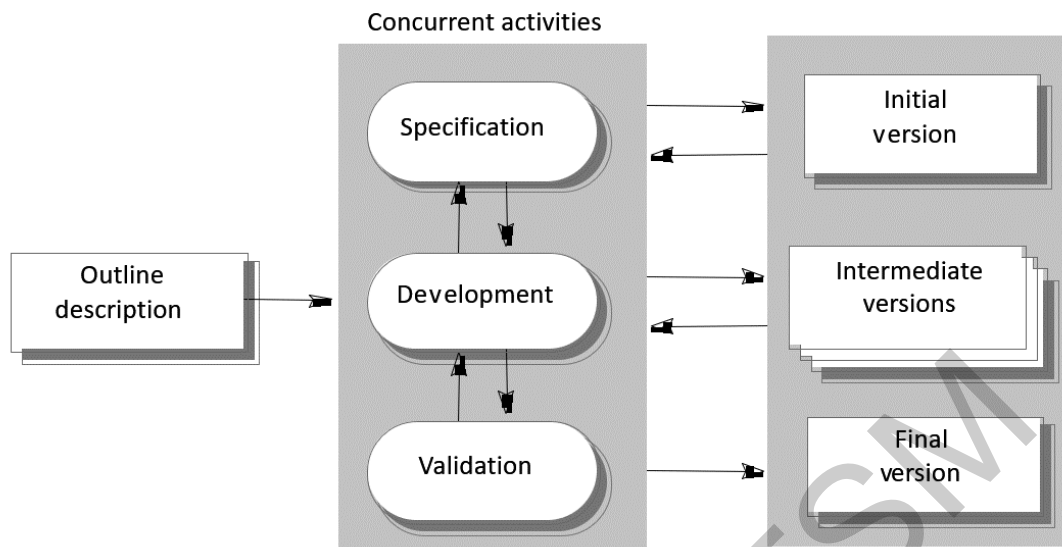


Figure 4.1 Incremental Software Development Cycle (Sommerville, 2011, Software Engineering. 9th Edition. Addison-Wesley, New York.)

In the early stage of development, only a general description of the software requirements is required, while the detailed description can be delayed and supplemented one by one in units of incremental components. This method is conducive to the gradual clarity of user needs and can effectively adapt to changes in user needs. The risk of project failure in incremental mode is low. Maybe some incremental components may encounter problems, but other incremental components will be successfully delivered.

#### 4.1 Analysis phase

This stage mainly completes the comparison of existing systems, requirements analysis, and the writing of requirements documents

#### 4.2 Design Phase

In the design phase, it is mainly divided into two parts, user interface and interaction design and software architecture design.

#### 4.3 Implementation Phase

This phase develops software based on requirements and design. This process is actually the most time-consuming part.

#### 4.4 Testing Phase

This phase will test whether the system can achieve the goal. The main test direction is the requirements test, compatibility test, and security stability test. In the final usability test part, related users such as senior citizens, community hospital medical staff, patient family members, and medical students were invited to test.

## 5 RESULTS OF THE STUDY

After testing, each sub-function of the system works well and meets the requirements. This chapter will demonstrate the main functions of the system.

### 5.1 Authentication

The authentication part is created using the scaffolding Jetstream that comes with the Laravel framework.

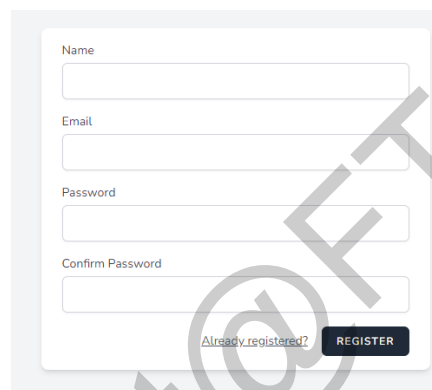
A screenshot of a registration form with a light gray border. It contains four input fields: 'Name', 'Email', 'Password', and 'Confirm Password'. Below the fields, there is a link 'Already registered?' and a dark gray button labeled 'REGISTER'.

Figure 5.1 Login

When the user completes the basic registration, it will jump to the user type selection page, which provides two roles of patient and doctor.

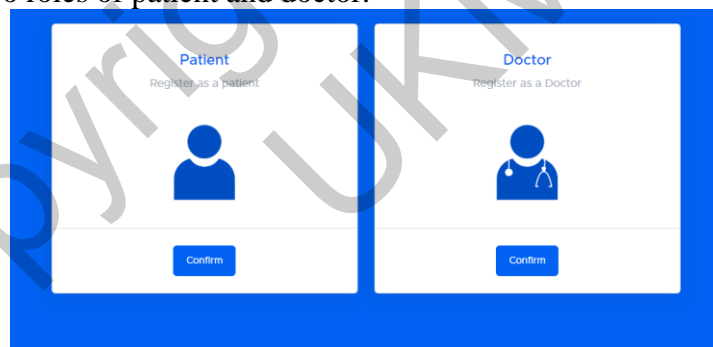


Figure 5.2 Role select page

### 5.2 Profile Page

Details of patients and doctors are stored in separate tables. Users can edit the information here.

DashboardPatient patient001


FOR PATIENTS

- Profile
- Doctor
- Appointment
- Consultation
- Medical Record
- Health Tracker

## Welcome

### My Profile

Username	patient001	Email address	patient@example.com
First name	pfnameaaa	Last name	plnamesss
<small>*Please enter your legal name on your identify card or passport</small>			
Disease	Nephrology	Gender	Male
		Age	75
Address			
xxxxx			
City		Province/States	
xxxxx		xxxxx	

Photo 

[Changes](#)

Figure 5.3 Profile Page - PC

Copyright © FTSM  
UKM

Dashboard<sup>Patient</sup>

Welcome

My Profile

Username  
patient001

Email address  
patient@example.com

First name  
pfnameaaa

Last name  
plnamesss

\*Please enter your legal name on your identify card or passport

Disease  
Nephrology

Gender  
Male

Figure 5.4 Profile Page – Mobile Phone

### 5.3 Doctor Page

Patients can view their own doctors on this page and can also change or bind other doctors. New users must bind a doctor before they can perform follow-up operations such as making an appointment.

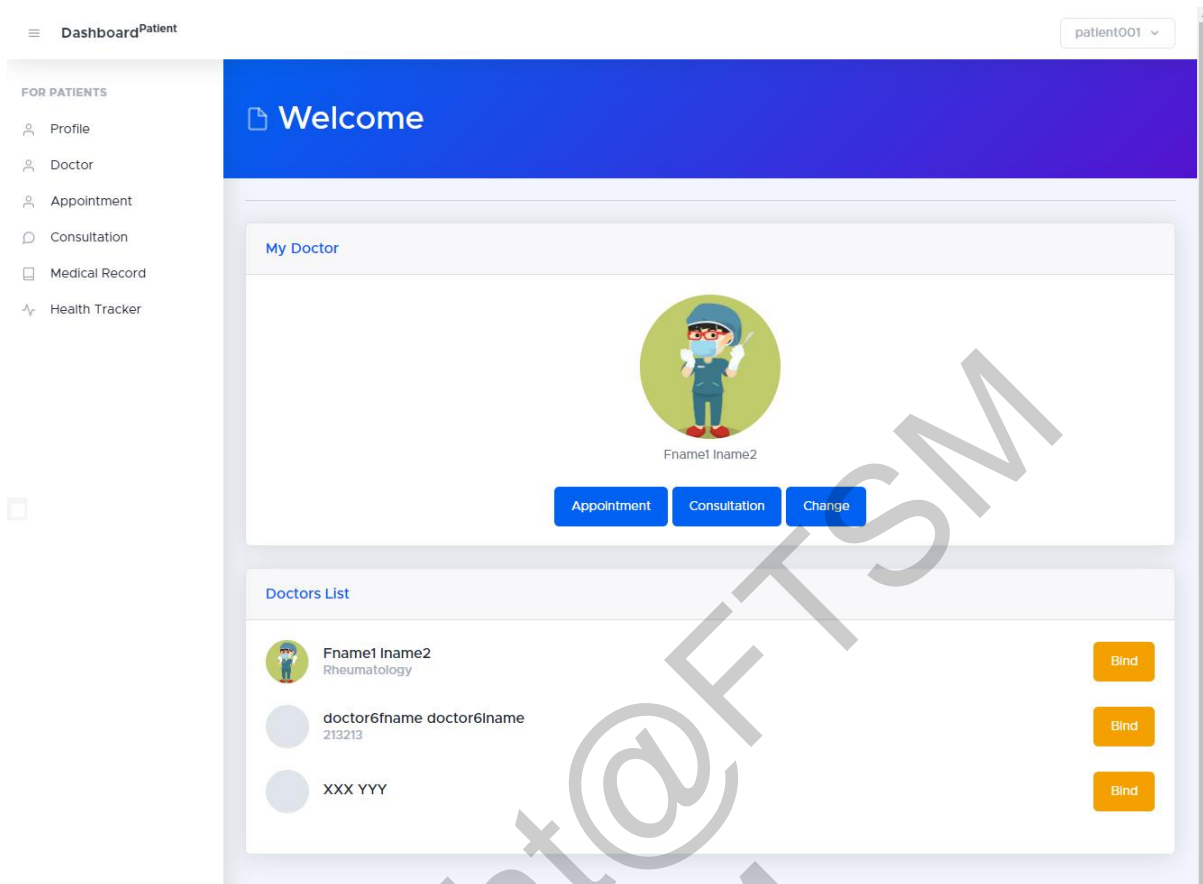


Figure 5.5 Doctor Page

#### 5.4 Appointment Page

Patients can create appointments here, doctor users cannot create appointments, but they can approve or decline the appointment.

DashboardPatient patient001

**FOR PATIENTS**

- Profile
- Doctor
- Appointment
- Consultation
- Medical Record
- Health Tracker

### Appointment

**First Name**

**Last Name**

**Date**

**Time**

**Message**

Enter message..

### My Appointment List

Firt Name	Last Name	Date	Time	Message	Status	Close
pfname	plname	2022-07-17	14:00 - 15:00	asdasdasdasdsadsa	Closed	<input type="button" value="Close"/>
pfname	plname	2022-07-16	14:00 - 15:00	sadasdsadsadsada	Approved	<input type="button" value="Close"/>
pfnameaaa	plnamecss	2022-07-07	09:00 - 10:00	adasdasdsadaa	Approved	<input type="button" value="Close"/>

Figure 5.6 Appointment Page – Patient User

## 5.5 Consultation Page



DashboardPatient patient001

FOR PATIENTS

- Profile
- Doctor
- Appointment
- Consultation
- Medical Record
- Health Tracker

## Welcome

### Consultation List

>>>

Doctor Name	Patient Name	Date	Time	Status	Consult
pfnameaaa plnamesss	Fname1 lname2	2022-07-17	14:00 - 15:00	Closed	Start Meeting
pfnameaaa plnamesss	Fname1 lname2	2022-07-16	14:00 - 15:00	Approved	Start Meeting
pfnameaaa plnamesss	Fname1 lname2	2022-07-07	09:00 - 10:00	Approved	Start Meeting

Figure 5.7 Consultation Page – Patient User

Video chat function using TRTC(Tencent Cloud Real-time Communication). Here, TRTC is embedded into the system through an iframe. Use a hidden label tag through the username to TRTC and get it with JavaScript.

```
<label id="username" hidden="true">{{data}}</label>
@include('patient.dashboard_head')
@include('patient.consultation.consultation_card')
@include('patient.dashboard_tail')
```

Figure 5.8 Consultation room blade

```
<script>
  var username= window.parent.document.getElementById("username").innerText;
</script>
```

Figure 5.9 JavaScript use to get label id

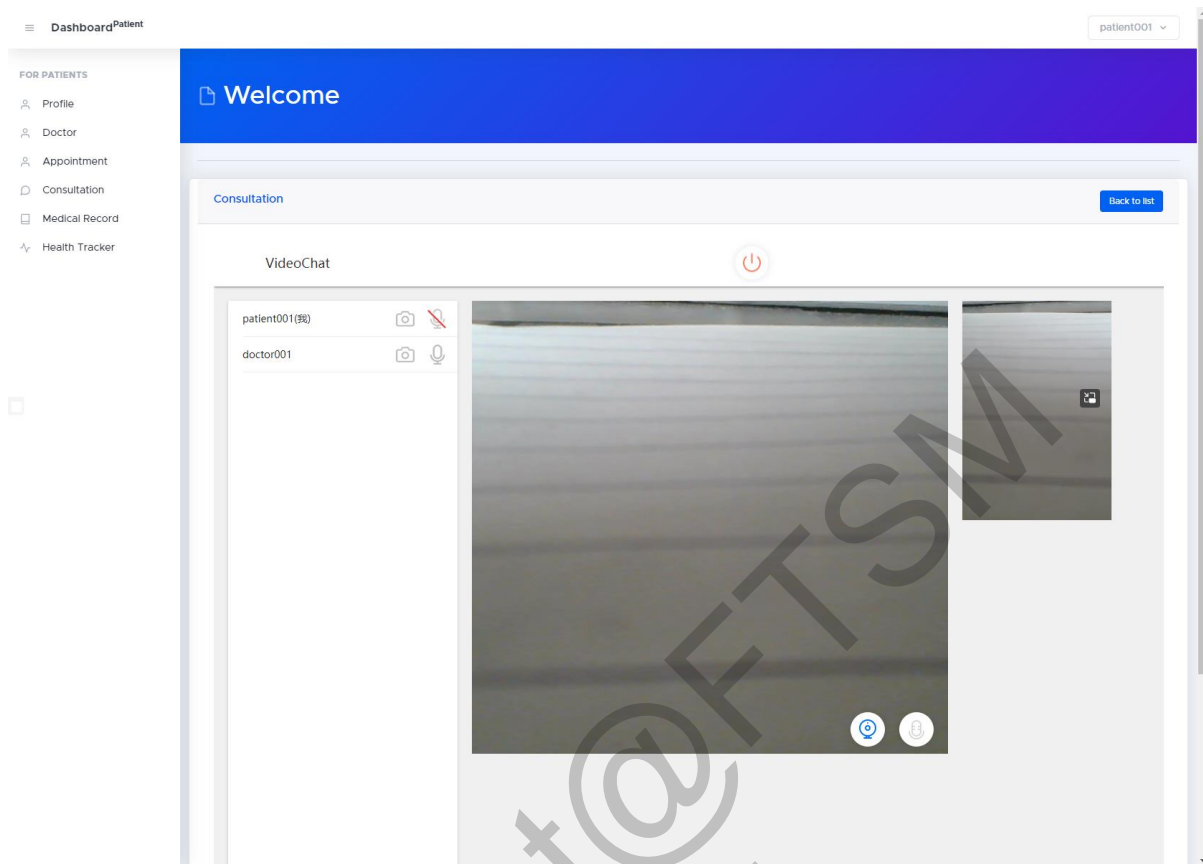


Figure 5.10 Consultation Room Page

## 5.6 Medical Record Page

After the video consultation, the doctor can write a medical record for the patient here. Once a record is submitted, it cannot be modified or deleted.

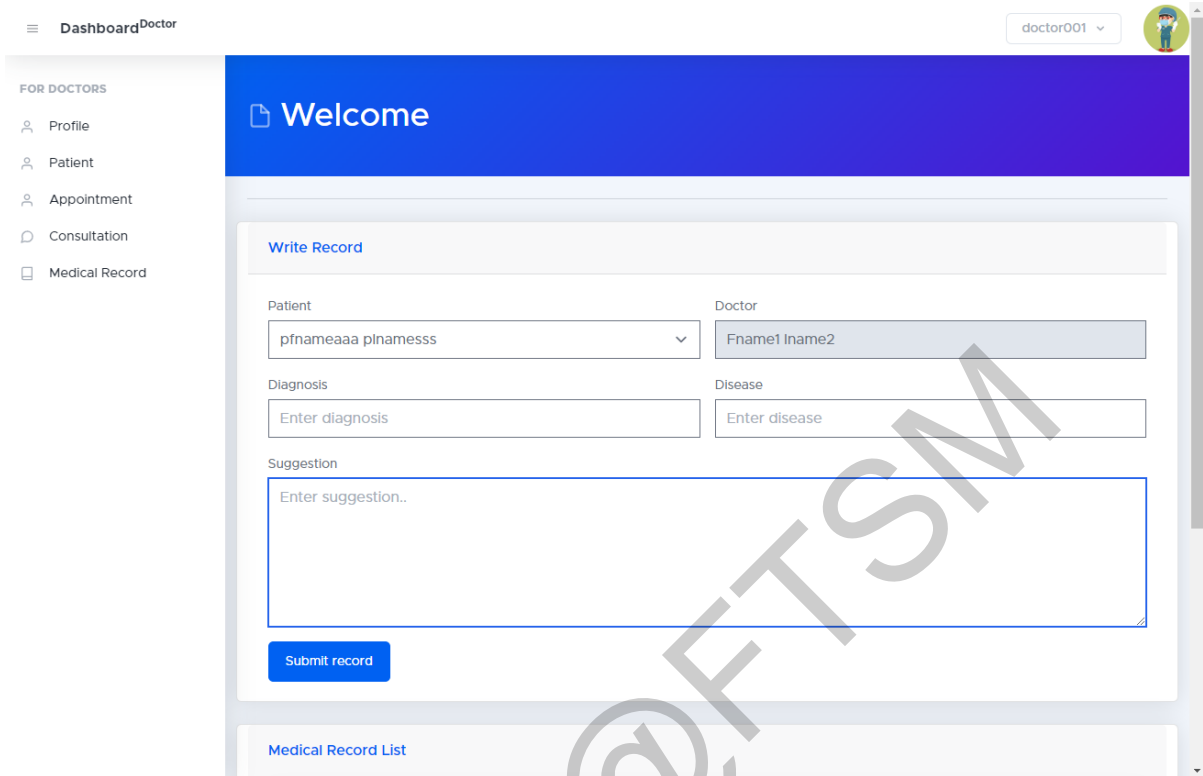


Figure 5.11 Medical Record Page – Doctor User

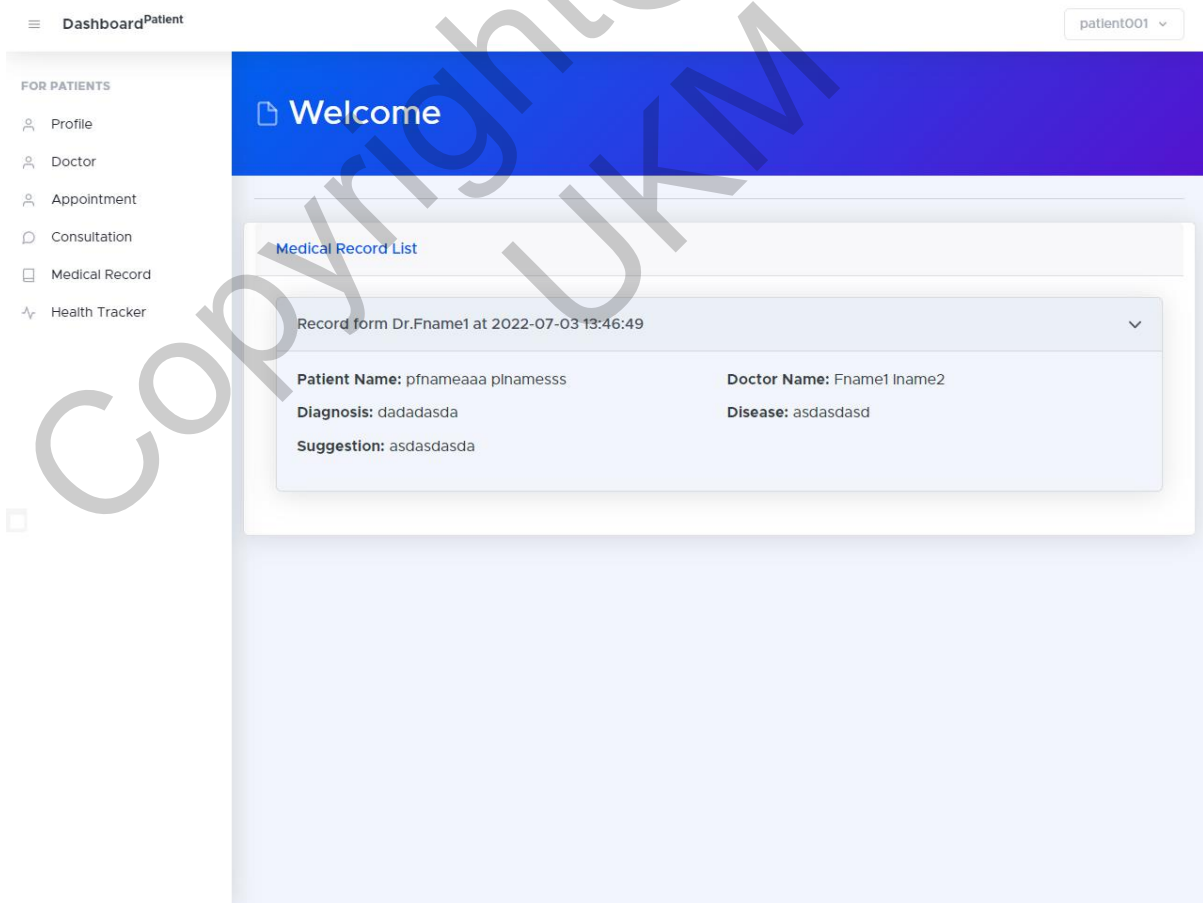


Figure 5.12 Medical Record Page – Patient User

## 5.7 Health Tracker

Health tracker page is created using Alibaba Cloud IoT Studio. Data can be displayed dynamically in the chart.

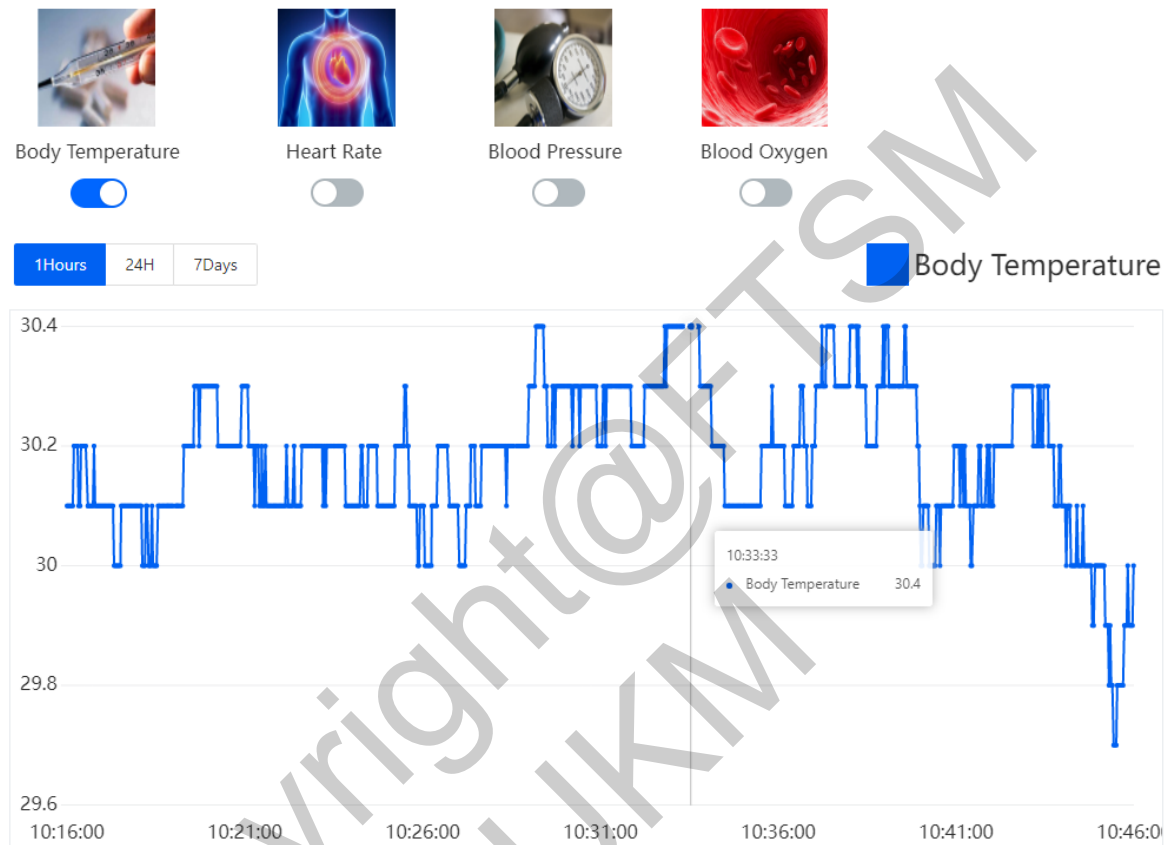


Figure 5.13 Health Tracker Page

## 5.8 Account Verify

After a new doctor is registered, the account needs to be approved by the system administrator before it can be used

Dashboard Admin admin

FOR ADMIN

Verify

## Welcome

### User List

Username	Email	Usertype	Register at	Status	Verify
patient001	patient@example.com	1	2022-07-03 13:44:02	Patient	Verify
doctor001	doctor@example.com	2	2022-07-03 13:46:46	Verified	Verify
doctor002	doctor2@example.com	2	2022-07-03 13:48:34	Verified	Verify
doctor3	doctor3@example.com	9	2022-07-05 01:39:08	Unverified	Verify
admin	admin@example.com	3	2022-07-05 01:54:48	Admin	Verify

Figure 5.14 Doctor Verify Page

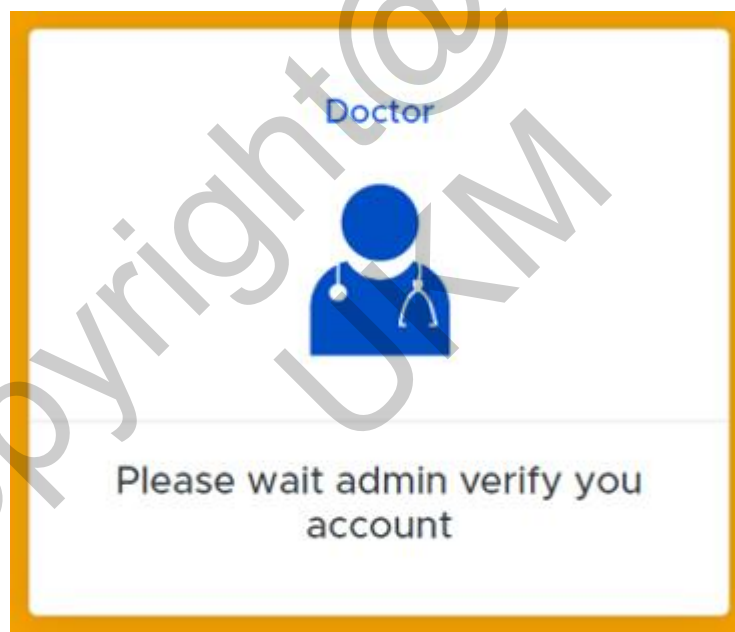


Figure 5.15 Alert when unverified Doctor login

## 5.9 Wearable Device Prototype

This device is for patient health condition monitoring, which is a prototype device used for the web-based real-time application for consultation.

The prototype uses Arduino Uno as a microcontroller and uses the BC260Y-CN Narrowband-IoT module to communicate with the Alibaba Cloud IoT platform through the MQTT protocol. At present, this prototype only uses the temperature sensor to obtain data as a demonstration.

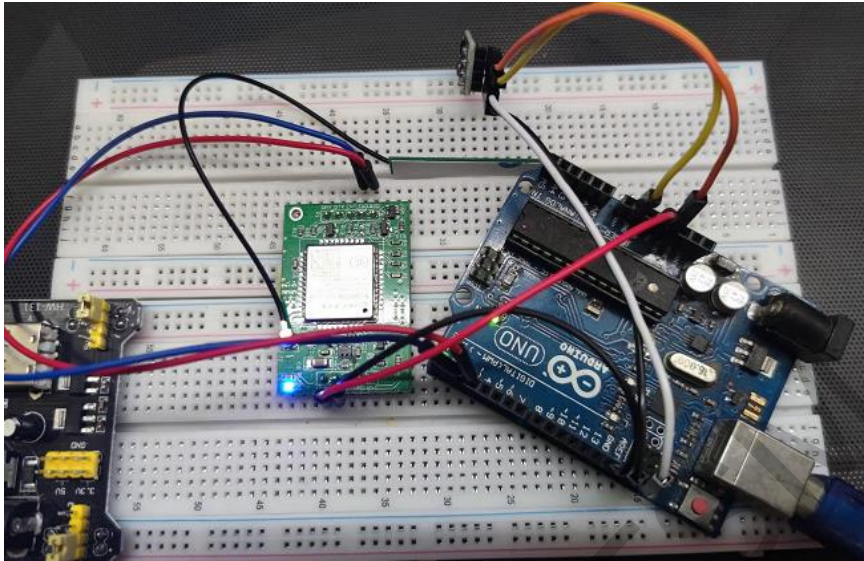


Figure 5.16 Wearable Device Prototype

## 6 CONCLUSION

This project proposes a prototype of an online medical system that combines cloud and smart wearable devices, but the functions are still relatively simple and can be further improved in the future. It is hoped that this project can inspire the development of an online medical system combined with smart wearables that can really be put into use. More convenience for patients and doctors.

## 7 REFERENCES

Alibaba Cloud IoT Platform Product Document

<https://help.aliyun.com/product/30520.html>

Alibaba Cloud, Q&A Domain name management

[https://help.aliyun.com/document\\_detail/254801.html](https://help.aliyun.com/document_detail/254801.html)

Alma Health official website

<https://almahealth.io>

Atella V, Piano Mortari A, Kopinska J, et al. Trends in age-related disease burden and healthcare utilization. *Aging Cell*.

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6351821/deliver>

China mainland Website Filing Policy

[https://help.aliyun.com/document\\_detail/36922.html](https://help.aliyun.com/document_detail/36922.html)

Health Symptom Tracker google play page

<https://play.google.com/store/apps/details?id=com.health.symptom.tracker>

Institute of Medicine. 2012. *Living Well with Chronic Illness: A Call for Public Health Action*. Washington, DC: The National Academies Press.

doi: 10.17226/13272.

Kang, C., Yang, S., Yuan, J., Xu, L., Zhao, X., & Yang, J. (2020). Patients with chronic illness urgently need integrated physical and psychological care during the COVID-19 outbreak. *Asian journal of psychiatry*, 51, 102081.

<https://doi.org/10.1016/j.ajp.2020.102081>

Laravel 8 Document

<https://laravel.com/docs/8.x>

Li Hongmei, Fu Wen, Nearly half of residents choose to go to major hospitals(in Chinese), *People's Daily*, 29 June, 2015 , page 16

<http://society1.people.com.cn/n/2015/0629/c1008-27220561.html>

QI Miao-jie, HAN You-li, School of Public Health, Capital Medical University. Research on the Status Quo of Online Medical Use of Hospital Patients and Related Factors. *Chinese Journal of Health Policy*, July 2019, Vol. 12 No. 7

Reiners F, Sturm J, Bouw L J W et al. Sociodemographic Factors Influencing the Use of eHealth in People with Chronic Diseases [J] . International Journal of Environmental Research and Public Health, 2019, 16: 654

Rheumatism Center official website

<https://91dr.cn>

Sommerville, 2011, Software Engineering. 9th Edition. Addison-Wesley, New York.

Tencent Cloud Real-time Communication Document

<https://cloud.tencent.com/document/product/647>

Teresa Niccoli, Linda Partridge, Ageing as a Risk Factor for Disease, Current Biology, Volume 22, Issue 17, 2012, Pages R741-R752, ISSN 0960-9822,

<https://doi.org/10.1016/j.cub.2012.07.024>.

We Doctor official website

<https://www.guahao.com>

Yang Yan, Health guidance for home protection of elderly patients with chronic diseases during covid-19(in Chinese) ,2021

doi: 10.19335/j.cnki.2096-1219.2021.3.045

Yogini V. Chudasama, Clare L. Gillies, Francesco Zaccardi, Briana Coles, Melanie J. Davies, Samuel Seidu, Kamlesh Khunti, Impact of COVID-19 on routine care for chronic diseases: A global survey of views from healthcare professionals, Diabetes & Metabolic Syndrome: Clinical Research & Reviews, Volume 14, Issue 5, 2020, Pages 965-967, ISSN 1871-4021,

<https://doi.org/10.1016/j.dsx.2020.06.042>.



LI SANCHUAN(GA04521)  
MOHAMMAD KAMRUL HASAN  
Fakulti Teknologi & Sains Maklumat,  
Universiti Kebangsaan Malaysia

Copyright@FTSM  
UKM