E-CARE a Telemedicine Application for Pandemics

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ABSTRACT

Innovations in Information and Communication Technology have transformed the way healthcare methods are experienced by both healthcare professionals and patients. Smart gadgets are becoming useful smart tools for monitoring one's health remotely and today, there are lot many emerging applications meant to increase self-monitoring, empowerment and quality of life. Telemedicine or E-CARE is one such alternative that can aid in controlling international pandemics. With Covid-19 case spreading across the country, physical consultations can be hazardous for both patients and the doctors. Under these circumstances, remote consultations over the smartphone or video calls can help Covid patients' access to telehealth care facility while also limiting self and Doctors' contact to the diseased patient. This paper exhibits the development of a telemedicine application called "E-CARE" that monitors the COVID-19 positive patients either at home isolation or at the Covid Care Centers(CCC) remotely which helps the Doctors and the care taker to receive the patients' real time vital parameters required to access his/her health conditions and also to monitor the emergency situation. Thus we have developed web based application software that works on smartphone that enables the access to Doctors through smartphone.

Keywords—CCC (Covid Care Centers) CCC (Covid Care Centers, FCM(Firebase Cloud Messaging),ICT(Information Communication Technology)

I. INTRODUCTION

Pandemic affects our lives, societies and economies massively. Pandemic is when a new disease quickly spreads through countries and continents. Corona virus (the latest pandemic), belonging to the coronaviridae family, causes sickness in both animals and humans. With respect to human body, the virus is recognized to cause contagions respiratory system problems including fever, body-pain, and common cold to more serious diseases infecting the upper respiratory region and thereby resulting in pneumonia and other associated infections, which can ultimately affect the significant part of our nervous system, leading to death for those with underlying health disorders. National capital witnessed the second wave of COVID-19 (roughly the period needs to be mentioned) and has now turned the corner [1]. The sudden daily spike in cases crossing 4k, which took place earlier this month, was the second wave of the disease. This is the first phase any state in the country experienced to have reached the second wave of the pandemic.

WHO (World Health Organization) suggested that governments globally should quickly strengthen active examination to diagnose the infected being to allow quick isolation. Many smart technologies like Internet of Things (IoT), Big Data and Artificial Intelligence (AI) have been in high demand to remotely monitor the quarantined patients. These new-age technologies could become one of the strategies to control the disease transmission and to avoid deaths [2]. The technological advancement provides new options as telehealth services to facilitate an ideal service provision while reducing the threat of direct face-to-face contact.

The practice of telehealth care medicine is a 21st century method which revolves around patient and protects them along with physicians, care takers, pharmacist etc. Telehealth deals with the supply of health care services by health care professionals, through using Information and Communications Technology - ICT where distance is a crucial factor. Telehealth services are smart technologies involving real-time store-forward methods

to exchange correct and valid information [3]-[5]. With rapid development and downscaling of wearable computing, many people have minimum one digital appliance viz. Smart phones.

Smart phones with webcams enable contact between pandemic patient and healthcare provider in telehealth care technology. Video conferencing and television systems are used as medium to provide healthcare programs for people who are quarantined or hospitalized. Using ICT reduces the risk of direct contact with the infected. Advantage of distant care decreases the resource utilization in health centers, improves accessibility, while reducing the threat of direct spread of the infectious agent from individual to individual [6]-[7]. Additionally, these technologies provide a widely access to care takers to operate remotely.

Telehealth care services handles any kind of pandemic hit and can become a basic requirement for the universal inhabitants like healthcare providers, and patients with COVID-19, specifically when diseased are in quarantine, enabling remotely monitoring the infected people in real time through contactless services. This paper thus proposes a method to develop a Telehealth care App that provides telehealth services in preventing, identifying, treating, and controlling the disease spread during the second wave of COVID-19 outbreak.

II. PROPOSED HEALTHCARE MOBILE APPLICATION

This work describes the design and implementation of smart phone based telemedicine system that can be used to monitor human body temperature, heartbeat, blood pressure mainly measure of SPO_2 level to provide the right treatment through stand-alone devices. The purpose of this developmental app is to help the COVID health team workers reduce the travel to hospitals by using a simple web application. The web application is also useful to doctors and caretakers who treat COVID-19 patients and will have the chance to access the patient's information 24 X 7. The recorded vital information can be used by the doctor to determine if there is any variations in the vital parameters beyond the clinical range, Tele-intensive care unit platforms, which consist of real-time audio, visual, and electronic connections between remote critical care teams and patients in distant covid care units or home isolation and provide expert guidance for to reduce the phase of recovery.

III. THE PROPOSED WEB APPLICATION PHASES

The build of the application witnessed many different phases depending on the generation of data, handling the data and usage of the data.

A. **Big Data**

Enormous amount of information is generated and processed in healthcare sector. Big data computations help to gather and evaluate the EHR (electronic healthcare records). The processed information can be used to improve treatments, provide more accurate diagnoses, conduct medical researchers, and eventually cut costs [8]-[9].

B. **Blockchain**

The technology eliminates the loss of healthcare information as opposed to paper records. Medical data exchange and storage is secured [10].

C. **IoT**

The telemedicine includes equipments like medical kiosks, tablets, digital cameras, smart gadgets, etc. The Internet of Things (IOT) contributes in tracking vital parameters, diagnosing, medication adherence, treatment suggestions, built-in emergency alerting systems, and many more. The combination of medical hardware and the efficient algorithms ultimately leads to better patient care through the telemedicine app development solution [11].

IV. APPLICATION OVERVIEW

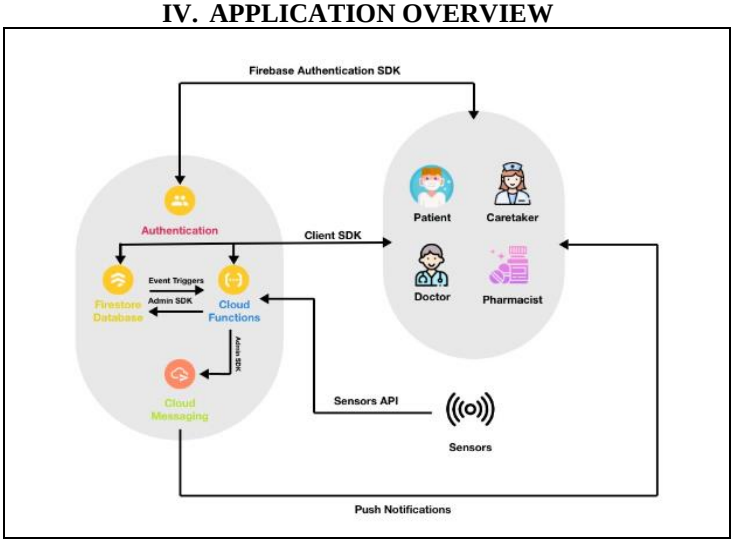

Figure 1: Proposed Application Mode.

Fig.1 illustrates the entire application flow of the proposed idea. E-CARE creates patient database at the time of registration and creates the interface to update the vital parameter by the patient. To handle this scenario, the application uses the database Firebase Firestore [12]. Firebase Firestore is a NOSQL database and is well backed by Google. The backend services of the database are reaching high popularity within the developer community. The main features of firebase are triggering functions, authentication, machine learning kit, analytics, crash analytics etc. These features were widely and wisely used in our application. Firestore helps the database to synchronize and collaborate in real-time with cross devices. This feature allows offline E-CARE usage and the data gets automatically synced during restoration. Another unique feature of firebase is that the query time almost remains the same for any sized database.

Authentication is the main and prominent feature of E-CARE. The application uses Firebase Authentication for patients'/ doctor personal user credentials. The use of firebase authentication was to authorize the three client platforms (Hospital management which is a web app, doctor and patients app portals). Authentication improves the sign-in feature and the on boarding experience for the end-users [13].

The application uses real time triggers and other online services such as Firebase Functions for timely updates to different fronts.Firebase functions help us perform these triggers. There are multiple triggers that keep the platform a float. The database gets responsive as soon as there is a trigger.

Firebase Cloud Messaging FCM is used to push notifications to the fronts. Push notifications form a real big portion of the E-CARE platform. To maintain industry level standards and to also to maintain clients' connectivity, FCM is strongly built into the application [13].

On the front end i.e. Hospital Management, the application uses Angular for web application. Angular is an application design framework and development platform for creating efficient and sophisticated single-page applications.

Flutter is used for the Doctor and Patient/ Client front. Flutter, an open-source User Interaction software is a development kit created by Google. It is used to develop applications for Android, IOS, Linux, MAC, Windows, Google Fuchsia and the web from a single codebase [14].

A. E-CARE features for Patient

- Registration- Patient can sign up trough handheld device i.e through mobile number, social network, or email. Since the E-Care app deals with sensitive data collection, it requires a higher security protection service. Hence in our app two -factor authentication services are enabled, which include SMS, and phone verification.
- Patient profile- Patient can sign up trough handheld device i.e through mobile number, social network, or email. Since the E-Care app deals with sensitive data collection, it requires a higher security protection service. Hence in our app two -factor authentication services are enabled, which include SMS, and phone verification.
- Patient profile- Patients will have a track of appointments based on Doctors availability, as well as the options to edit or cancel them.
- Communication- The mode of real time consultancy is through audio or video conferencing.

- Geolocation services- The app will gather patient geolocation with the help of Google Maps and GPS services. One of the important features in our app is that the patients' location will be shared to Ambulance network in case of emergency situations.
- Payment- E-Care app monetization is done through payment gateway system. The patient can access their transaction history.
- Notifications- SMS notifications and relevant reminders will be frequently received by the patients to keep track of appointments and updates.
- Rating and review- This feature ensures the Doctor-patient interaction and also ensures proper service quality based on the acquired feedback.

B. **E-CARE App features for Doctors**

As for the E-Care app for Doctors are concerned, some of the features correlates with the E-Care patient's app. On other hand, there are some specific functions is implemented only in this part of the system namely

- Dashboard and analytics- Doctors will be having different dashboards to make the necessary modifications to communicate with the patients.
- Scheduling- The doctor will set their availability slots to accept consultation requests, and to track their calendar filled with appointments.
- Communication- The patient-doctor communication will be enabled through mobile phone, can be used to interview patients with COVID-19 or any other pandemic diseased to find the person in contact with potentially infectious people and to follow-up with their contacts to inform them of the need to quarantine, assess whether they have any symptoms, and tell them what to do if symptoms develop, implemented through video conferencing for more detailed medical examinations.
- EHR review- Doctors will check COVID-19 patient's medical records either from their profile ,data hospital database and preliminary-filled questionnaires.
- Medical prescription- E-Care app supports Digital prescriptions. Once the patient receives the prescription either the diseased can get the medications from drugstore through caretaker or from drugstore directly to avoid the delay in services provided by the app. In this way our app supports web applications which is more efficient for Doctors to treat COVID-19/ Pandemic or chronic diseases through cloud based platform.
- Video or audio session recording- The app also supports the video and audio recordings for further review .These files can be essentially used to track the treatment plan over time.
- Pharmacy databases- The app is integrated with drug stores to provide patients with necessary medicine on time.

The illustration below shows the intersections of modules within telemedicine app development. This web application has been designed with the aim of being very easy to use and access the database with respect to treat COVID-19 or any Pandemic, chronic patients. Remotely the patient's vital parameters and initial survey reports have been accessed by both the caretaker and also the Doctor of the concerned hospital where the COVID-19 patients are registered and also for further consultancy to avoid any emergency during their 14 days treatment.

Our "E-Care" app remotely monitors patients health using Android Technology using Java enabled 3G/ 4G mobile phones .The features in the Apps enables doctors to monitor the vital parameters that includes heart rate, SpO2 , temperature and blood glucose level using digital devices. The waveforms and digital data monitoring function of installed Java based application on the mobile phone or on the computer system enables the Doctor who has registered with Patient ID to review the parameter and send feedback in terms of prescriptions. In any emergency circumstances like if the recorded vital parameters are abnormal and in dangerous conditions an immediate video conferencing call is initiated from the hospital to connect Care taker, Patient and Doctor in order to take preventive measures before the patient reaches the hospital. The Pharmacists and the Ambulance networks are incorporated in our ecosystems in order to provide the medicines as well as to provide the ambulance services during emergency situations to avoid deaths. Hence the major outcome of this App is to treat the covid infected person or any pandemic diseased remotely and monitors his/her health conditions and enables the smooth services 24x7 in order to avoid dangerous situations encountered by the patients. This app also has a special feature in updating every day nutrition diet plan and also physical exercises required for the patient based on the initial survey analysis.

C. **Application Design**

This work was executed in two steps. The first step was survey to gather the information of health history of Covid patients. The second step was to implement a complete application for smartphones and i- phone, so that application is installed by the intended users. Fig. 2 shows the flowchart of the entire process.

The complete application is developed using Android Software Development Kit (ASDK) which is used to include many custom tools that are used to develop mobile based smart applications on an android platform [15]-[16] along with this IDE, Android Emulator and Android Development Tools (ADT) plug-in Eclipse are also used. The user interface application is feasible and easy to operate.With the use of API mentioned, user profile and Doctor's profile dashboards are created and thus are both compatible on the same smart handheld devices. A common user can also easily trace the working of the application. The interactive screens are designed using XML and complete working model is built using Java programming language. The web services are used to connect the android smart devices with Google Libraries in PHP. Important feature in our application is of using the Google Maps API in the design which is to locate the nearest hospitals and ambulance services in case of emergencies.

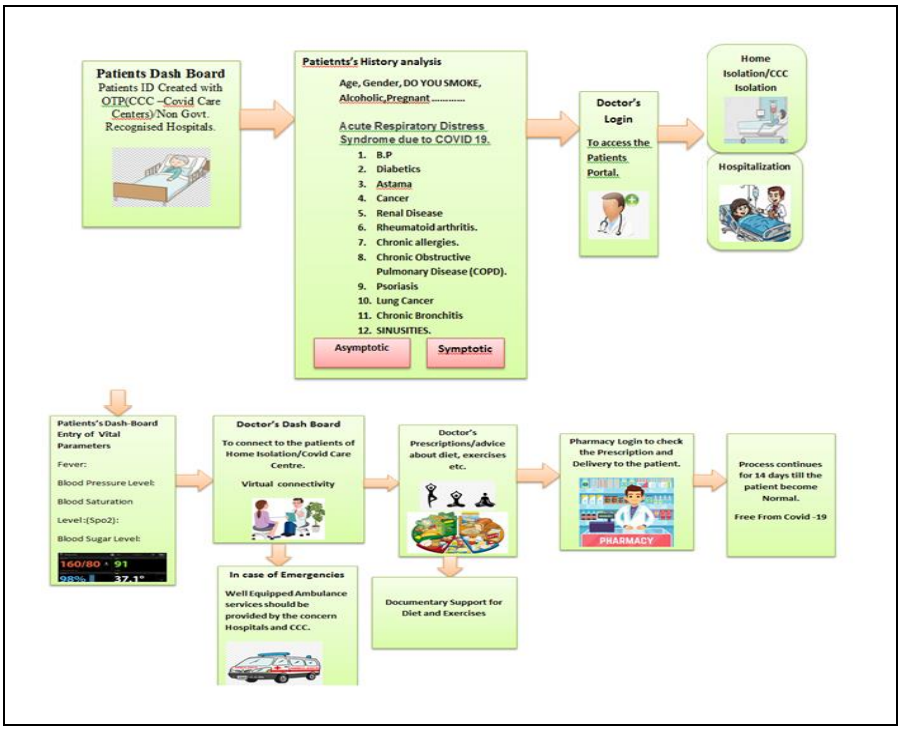

Figure 2: Complete Tele-Dataflow.

V. THE PROPOSED SYSTEM ARCHITECTURE

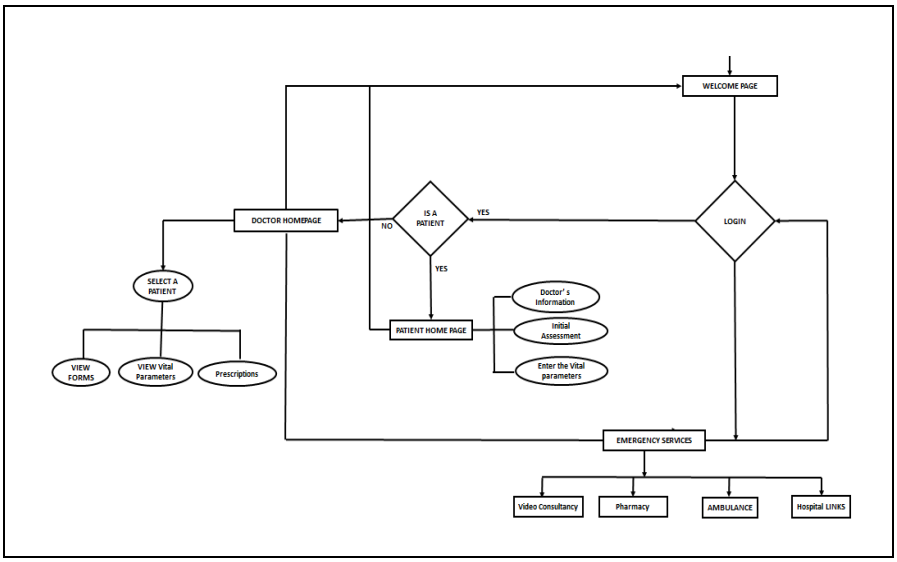

Figure 3: Application flow chart and approach of Project.

Fig.3 shows the system architecture, the heart of our application is Authentication,it is the main and prominent feature of E-CARE. Other function used are Firebase Functions for user alerts, Firebase Cloud Messaging is used for notifications Angular web application to create a single-page applications [17]. Flutter Doctor and Patient/ Client front to form a single codebase. The flow diagram of the implementation is shown in the Fig. 2. The web page has client and Doctor's login page, if client is a patient then the initial physiological parameters verifications will be enabled by the application software and also Doctors profile is available to complete the registration process .Similarly once the patients registration is successful. Doctor can access the registered patients records and reports to enable the recommendations based on the service opted by the Patient. Mobile application collects patient's physiological data through the digital inputs by manually measuring the vital parameters with medical kits provided by the hospitals. The received data is checked against the normal range of various important parameters like Fever: 97.8° F (36.5°C) to 99°F (37.2°C), Blood Pressure Level: 120/80, Blood Saturation Level: (Spo2): 96 to 100%, Blood Sugar Level: Before Fasting: 77 to 99 mg/dl / Random: 100 to 125 mg/dl BMP: 60 to 100 (adults), 80 up to 125 for children. The recorded physiological parameters are entered into the Application incorporated at the user end and the same has been forwarded to Doctor's chat window. Personal computer or mobile devices can forward the data to the medical server through client SDK for analysis. After the data is analyzed, the medical server provides feedback to the patient's personal computer or mobile phones through Push notifications.

The services incorporated are Video conferencing, chat communication and Audio consultancy. On successive data exchange the suggestions and prescriptions are provided through the prescription menu. The patient can either purchase the medications from the pharmacy through caretaker or can seek the option of delivering the medicines prescribed, from the hospital Pharmacy. The hospital pharmacies are integrated in our application ecosystem. Timely updates on the nutrition intake and physical exercises for different patients will be accessed through this app. System efficiency is increased by integrating the ambulance network in our ecosystem in case of emergencies faced by the Pandemic patients. Timely access to data in the COVID-19 emergency situations will overall improve the efficiency of the application softwareThe build of the application witnessed many different phases depending on the generation of data, handling the data and usage of the data.

VI. RESULTS ON E-CARE APPLICATION

Fig. 4 - Fig. 7. indicates various screen shots on the output obtained

Figure 4: Proposed E-Care mobile applications screen shot: Registration Process.

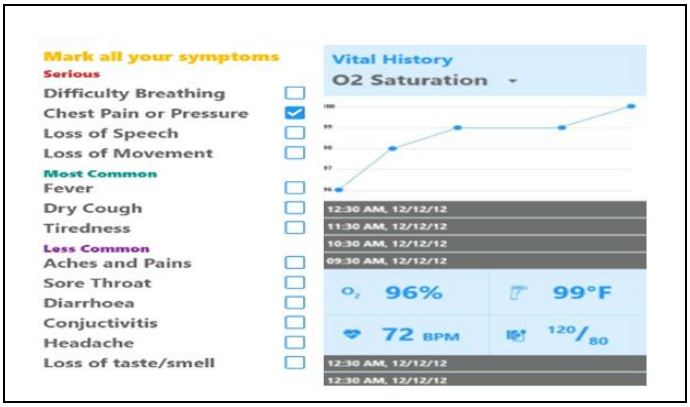

Figure 5: Proposed E-Care mobile applications screen shot: Vitals Analysis.

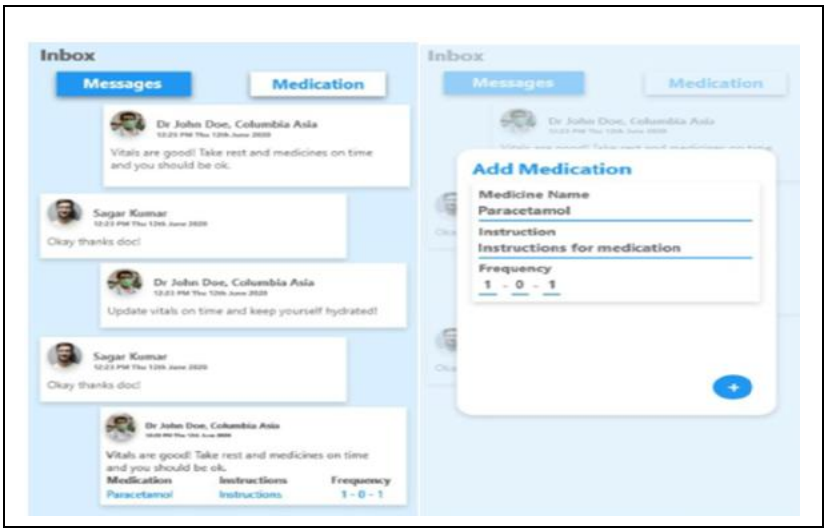

Figure 6: Proposed E-Care mobile applications screen shot: Data Exchange and Medications.

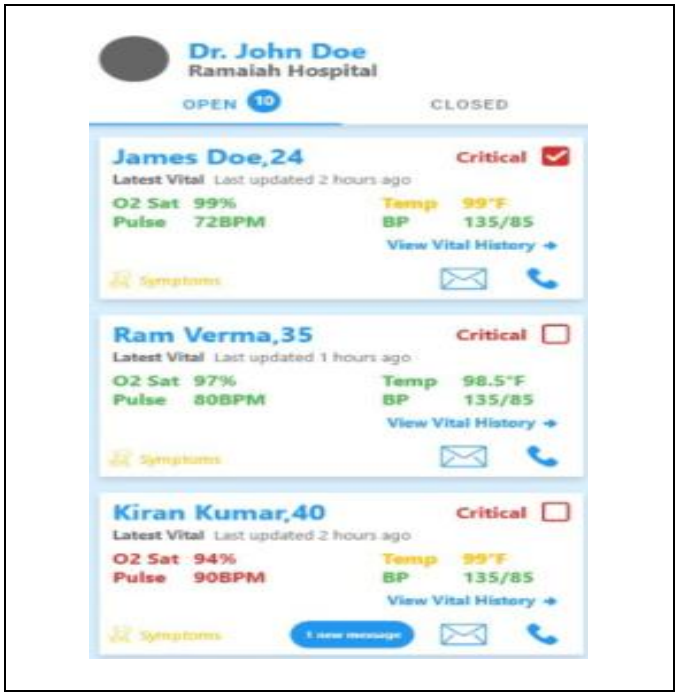

Figure 7: Proposed E-Care mobile applications screen shot: Critical Indications and Identification of Patients.

VII. CONCLUSION /ACKNOWLEDGMENTS

One of the main goals of this study is to provide an interactive and practical instrument in the fight against any pandemic sickness, such as the devastating Corona that the entire country is currently experiencing. The creation of the ipath for online services, which were primarily needed to establish the entire working model on the Internet and web platform for telemedicine, based on a virtual community mode, was a crucial component of this project. Distance collaboration between patients and those with medical backgrounds has proven to be quite effective when using the web and its IDK'S to the same database. The E-Care app's user interface is practical and simple to use. With ASDK, the full web services are created (Android Development Tools). As a result, the proposed application has a virtual telemedicine service that enables medical professionals to assess patients remotely for COVID-19 symptoms, gauge the severity of those symptoms, and decide whether the patient needs to be seen for an evaluation, admitted to the hospital, or needs a critical care unit. To prevent life-threatening circumstances, the health status of the patients will be tracked around-the-clock. Also, this app has unique characteristics that allow it to work with different pharmacies and ambulance services according to the patient's selected needs.

The app is installed and clinical trial tests are made in some clinics and it was successful about the usability, they have declared that by using this application they can reduce the number of visits to the hospital during the pandemic situations. The developed E- Care can also be used in many rural places where they have less access to the services offered by the urban hospitals in this Pandemic situations. Only authorized users are allowed to access the private interfaces, so the personal and medical information is safely stored in the database. Hence with this web application we have tried to find a solution to, handle a second wave of Corona hit in various countries at any instants. Further features can be added to evaluate any kind of infectious diseases by integrating various biosensors in the applications.

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