E-CARE A TELEMEDICINE APPLICATION FOR PANDEMICS

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)

Authors

M S Divya Rani
Department of Electronics & Communication
Presidency University
Bengaluru, Karnataka, India
divyarani@presidencyuniversity.in

Syed Abrar Ahmed
Department of Electronics & Communication
Presidency University
Bengaluru, Karnataka, India
syedabrarahmed@presidencyuniversity.in

Pallavi
Department Computer Science and Engineering
Presidency University
Bengaluru, Karnataka, India
pallavi.r@presidencyuniversity.in

Annapurna H S
Department of Electronics & Communication
Presidency University
Bengaluru, Karnataka, India
annapurna.hs@presidencyuniversity.in

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 tract and thus cause pneumonia and other related diseases, which can eventually damage a substantial portion of our neurological system and, in the case of people with underlying medical conditions, result in death 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. Numerous intelligent technologies, including Big Data, Artificial Intelligence (AI), and the Internet of Things (IoT) 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 paper details the development and deployment of a telemedicine system based on smartphones that can track a person's 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, Platforms for tele-intensive care units, which provide instantaneous electronic, visual, and acoustic communication between distant critical care teams and patients in distant covid care units or home isolation and provide expert guidance for to reduce the phase of recovery.

1. **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.

   - **Big Data:** The healthcare industry generates and processes enormous amounts of data. Electronic health records, or EHRs, are gathered and assessed with the aid of big data computations. The information that has been analyzed can be utilized to perform medical research, provide more precise diagnoses, enhance treatments, and ultimately reduce expenses. [8]-[9].

   - **Blockchain:** Unlike paper records, healthcare information is never lost because to technology. Exchange and storage of medical data is safe. [10].

   - **IoT:** Devices used in telemedicine include tablets, digital cameras, medical kiosks, smart devices, and more. In addition to many other benefits, the Internet of Things (IOT) helps with monitoring vital signs, diagnosis, medication adherence, treatment recommendations, and integrated emergency warning systems. Through the use of telemedicine app development, improved patient care is eventually achieved through the combination of medical technology and effective algorithms. [11].

2. **Application Overview**

Figure 1: Proposed Application Mode.

Figure 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. An application design framework and development platform called Angular is used to create sophisticated and effective single-page applications..

Flutter is used for the Doctor and Patient/ Client front. Flutter, a development kit made by Google is an open-source User Interaction program. Using a single codebase, applications may be developed for Android, iOS, Linux, Mac, Windows, Google Fuchsia, and the web. [14].

E-CARE features for Patient:

- **Registration:** Patient can sign up trough handheld device i.e via email, social media, or a cell phone. The E-Care app needs a stronger security protection service since it collects sensitive data. For this reason, two-factor authentication services—SMS and phone verification—are enabled in our app.

- **Patient profile:** Patients can register using a handheld device, such as an email address, social network account, or mobile number. Because the E-Care app collects sensitive data, it needs a higher level of security protection. For this reason, we have implemented two-factor authentication features in our app, which include phone verification and SMS.

- **Patient profile:** Patients will be able to modify or cancel appointments and keep track of them based on the availability of their doctors.

- **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.

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 analytic:** 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 using a mobile phone, clinicians can conduct follow-up interviews with patients who have COVID-19 or any other pandemic disease to determine who may have come into contact with potentially infectious individuals. They can also use the phone to notify patients' contacts about the need for a quarantine, determine whether the patient has any symptoms, and provide instructions if symptoms appears, implemented through video conference to conduct more thorough medical assessments.

- **EHR review:** Physicians will review the medical records of COVID-19 patients, either through 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 connected with pharmacies to ensure that patients receive their prescription drugs on schedule.

The diagram below illustrates how the modules in a telemedicine app are connected. 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. An installed Java-based program on a computer system or mobile device allows the doctor who has registered with a patient ID to watch waveforms and digital data monitoring, which allows the doctor to review parameters and issue prescription feedback. When a patient is in an emergency, such as when their vital signs are wrong and they are in dangerous conditions, the hospital immediately sets up a video conference call between the patient, the caregiver, and the doctor so that preventive actions can be taken before the patient even gets to 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.

- **Application Design:** There were two stages involved in this effort. The first stage involved conducting a survey to learn more about the medical histories of Covid patients. Developing a whole smartphone application was the second stage 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 a variety of specialized tools for creating smartphone applications with intelligence on the Android platform [15]-[16] along with this IDE, Eclipse plug-in for Android Emulator and Android Development Tools (ADT) 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.
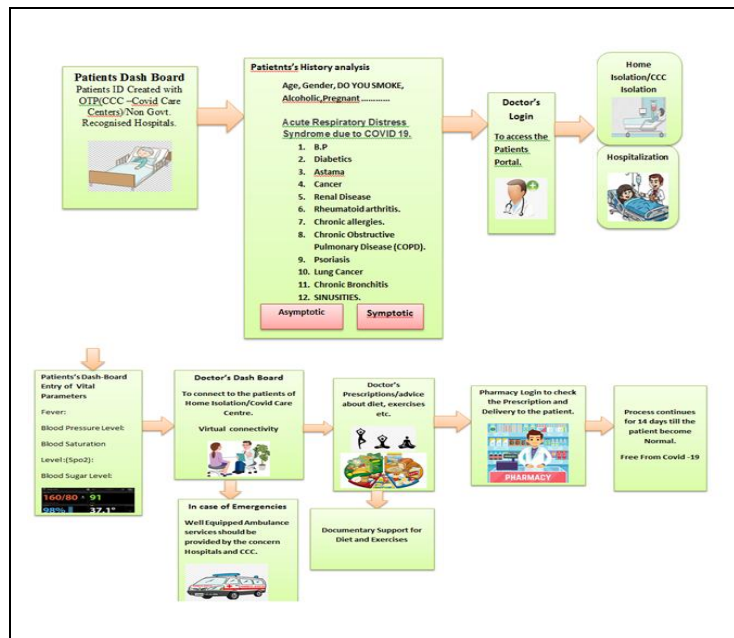

Figure 2: Complete Tele-Dataflow.

3. The Proposed System Architecture
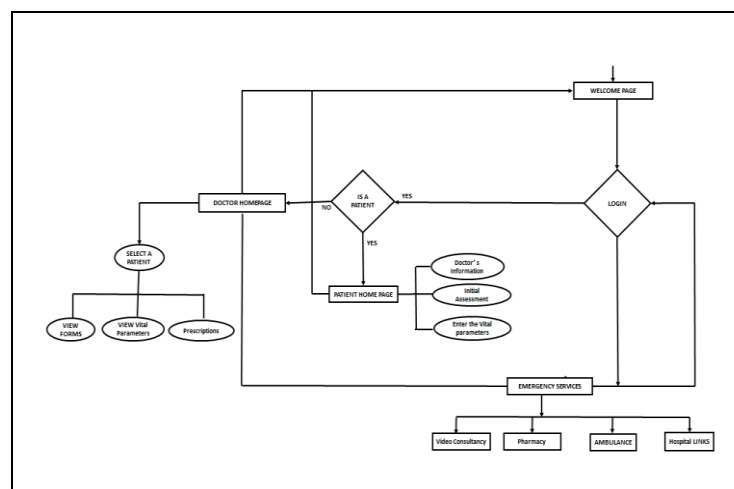
Figure 3: Application flow chart and approach of Project.

Figure.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. Fig. 2 displays the implementation's flow diagram. 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 via the client SDK to the medical server for examination. Following analysis of the data, the medical server sends feedback to the patient's PC 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.

4. Results on E-Care Application

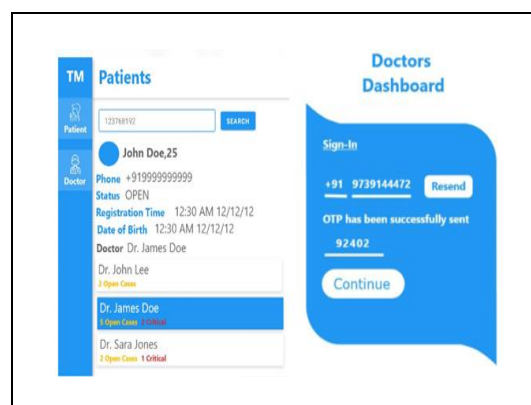Figure. 4 - Fig. 7. indicates various screen shots on the output obtained

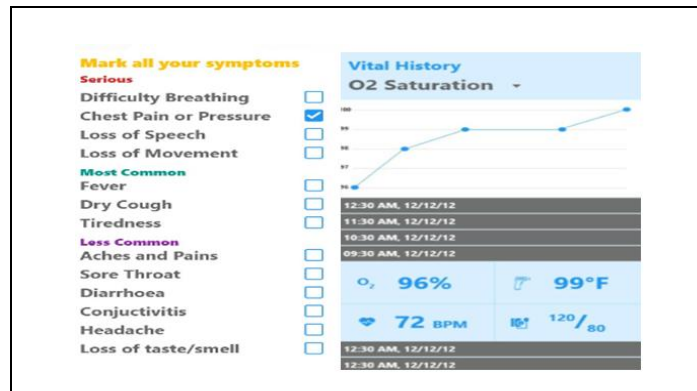**Figure 4:** Proposed E-Care mobile applications screen shot: Registration Process.

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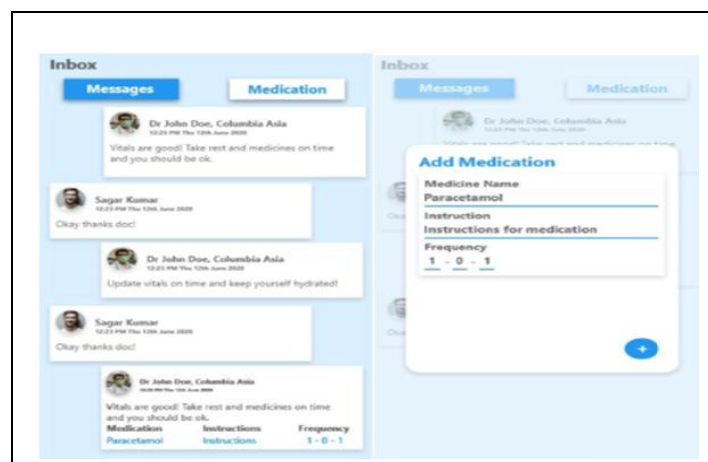

Figure 6: Proposed E-Care mobile applications screen shot: Data Exchange and Medications.
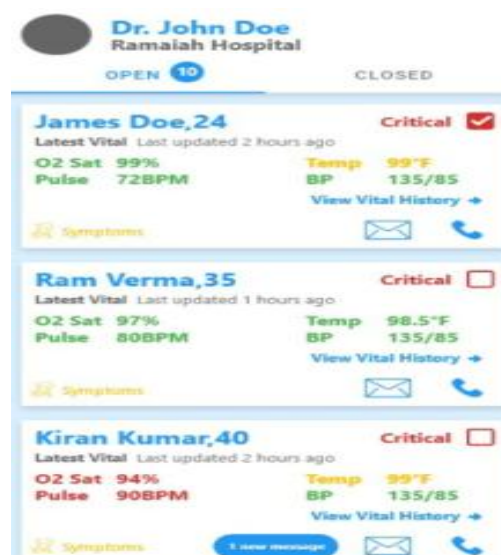

Figure 7: Proposed E-Care mobile applications screen shot: Critical Indications and Identification of Patients.

III. CONCLUSION

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 signs, determine the intensity of those symptoms, and determine whether the patient requires an examination, hospital admission, 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 quantity of hospital visits 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.

REFERENCES

[1] Hafez Fouad ,Hesham Farouk "Healthcare Mobile Application for Embedded Telemedicine System Design and ImplementationInternational Journal of Scientific and Engineering Research January 2017.
[2] Bashshur, R.; Shannon, G.; Krupinski, E. The taxonomy of telemedicine. Telemed J. E Health 2011, 17, 484–494.
[3] NICE. Evidence Standards Framework for Digital Health Technologies; NICE: London, UK, 2019.
[4] WHO. Guideline: Recommendations on Digital Interventions for Health System Strengthening;
[5] World Health Organization: Geneva, Switzerland, 2019.
[6] Kruse, C.S.; Soma, M.; Pulluri, D.; Nemali, N.T.; Brooks, M. The effectiveness of telemedicine in the management of chronic heart disease—A systematic review. JRSM Open 2017, 8, 2054270416681747.
[7] Delgoshaei, B.; Mobinizadeh, M.; Mojdekar, R.; Afzal, E.; Arabloo, J.; Mohamadi, E. Telemedicine: A systematic review of economic evaluations. Med. J. Islam. Repub. Iran 2017, 31, 113.
[8] Lee, J.Y.; Lee, S.W.H. Telemedicine cost-effectiveness for diabetes management: A systematic review. Diabetes Technol. Ther. 2018, 20, 492–500.
[9] InstitutCatalà de la Salut. Llibre de Retribucions 2019. Available online:http://ics.gencat.cat/web/.content/documents/transparencia/personal/2019-Taules-retributives-estatutaris-gener-juny.pdf.
[10] Bairagi V.K. (2017) Big Data Analytics in Telemedicine: A Role of Medical Image Compression. In: GarcíaMárquez F., Lev B. (eds) Big Data Management. Springer, Cham.
[11] https://doi.org/10.1007/978-3-319-45498-6_7.
[12] Michael Coakleyet. al. (2015) Transforming Telemedicine Through Big Data Analytics. In: Computers and Society (cs.CY), arXiv:1505.06967
[13] Bringing Blockchain Technology to Telemedicine by Daniel Yasri; medium.com/ pikciochain/ bringing-blockchain-technology-to-telemedicine-4090d283922b

[14] Raja Wasim Ahmadaet. al. (2021) The role of blockchain technology in telehealth and telemedicine. In: International Journal of Medical Informatics, Volume 148, April 2021, 104399, doi: https://doi.org/10.1016/j.ijmedinf.2021.104399

[15] Asad Ali Siyalet. al. (2019) Applications of Blockchain Technology in Medicine and Healthcare: Challenges and Future Perspectives, an article in: Journal/ Cryptography, doi:10.3390/cryptography3010003

[16] Mohammad M. Abdellatif, Walaa Mohamed (2020) Telemedicine: An IoT based Remote Healthcare System. In: International Journal of Online and Biomedical Engineering (iJOE) – eISSN: 2626-8493, Vol. 16, No. 06.

[17] Francesca Stradoliniet. al. (2018) IoT for Telemedicine Practices enabled by an Android Application with Cloud System Integration. In: Conference: 2018 IEEE International Symposium on Circuits and Systems (ISCAS) doi:10.1109/ISCAS.2018.8351871

[18] A. Mukhopadhyay, B. Xavier, S. Sreekumar and M. Suraj, "Real-Time ECG Monitoring over Multi-Tiered Telemedicine Environment using Firebase," 2018 International Conference on Advances in Computing, Communications and Informatics (ICACCI), Bangalore, 2018, pp. 631-637, doi: 10.1109/ICACCI.2018.8554736.

[19] Kostas M. Tsiouriset. al. (2020) Designing interoperable telehealth platforms: bridging IoT devices with cloud infrastructures. In: Enterprise Information Systems Volume 14, 2020 - Issue 8: Special Issue on: Interoperability Enablers for Cyber-Physical Enterprise Systems, doi.org/10.1080/17517575.2020.1759146

[20] Sumiati, HarisTrionoSigit, Design of Android Application for Telemedicine System to Improve Public Health Services. In: January 2018, MATEC Web of Conferences 218:03005, doi: 10.1051/matecconf/20182180300.