CODOC: COVID – 19 PATIENT TRACKER

Umamaheswari E[1*], *Gazal* Madan[1], and *Chinmayee* Das[1], *Shashank* Sridhar[1], and *Ajay* DM[1]

[1]School of Computer Science and Engineering, Vellore Institute of Technology, Chennai (VIT), India

Abstract. The COVID-19 corona virus has affected 81.9 million people with 1.79 million deaths in the entire world and has transformed into a global pandemic. The disease has effected 10.2 million people in India with about 148K deaths till December 2020. The COVID-19 virus is a highly infectious disease, which mainly spreads through the droplets generated by the cough, sneeze or exhale of an infected person. The disease spreads rapidly in crowded and poorly ventilated places. The virus quickly contaminates on floors and surfaces, people touching their eyes, nose and mouth after their contact with these contaminated surfaces get infected with this viral disease. As there is no cure and a vaccine currently for COVID-19, tracing, testing, tracking and treating are the most efficient tools to combat it. In order to track patients the existing methods implement fall detectors and routers which are effective in tracking patients in smaller areas. In order to overcome this drawback, a patient tracking technique COVID-Doctor (CODOC) has been proposed in this work which implements Global Positioning System (GPS) and multiple sensors to track patients in larger areas.

1 Introduction

The personal health monitoring of every individual is considered very important because of the rising health problems in today's world. COVID-19 scenario has made a tremendous increase in patients which is resulting in a vicious cycle. COVID-19, a rather infectious disease, made its first appearance in December,'19 in Wuhan [1-3], China. The Coronavirus (the cause of the disease) made its way around the world within a few months and was declared a global pandemic by the World Health Organisation (WHO) [4]. The symptoms were mostly low to moderate in majority of the population which including dry cough, fever, and loss of taste or smell, etc. However, in the elderly and people with cardiovascular disease, diabetes, chronic respiratory diseases, etc., the symptoms were rather serious, even resulting in the death of the individual in most cases. The lack of proper isolation and tracking of the numbers has resulted in a higher growth rate of patients. With the predicted second wave of COVID-19 as well as the development of new variants of Corona Virus, social distancing has become a new normal. In these circumstances, regular physical medical visits for a check-up might not be the most efficient option during this time [5-7]. In this situation, there is an urgent need for social distancing, staying from crowd and lockdown is essential to stop its spread. However, if online facilities and health tracking were made easier, it could result in an improvement in the patients' health conditions. Globally, there have been 79.8 million confirmed cases of COVID-19, including 1.75 million deaths as of December 2020 [8-10]. The following system is motivated by the world-wide pandemic, to handle the current situation as well as, tackle any major health concern in the future.

This paper proposes a system that continuously monitors the patient through a mobile application (app) that is connected to a wristband that continuously monitors the temperature, heartbeat rate, and blood pressure and is continuously updated in the application without any delay. Whenever any discrepancy is found in the patient's health or if the patient has come in contact with a COVID positive person, an alarm is triggered in the patients and the patients care takers mobile phone. Then the patient is automatically assigned to a doctor and the treatment is carried over the application itself. This system is described as the following:-

Continuous monitoring of the patient's health through an app which is connected to a wrist-band that continuously monitors the temperature, heartbeat rate, and Blood pressure and is updated in the app right away. The smart band can calculate temperature anytime without sitting or standing in an appropriate posture. It monitors the body temperature using a temperature sensor, the heart-rate monitor is based on Photo Plethysmography (PPG), which basically uses green LED lights paired with light-sensitive photodiodes to illuminate the skin and measures changes in light absorption and there also exists a cuff-less method called Pulse Transit Time (PTT). PTT is the time it takes for one pulse to travel from the heart to a peripheral point on the body (in this case, the wrist). It requires a PPG sensor to detect the pulse on the wrist and an ECG sensor to know detect the heart-beat. Any discrepancy is found in the patient's health, is immediately notified to the

* Corresponding author: umamaheswari.e@vit.ac.in

patient and the family members, an appointment with the doctor is immediately scheduled and continuous health updates are sent to the doctor from then till the patient cures. Though there are already many android patient tracking applications, most of them either measure the different health conditions of patients or only track the location of patients, if there is any contact with a COVID positive person. On contrary, CODOC contains the features of health monitoring using sensors as well as proper information delivery to the hospital database. The presence of a system for continuous storage of health data of an individual makes individual, resulting in the prediction of major health conditions. This system also features the emergency option, through which alerts can be sent concerning serious ill-health conditions to the nearest health facility for the faster health service delivery. This also ensures proper effective treatment of the patient while assuring higher rates of survival. The presence of a thermal sensor, a pulse rate monitoring system provide efficient information regarding the patients' health.

2 System Description

The CODOC system, an online application is an integrated approach of linking the GPS enabled Android app with wrist band towards continuous surveillance of suspected/confirmed COVID-19 patients, wherein timely medical intervention would assist in reduction of morbidity and mortality. As a step towards tele-medicine the proposed system utilizes the latest available technology for integration of android app through enabled GPS as sharing mode of information for alert generation.

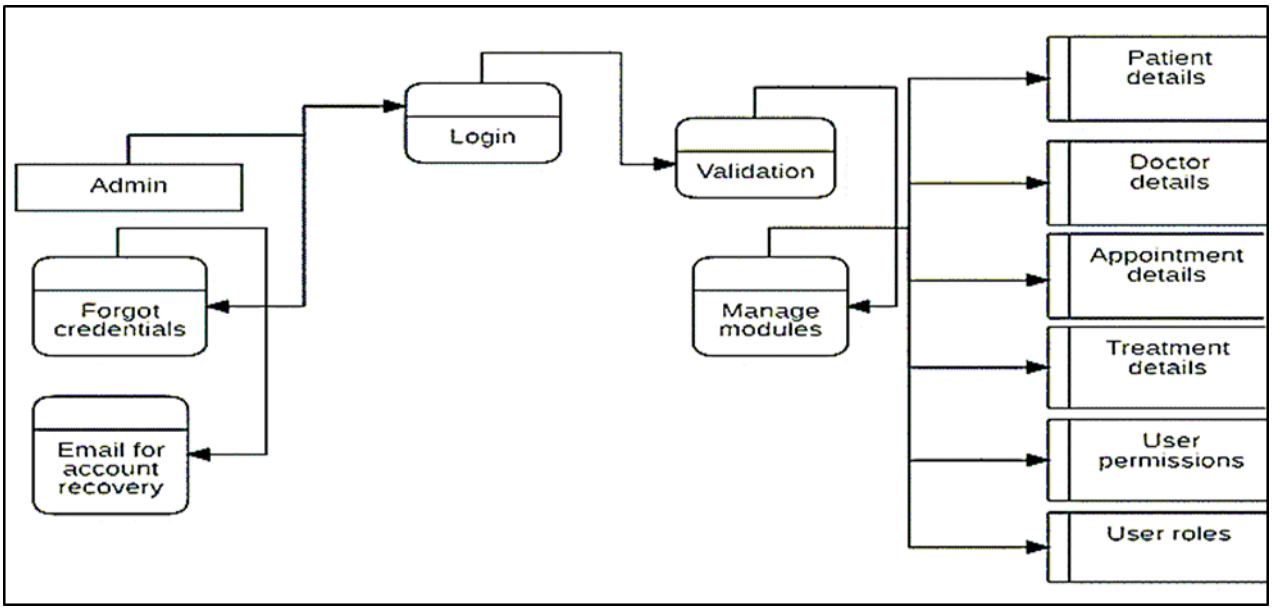

Fig. 1. Architecture diagram of CODOC

The prerequisite for successful system configuration is an android based device with GPS, its registration on the said app and a sensor sensitive wrist band for completion of loop, the details of the proposed system are as follows:

The CODOC system, an online application is an integrated approach of linking the GPS enabled Android app with wrist band towards continuous surveillance of suspected/confirmed COVID-19 patients, wherein timely medical intervention would assist in reduction of morbidity and mortality. As a step towards tele-medicine the proposed system utilizes the latest available technology for integration of android app through enabled GPS as sharing mode of information for alert generation. The prerequisite for successful system configuration is an android based device with GPS, its registration on the said app and a sensor sensitive wrist band for completion of loop, the details of the proposed system are as follows:

The CODOC system is designed to introduce the health care infrastructure and support the covid patients. The following technologies have been used in the system. It is an effective integrated system consisting of an android app linked with wristband which monitors covid and non-covid patients. The system is embedded with a feature that can prevent thousands of people from coming in contact with Corona virus by providing timely treatment.

2.1 Monitoring Device

The monitoring device is designed as a wrist band with sensors namely light sensitive photodiodes, PPG, ECG and bio-impedance which detect the temperature, heartbeat and blood pressure of the patients registered in the app. In addition to regular monitoring of vitals of the patients, the device is programmed to generate alert in case of abnormalities read in any of the measurable parameters and an alert is triggered which flows not only to the registered android device but also to the emergency contact devices registered and also the associated concerned medical doctor for necessary intervention. The device used for monitoring the covered patient is in the form of a wristband which has the ability to detect the temperature, heartbeat and blood pressure of the patient which is regularly updated in the Android app whenever any abnormality is found. The Android app automatically

connects to the list of doctors by sending an alert and immediately a doctor is assigned over the patient.

These sensors helps in tracking the patient's health through monitoring all the essential requirement of determining any risk to health. In case of any discrepancy these sensors shows variations due to which the problem is detected.

2.2 Alarms and Locations

Automatic alarms in emergency situations are triggered with the beep in the Android app, through which the family members and emergency contacts as well as the doctor gets intimated simultaneously and the location information of the patient is sent to all. This feature enables the system to know the location of the patient within the safety parameters and update the same in the Android app. With this regular update spreading of Corona virus can be reduced. And the patient can be saved within the time limit and as soon as these updates are done in the doctor's app window as well as the patient's family members' app window the appointment will be automatically set with the doctor and over the call for further advice from doctor. The alert system is in fact a closed loop for alert generation and feedback facilitation from the expert for further management. It is envisaged not only for timely intervention for morbidity reduction but also as a contribution towards public health emergency control.

2.3 Doctor and family member's devices

As soon as an alert message from the patient's device is transmitted to the doctors and his or her family members' device. The option to accept or reject the appointment is flashed on the family members device along with an alarm and as accepted or rejected by the family member is transmitted the same to the doctor. When the appointment is accepted the appointment ID, date for the appointment, timings for the appointment, doctor's name, his qualifications, patient's details such as name, gender, age And his previous disease history is set with the date and time alarm on patients as well as doctors CODOC app.

This will facilitate the training doctor to have a complete details of patient to initiate the management and plan for any further intervention, if required. The patient is under constant surveillance. If the patient or his caretakers opt for online consultation with doctor online prescription after the audio or video call is generated. This consultation is updated in the patient's previous history record.

3 System Implementation

To ensure continuous surveillance of subject registration in the CODOC app is essential. Following the completion of registration procedure which requires demographic details of the subject along with essential information regarding any existing co morbidity and treatment details a unique ID is generated by the system which is co-shared with registered subject and the associated medical professional at same point of time.

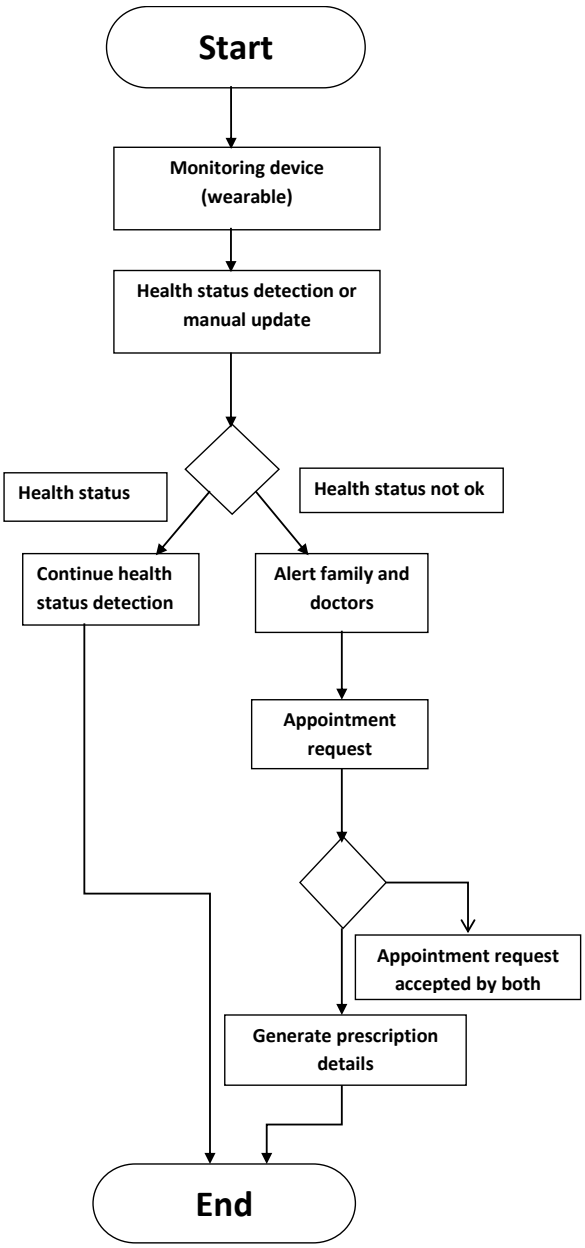

Fig. 2. Working process of CODOC

The prerequisite for the subject to be under continuous surveillance is regular wearing of wrist band with active connection to the registered mobile through GPS. The inbuilt alert system gets activated once there any discrepancy is cited for any of the values under surveillance as detailed above. The actionable alert is referred to the registered subject mobile, emergency contact device and designated medical professional.

The architectural diagram depicted in figure 1, gives an overall architectural view of CODOC and the application allows the admin to have all the controls, to edit the details, manage the modules, and grant permissions to the

users. The Login module would be for both the patients and doctors or the health staff. Appointment details will have both upcoming appointments and the history of the past appointments with their respective details. Treatment details will have the medical history of the patient and the current treatments. In case a user forgets the login credentials, he/she will also have the option for recovery of their account.

The app further facilitates the appointment with the treatment doctor for a video conference or telephonic call depending upon the option agreed by the registered subject along with generation of prescription for effective timely intervention. Not only for emergency, but even for routine follow up visit the app can be of immense utility and a move towards digital health by effective telemedicine, a lesson learnt from the on-going COVID-19 pandemic. The screen shots of CODOC and the working process of the proposed system is represented in figure 2.

Once the patient registers himself on the app and wears the wristband. He is under constant surveillance. As soon as any discrepancy is found in patient's health an alert is given to the family and patient and appointment is made with doctor with patient's details. The patient is monitored by the doctor through online prescription and check- ups. These regular check-ups and prescription generation are regularly updated in patient's history.

4 Results

In order to design and develop a user friendly and user preferred application, a survey was carried out in order to understand the user preferences. The survey also helped in finding out people's opinion on CODOC mobile application being incorporated with a wrist band. This survey helped us to decide if people were interested in such an innovation. The survey was carried out among 80 people aged 15-70. The questions in the survey were- the device preferred by the people such as Locket, Mobile phone or Wrist watch/band, in order to make their family informed immediately of their health conditions with an affirmative and a negative option and if they want an automated doctor appointment at that very point of time where a positive and negative option was given. The results of this survey as presented in figure 3, were that 66.3% people chose a wrist watch, 27.5% favouring mobile phone and rest 6.2% wanted with the locket. When it came to informing the victim's health conditions to the family, as presented in figure 4, 95% had optimistic opinion. As presented in figure 5, about 86.3% preferred generating an automatic doctor's appointment on a contrary 13.7% didn't want an automatic doctor appointment to be generated.

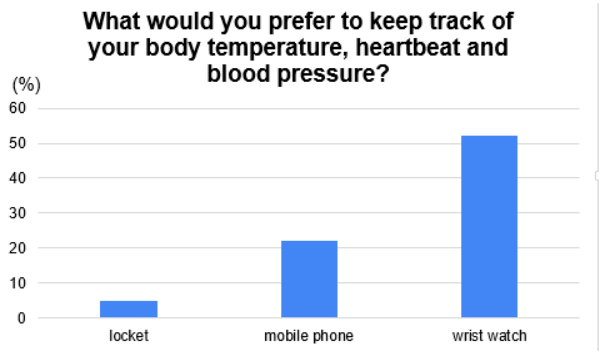

Fig. 3. Survey results for question 1

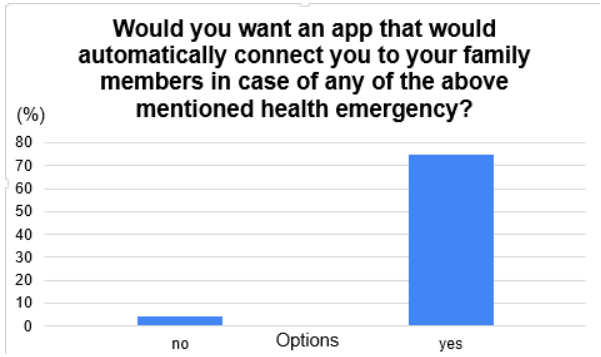

Fig. 4. Survey results for question 2

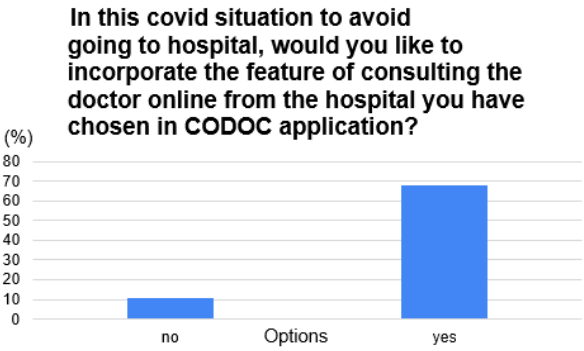

Fig. 5. Survey results for question 3

The CODOC application connected according to the survey results was incorporated with a wristband. The CODOC in a wrist band was tested in a home environment with where an elderly patient wore the wrist band continuously and the family members along with nearest hospital were connected through CODOC application. The results of the experiment were fruitful and the application performed as expected. In an instance of some disparity was found with regard to patient's health, the doctor and family members were notified concerning the same and the victim was treated over the telephonic conversation immediately as per the option of telemedicine. If health condition was so serious an automatic appointment was generated. The implementation of the CODOC application has been represented in the below figures.

Figure 6. CODOC Patient wrist band with sensor

Fig. 7. Patient health monitoring results

Figure 8. CODOC Patient family and doctor alert

The figure 6 describes the temperature sensor attached to a wristband in order to monitor the body temperature of the patient. They allow monitoring of important health parameters which are helpful in detecting temperature sickness of the person using it in any posture. The figure 7, describes the user interface on the wearable device, which shows the result of the continuous health monitoring. Left watch: Shows the result of heart rate with systole and diastole reading on the wearable device along with a notification of not using these readings for self-diagnosis. Right watch: Shows the body temperature of the use in degree Celsius. The figure 8, describes the alert system included in the CODOC application. This helps in detection of any major discrepancies in health monitoring as mentioned above regarding the heart rate, temperature or blood pressure. The alert system automatically sends a notification to the doctor and family members to accept, emergency medical service for the patient's treatment.

In order to calculate the efficiency of CODOC, experiments were conducted to analyse the time taken for alerts to reach family member devices and the time taken for the alerts to reach the doctor's device has been noted. Twenty sets of experiments have been conducted for each device i.e., 3 family devices and one doctor device and the results state that the alerts in order to reach the family member devices on an average took about 158 seconds, the experimental results have been presented in figure 9, figure 10 and figure 11. The experiments results show that it took about 116 seconds for the alert to reach the doctor's device as presented in figure 12.

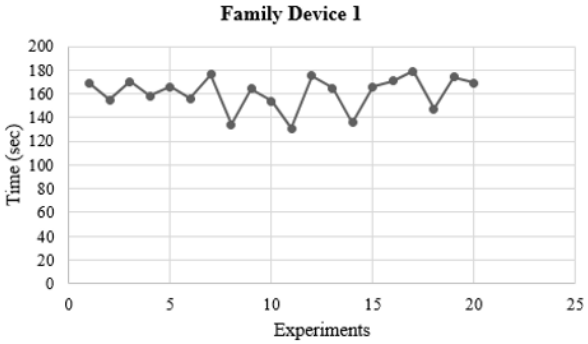

Figure 9. Alert Delivery time for Family Device 1

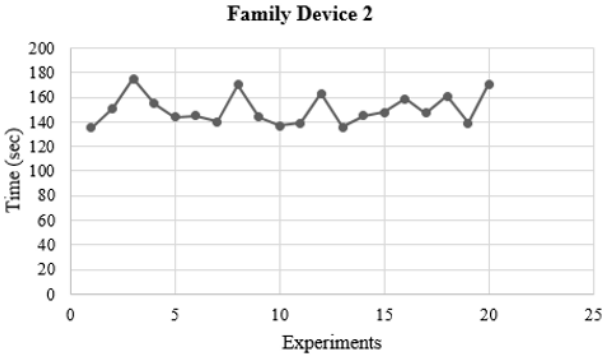

Figure 10. Alert Delivery time for Family Device 2

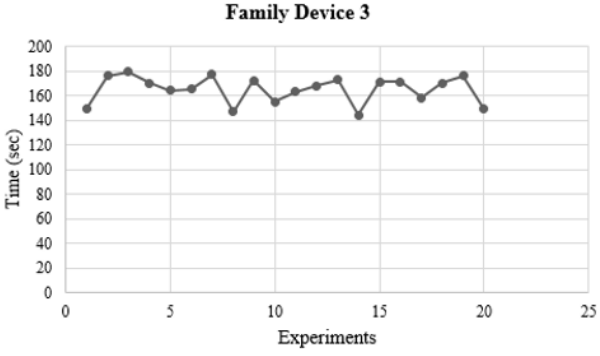

Figure 11. Alert Delivery time for Family Device 3

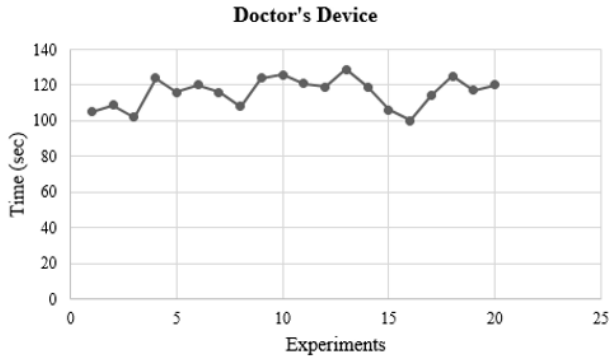

Figure 12. Alert Delivery time for Doctor's Device

The reason for the variation in the delivery time of the alert with respect to family member device and doctor device was the difference in the internet connections of the devices. The doctor's device was connected to a Wi-Fi connection in the hospital with 250Mbps speed and while the family devices were utilising the mobile internet speeds ranging from 10-15Mbps and the current location of a family member also played a major in the delivery time of the alert. More efficient results are to be expected in the extension of the project which would overcome the scenario of time delay due to variations in internet signals.

5 Conclusion and Future work

The world population is facing a global pandemic caused by the COVID-19 and it has endangered the human like never before. The disease has effected 10.2 million people in India with about 148K deaths till December 2020. The COVID-19 virus is a highly infectious disease, which mainly spreads when a person comes in close contact with an affected person. The disease spreads rapidly in crowded and poorly ventilated places which has forced the global population to live isolated, follow social distancing guidelines. The health concerns developed in the current situation and the alarming rate of increase in the number of COVID-19 patients which brings out the necessity of such telemedicine and online tracking, treatment of patients with other medical emergencies. The CODOC project is user-centric and was developed focusing on the problems faced related to medical visits and maintenance during the current situation. The proposed CODOC system ensures an increase in treatment efficiency and reduces the spread of the virus, by enabling digital services, maintaining the requirement of social-distancing and proper health monitoring of the patients. Patients and individuals suffering from the diseases can use this system for medical efficiency and personal well-being. Also, the CODOC feature of notifying in case of emergency using alerts to the nearest available medical services allows acquirement of medical services at the earliest. CODOC solves issues related to hospital management by providing them a full-fledged system. In the extended version of the CODOC application is aimed at reducing the latency delay in the alert mechanism and also addition of user customisations are to be implemented in the CODOC application.

References

1. Swain, Kaliprasanna, Prasad, M, Sahoo, Jagannath & Sahoo, S, Palai, Gopinath. (2016). *Patient Monitoring System using CAN and Android,* Journal of Research in Science, Technology, Engineering and Management (JoRSTEM). 2. 101-105 (2016)
2. T. Reza, S. B. A. Shoilee, S. M. Akhand, M. M. Khan, *Development of android based pulse monitoring system*, Second International Conference on Electrical, Computer and Communication Technologies (ICECCT), Coimbatore, 2017, pp. 1-7 (2017)
3. P. Hii, W. Chung, *A Comprehensive Ubiquitous Healthcare Solution on an Android Mobile Device*, Sensors (14248220), Vol. 11, Issue 7, pp.6799-6815, (2011)
4. P. Szakacs-Simon, S. A. Moraru, L. Perniu, *Android application developed to extend health monitoring device range and real-time patient tracking,* IEEE 9th International Conference on Computational Cybernetics (ICCC), Tihany (2013)
5. Kamel, Mohammed B., George, Loay, *Remote Patient Tracking and Monitoring System*, IAENG International Journal of Computer Science and Mobile Computing. 2. 88-94 (2013)
6. Gamboa, Hugo, Silva, Filipe, Plácido da Silva, Hugo, *Patient tracking system*. 1-2. 10.4108/ICST.PERVASIVEHEALTH2010.8916. . (2010).
7. Horgan D, Hackett J, Westphalen C, B, Kalra D, Richer E, Romao M, Andreu A, L, Lal J, A, Bernini C, Tumiene B, Boccia S, Montserrat, *A: Digitalisation and COVID-19:* The Perfect Storm. Biomed Hub (2020)
8. Organization WH. Coronavirus disease 2019 (COVID-19) Situation Report - 70. 30 March (2020).
9. Sang-Joong Jung, RistroMyllyla, Wan-Young Chung, *Wireless Machine-to-Machine Healthcare Solution Using Android Mobile Devices in Global Networks*, IEEE Sensors, vol. 13, no.5, pp.1419-1424, May (2013).
10. Zhonghua Liu Xing Bing Xue Za Zhi, *Epidemiology Working Group for NCIP Epidemic Response, Chinese Centre for Disease Control and Prevention. [The epidemiological characteristics of an outbreak of 2019 novel coronavirus diseases (COVID-19) in China]*, 10; 41(2):145-151. Chinese. DOI: 10.3760/cma.j.issn.0254-6450.2020.02.003. PMID: 32064853, Feb (2020)