

Internet of Things for e-healthcare employing Telemedicine to treat COVID-19

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ABSTRACT: Telemedicine and Internet of Things (IoT) technology has gained a lot of attention in recent years owing to its potentiality to elevate the present healthcare scenario. Though being invented a few decades ago, they are now widely used due to the variety of scopes it offers. In spite of their effectiveness in a wide range of applications, they had not been implemented thoroughly to extract the best possible outcome from it. This can be mainly attributed to the absence of a constructive and standardized model, resulting in deprivation of people from their life-changing benefits. Needless to say that healthcare still stands at the forefront of any research areas even today. The current situation of combating the pandemic created by COVID-19 brings the entire healthcare systems on the verge of an existential crisis at every corner of the world. Thus the urge to find and propose alternatives like Telemedicine and e-Health is worth necessary. This paper proposes a cost-effective and time-efficient model of Telemedicine incorporating the use of IoT technologies with an aim to contribute an advanced solution to fight the battle with COVID-19.

KEYWORDS: Cost-effective, COVID-19, e-Health, Internet of Things, Telemedicine, Time-efficient.

I. INTRODUCTION

Healthcare is the most essential requirement for every human being. This often lead most researches get oriented towards improving the existing healthcare system by enhancing the quality of treatment. With the progress in technology, the concept of Internet of things (IoT) got documented in literature for the different services it offers [1]. The initial concept was framed a few decades ago defining it as the incorporation of internet connectivity with day-to-day gadgets to provide effective solutions by fulfilling people's necessities. The importance of IoT is recently gaining even more attention as it is becoming an integral part of everyone's daily life. This life changing concept has been implemented in diverse fields of applications to utilize the maximum effective solutions offered by it. Healthcare services stands at a priority among the several other applications it has been used for so far [2, 3].

Telemedicine, though not a very new concept in context of health-care systems [4] is still gaining maximum attention in recent times as it aims to provide proper care to patients in a very effective way with the aid of telecommunication technologies [5,6]. In spite of being a potential candidate to treat several infectious diseases with ease, lack of knowledge about its usefulness is still a major hindrance. With the emergence of COVID-19, people are getting familiar with it and its advantages in healthcare [7].

The modern healthcare system is employing IoT based sensors and services to collect data from devices for monitoring and continuous checking purpose, which are also being transmitted using different network transmission protocol to monitor patient's data in real time, thus creating a visionary changes in healthcare system [8]. While Telemedicine is a tool to provide healthcare services via telecommunication technologies, IoT provides the interaction of healthcare devices via machine-to-machine communication [9]. Though there are huge opportunities in research on the integration of both IoT and telemedicine in healthcare system [10], the lack of vision and proper construction of model renders it impractical. To the author's knowledge no such system has yet been proposed to avail the benefits of both IoT and Telemedicine using the same platform. Thus the urge to find and propose alternatives to employ both technologies for e-Healthcare is worth necessary. Exploring the stated reasons, this paper proposes a novel model of Telemedicine incorporating the function of IoT technologies to deliver an advanced treatment plan to fight against COVID-19.

II. OBJECTIVE

The pandemic created by COVID-19 is currently the most thought-provoking serious issue persisting throughout the world. Due to the rapid spread of the virus and the increase in the number of patients daily, the existing healthcare systems are failing miserably at most of the places. Lack of proper planning to face such a critical crisis

is making a country's healthcare service chaotic and disoriented. On the contrary, the medical resources are limited in terms of both manpower and necessary equipment leading to the creation of an uneven distribution and scarcity.

The proposed model in this paper has been built with the vision of incorporating both IoT and Telemedicine to deliver an efficient and constructive approach to combat COVID-19. This will lead to conserving precious health-workers by saving their lives and also place lower stress on the resources thus preventing economic disbalance as well. Another most effective advantage of this system is that it can provide a complete hassle-free service for persons staying alone. This model also aims to provide cost-effective and time-efficient treatment for everyone. Only severe patients who urgently require treatment have to move to hospitals to avail special amenities, ensuring proper distribution of medical resources. Treatment from the comfort of one's home always ensures a speedy recovery and decreases the chances of further spreading.

III. IMPLEMENTATION MODEL & METHODOLOGY

The model shown in Fig. 1 proposes the idea of treatment by intrinsically employing IoT and Telemedicine services. The methodology for implementation of the model takes into account certain steps that has to be followed by the either side, from the doctor's end as well as the patient's end. For the purpose of clear visualization, the system is designed lucidly for both the patients and the doctors.

The system implementation takes into account the diagnostic process as well as the treatment process making sure that the patients are not made vulnerable to contraction, by allowing them to move to hospitals just for the sake of testing. The system implementation is done in two phases, namely the preliminary phase where the diagnostic process is taken care of and the treatment phase where treatment can be done at home via telemedicine and with the aid of IoT without any manual interventions. In severe cases, patients may be shifted to hospitals for required treatment.

Preliminary phase:

- The symptoms shown upon coronavirus affection is more or less well circulated by media. On experiencing the symptoms of COVID-19, any patient has to initially contact the nearest hospital without physically moving there. This can be done by downloading the specific mobile application service provided by a centralized governing organization to book appointment to the patient's nearest hospital.
- After the appointment is done, within a very short span of time, consultation with the doctor via teleconference may be done. The severity of the patient's condition is decided by the doctor based on diagnosis and further actions has to be undergone.
- The patient may be advised to stay home-quarantined following the stated preventive measures as deemed necessary by the doctor.
- If testing seems required suspecting COVID, an attendant from the hospital will be sent to collect the test sample from the patient's residence.
- Post testing, if the result is obtained positive with symptoms of a serious health concern which requires the individual to remain in the purview of proper healthcare infrastructure, then the patient has to be transferred to the nearest hospital.
- Besides, if the result is positive but the condition is moderate, then that one can be treated with the aid of Telemedicine along with a treatment package consisting IoT-based healthcare devices and relevant mobile application. The patient will enroll in the treatment package designed for COVID-19 via the mobile application through their smartphone by making the required online payment.
- While negative test is obtained, treatment employing telemedicine may be done for the particular symptom eradication.

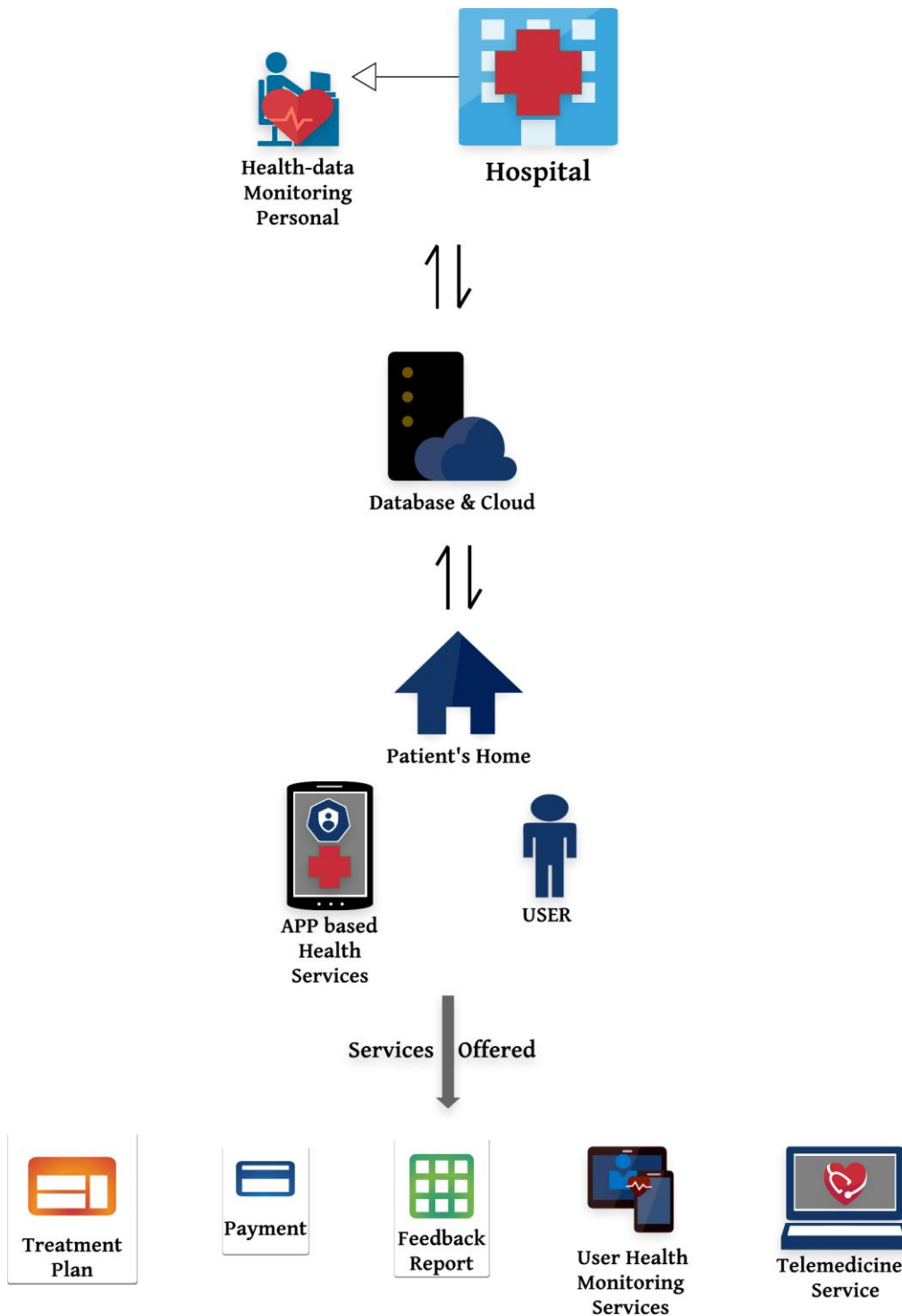


Fig. 1: Proposed model for e-Healthcare service employing IoT and telemedicine

Treatment phase:

- That treatment phase would be undergone for those patients who are tested COVID positive during the preliminary diagnosis process. A treatment kit would be given to all of them upon enrollment policy. It would contain:
 - Special authorized access for the personalized service received via the specified mobile application provided by the hospital.
 - A customized treatment plan designed for the use of the particular patient's recovery.
 - IoT based medical devices to monitor heart rate, temperature and pulmonary health would be included as a part of the kit. These devices would collect and transmit patient's data in real time.
 - Regular consultation with doctor via video-conferencing would be undergone for the doctor to be updated with the patient's health condition.
 - An emergency button would be there in the mobile application to provide just one-click-contact facility with the hospital in case of any emergency situation faced by the patient.
 - Medicines required for the treatment would be an optional facility. Patient can get them delivered from hospital or from pharmacies upon requirement.
- Upon reception of the kit, the patient need to log in using the authorized credentials which will lead the patient to enter in the virtual treatment room.
- The individual can view the customized treatment plan, medications and other relevant information to be executed.
- The patient would receive time-to-time notification stating the required action that needs to be performed (like which medicine has to be taken, or other practices required to be executed for the betterment of health like taking vapor, doing gargle, etc.)
- At the required time the reminder notification would come to turn the sensors on (in case it has been turned off) in order to transmit health data to the hospital using the IoT-based health monitoring devices.
- Based on patient's received data and tele-consultation, the treatment plan would be updated on a regular basis.
- Patients can also put forward any query or report any problem whenever required either via text message or audio message, which will be attained by the designated person at the hospital.
- The doctor on perceiving that the patient's condition has been improved or completely cured then a second COVID test may be done.
- If the result then turns negative then the patient will be discharged virtually that means the kit will be returned and his/her authorization id will be disabled, otherwise further treatment steps will be progressed.

IV. CONCLUSION & FUTURE SCOPE

We are in an era of constant technological development. Technological advancement is undoubtedly a better alternative in addition to the existing healthcare facilities for a wider horizon of people. With the systematic approach of incorporating technologies like IoT and Telemedicine to combat COVID-19 will not only save resources but also save more number of patients from the external stress of rushing to the hospital. Treatment can be done at the comfort of the home which will definitely provide extra support of family members to keep patient's mental health balanced and rejuvenated even at times of crisis. The chaotic situation at the hospitals due to the rush of so many affected person will be eliminated to a great extent by implementing the proposed model. The initial deployment of this system doesn't require a huge investment as most of the infrastructure is inbuilt already, which can bring the proposed model in effect, very quickly. At this current era of expensive treatment, this model will save a portion of healthcare cost for an individual as the person has to pay only for consultation and associated devices. The model thus aims at an overall improvement of the current scenario of healthcare against COVID-19 to a noticeable extent by all means. This model will not only be an effective tool for combating COVID-19 but also serve as a backbone to the existing healthcare system by being a part for regular treatment process to improve the quality and efficiency of healthcare services.

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