A Novel Smart Hospital for Isolation of COVID-19 Patients

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Abstract— **In this paper we describe a smart and innovative system which provides prime contribution to our society in this pandemic situation. We propose a novel smart hospital with multi featured equipments along with fashionable isolation ward for COVID-19 patients. A website interface has been proposed under anyone can visit and after knowing the status of the beds either for the isolation or emergency ward they can easily book from remote location. A QR code with registration number will be provided to the users. These users may reach to the hospital and have to pass through the QR code scanner for verification and sanitization process. A pre-evaluation section has been defined where proper mask at face will be detected with thermal scanner facility. All the designed section is controlled and monitor by control unit through server. Well featured with multiple sensors a unique ward is designed where oxygen level sensor is used to sense the level of oxygen and if the level of oxygen of patient is less than defined value supply of oxygen will switch on the supply automatically. Doctor will monitor and take care of patients through CCTV and video conferencing. The entire sub design unit is controlled and monitored via hybrid network and IoT.**

Keywords— *COVID-19, IoT, Isolation Ward, Pre-Evaluation Section, Hybrid Network, Smart Hospital*

I.   INTRODUCTION

Increasing cases of COVID-19 have been a major concern for many countries nowadays. The virus when infected in the lungs leads to major problems comprising of mild to severe symptoms. People who have fundamental clinical issues like cardiovascular sickness, diabetes, constant respiratory illness, and disease can get infected easily and it could even lead to their death [1]. The disease is causing death to many people all over the world. The second wave of COVID-19 comes with many symptoms, hence confusing people to interpret whether they are suffering from the disease or not. There have been many types of research leading to a solution for the disease. Still, we are facing a shortage of doctors, beds, and hospitals. The chances of getting infected while treatment of the patients are very high, it will affect the ward boys, nurses, and doctors. Many systems focusing on the day-to-day analysis of hospitals functioning are available in the market which gives information about the functioning of hospitals and also keeps a track of it [2]. These frameworks should be refreshed to be more smoothed out, diminish copy tests or methodology and mechanize the manual interaction [3]. Many works have been done so far making the hospitals self-sufficient and helping both the patients and the hospital administration using hybrid cloud, internet of things, machine learning, and artificial intelligence [4]. Using hybrid cloud and artificial intelligence the management part of the hospital can be automatized entirely [5]. On applying machine learning we can also enable the system to detect cleaning and filtration of data collected automatically [6]. Due to advancements in technology doctors are seen with iPads containing the information of patients [7]. The creation of a huge database may prove useful to the patients in several ways [8]. Abound together client personality confirmation stage, a brought together server farm, brought together cloud administrations, and bound together insight is found in a smart hospital [9]. Without the assistance of a hybrid cloud framework, it is difficult to extend admittance to medical services in a moderate way [10]. Integration of artificial intelligence, machine learning, and IoT is multi-dimensional data assembling, handling, and showplace for the medical clinic [11-12]. Research has been done on frameworks that can perform continuous observing furthermore, the early admonition of patient exercises in the ward, which mirrors the situational attention to smart hospitals [13-14]. Few authors had proposed an image processing based system for proper mask positing [15]. Generation of QR codes for each people can also prove to be useful in determining the symptoms along with thermal scanning [16]. Proper masking is also very essential to break the chain of corona virus. Around 80% of people suffering from -19 have mild symptoms [17]. However, these are the main carrier of the virus leading to infections. People having mild symptoms don't need special treatment and can fully recover when isolated and treated with care. The best way to break the chain of the spread of the virus is by isolating the people having mild symptoms [18].

In this paper, we are proposing a smart hospital equipped with smart isolation wards and capable of self-oxygen level monitoring along with automatic switching on the oxygen supply when needed. The process will start from an easy hassle-free registration process through a mobile application or by the website and continues at the entrance. Availability of the beds and automatic sanitization system, thermal scanning zone with a smart mask positioning system is presented. The bed will contain an alarm which the patient can press in case of any emergency and a Wi-Fi-enabled screen for routine video consultation and entertainment of the patient. The automatic system will also prevent wastage of oxygen as well as the patient will not be needed to monitored regularly by the visit in person. Using the technology the doctors can keep a track of their condition from a distance. The patient will be monitored at a regular interval of two hours and the patient's information will be updated to the doctor's office with the use of hybrid cloud and IoT. We had also connected a heartbeat sensor and a thermal sensor in the isolation ward. All the data will be updated regularly on the official website of the isolation

center and not only the doctors but also the family of the patient can keep a track of the health of the admitted person. The patient needs to pre-book the beds. The entrance of the hospital will have a mask detection sensor and thermal scanner installed which will make the barricade open only after the mask is properly placed and the temperature is scanned. This will be fully automatic and less human intervention will be needed. The smart hospital proposed will be for people who have mild symptoms and need isolation. The proposed paper is organized as follows. Section II contains the working principle. Section III represents the proposed system.

II. MOTIVATION

In this pandemic situation everyone is fighting with COVID-19. Basically, peoples get panic due to unavailability of beds in the hospitals and they don't have proper monitoring system so that they can utilize it and gets benefited. Currently wearable devices have been proposed so that persons can easily monitors there body temperature, oxygen meter and so on which is directly related to healthcare concern by using Wi-Fi module or Bluetooth devices easily [19]. Remote monitoring system is also developing so that doctors or hospital administration can monitor the respiratory or heart rate and by using thermal sensor the body temperature of patients remotely [20]. By accessing these data for formation of prescription and sharing it via tablet or smart phone. The system of hospitals are not up to mark as many hospitals are not so smart due to lack of technology, by improvising with different multiple sensors and technical aspects we can initiate telemedicine facility so that we can provide proper diagnosis to patients from remote location [21]. In this system we combine all the aspects into one system where we can remove the human intervention for measuring body temperature, proper sanitization machines based on sensors. Our objective is to define smart hospital which having its own operating system under which patients gets easily beds and also by knowing the availability of oxygen or not. According to the situation of patient based on serious, mild or normal we separated isolation ward smartly and by proper monitoring every ward is under surveillance with defined doctors. All the things defined in our system are based on internet of things and by using multiple devices or sensors we can easily transform our hospital into smart way.
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III. WORKING PRINCIPLE

Our proposed system is fully automatic and involves less human intervention. During the COVID-19 outbreak when there is a shortage of doctors in hospitals and a high risk of infection, the proposal of an automatic smart hospital will prove useful and help in preventing infections to doctors. Our proposed system will work in coordination with a hybrid cloud, IoT, and multiple sensors to monitor the patient and update their health conditions regularly. The functioning of the system is divided into three stages.

In *stage 1*, the patient will have to pre-book the beds which are available by registering on the respective websites or by mobile applications. When they will register they will be asked about their symptoms and aadhar ID for verification. After the patient will pre-book the slots, they will be given a QR code which will be unique to them.

In *stage 2*, when the patient reaches the hospital he will be properly thermally scanned, it will be insured if his mask is placed properly or not using image processing technique and after full sanitization QR code given at the time of booking will be asked. On scanning the QR code the barricade will be open and he may enter the isolation ward.

In *stage 3*, being in a smart isolation center they will get a bed well equipped with a pulse sensor, oximeter, tablet for video consultation to doctors, and an alarm in case of any emergency. If the oxygen level falls below 92 the knob will open automatically and oxygen will be provided to the patient until his oxygen becomes normal. Moreover, the patient's health information and updates will be available to the doctor as well as family members through a website.

The *proposed system* is of a smart isolation center well equipped with technologies to assist the patient. The patients having mild symptoms need to be isolated to prevent further infections to others. The major equipments that we will use to make this proposed system are:

A. **Pulse Oximeter:** It uses the spectro-photometric method to measure the saturation level of oxygen in your body and pulse rate. The clip-like device is attached to a body part commonly a finger. A healthy person must have a 92 percent or above the level of oxygen saturation and at least 86 percent of oxygen saturation in the blood.

B. **Thermal sensor:** It is used to measure the temperature of the human body. The normal temperature of the human body is 97.5 degrees F to 98.6 degrees F. It uses infrared to detect the temperature of surfaces. For fast recovery of the patient, the temperature of the patient should be maintained under appropriate ranges.

C. **Heart Beat Sensor:** This sensor is used to measure the heartbeat of the patient as heart attacks are very common for covid-19 patients. So its monitoring is very important.

IV. PROPOSED SYSTEM

We know that in 80-85 % of cases of COVID-19 there exhibits only mild symptoms but they can be the main reason for its spread. So, proper isolation with appropriate care and monitoring of them is required. As the second variant of the Covid-19 are very deadly and dangerous. Our proposed system is the best possible arrangement for isolation with minimum human interventions. As discussed earlier our proposed smart isolation center has a pre-booking bed option for the end-users with the help of the hospital website or by mobile application. Fig. 1 consists of a general description interface of the website of the smart hospital.

Any of the end-user who can easily access this website can register or for this. Availability of beds is always a problem for the developing nations and moving here and there for beds at hospitals will always not be a good practice. It creates a panic situation. For this, we had proposed the interface having a detailed description of the availability of the beds for the isolation ward as well as for the emergency ward. Once the end-user found the bed he/she can register for the process and they can select for isolation ward or emergency ward. Once the registration process is completed a unique Quick Response (QR) code will be generated and also the ward no. and bed number is allotted to the registered COVID-19 patient. This facility of registration can be done 24 crosses 7 without any human intervention other than the end-user.
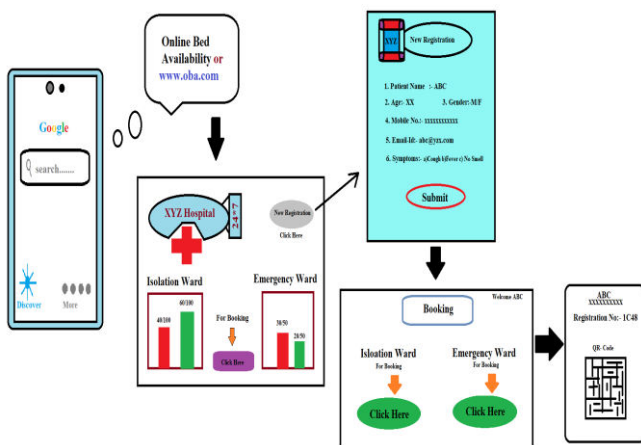

Fig.1. Website interface of the hospital

Fig. 2 depicts the arrangements made at the entrance of the smart hospital. We had proposed a smart sanitization system with QR scanner/ reader which will confirm the patient's registration and the connected IR sensors will control the entrance of the barricade of the hospital once both things are done correctly. It will be opened only when proper sanitization work is done as shown in Fig. 2(a). After the sanitization and QR scanning, the patient will move forward and then they will go into the pre-evolution section in which mask scanning and thermal Scanning zones are made which is shown in Fig. 2 (b).The Patient has to move in both these
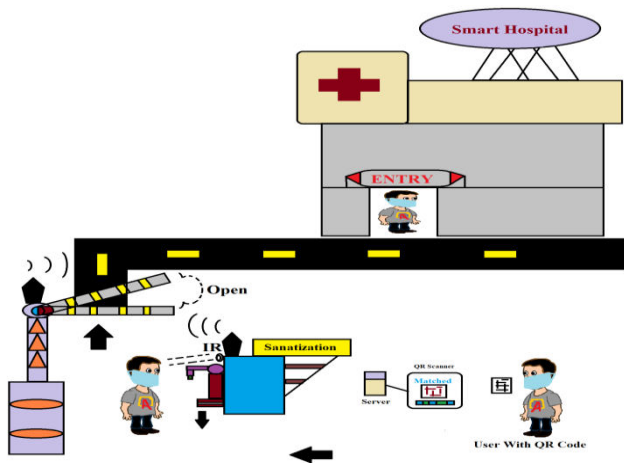

Fig.2.(a). Pictorial representation of the smart hospital at entrance
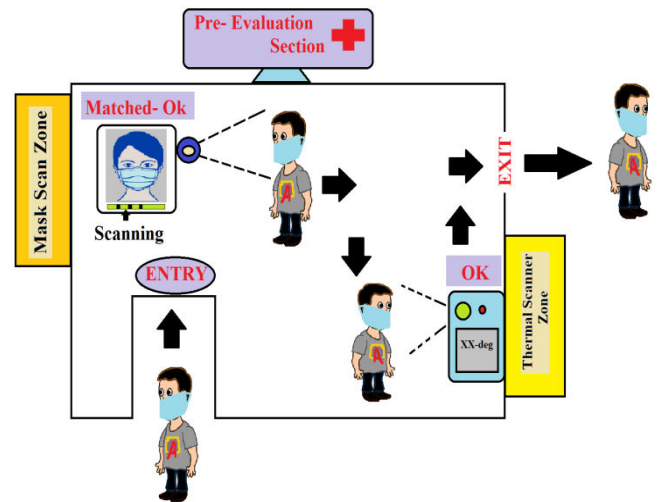

Fig. 2.(b). Pictorial representation of pre- evaluation section

zones in which proper mask positioning is checked and the patient's temperature is checked at this point. In the mask scanning section, the position of the mask in real-time is compared with a database of different person's positioning of masks with the help of image processing. It will consist of a high-quality zoomed camera that will take the picture of the patient in real-time and compare its positioning with the predefined database. It will inform the patient to properly mask himself/herself if it's not matched with the database. In the thermal scanning, with the help of a thermal scanner, the real-time temperature of the patient is taken, and then will be allowed to enter the main lobby of the hospital. Proper masking and thermal scanning are very important which is done without human intervention at the entrance only. Once the entrance of the patient is made in the hospital He/She can wait in the waiting section for any paperwork to be done or can directly go isolation ward which is shown in Fig.3. We can find the display in the lobby which is showing the status of available beds at the hospital. We can see at the later section we had two types of wards one is a special ward which is more equipt and can be utilized for
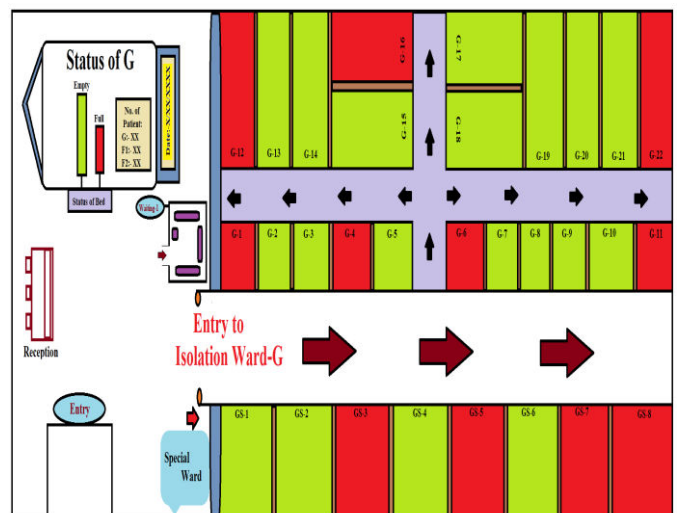

Fig.3. General pictorial representation of the smart hospital lobby and the positioning of the wards

the critical patients whereas the other section is the general isolation wards with all the required monitoring equipment and devices. As prebooking of the patient is done so they can directly go to their respective allocated wards. In the Fig.3 a general setup of wards and the waiting section of the hospital is shown. Fig. 4.comprises with the description of the isolation ward with all the devices and facilities present in the ward. First of all, at the outside section of the isolation ward, a display will be present which will give the information about the vacant or occupied status of the ward. We had proposed a total smart isolation ward in which an oximeter is present to get the oxygen saturation level of the patient which is further connected to the oxygen cylinder and a preexisting program will be there for opening the knob of the oxygen level once the saturation level goes down a level of 92. By this process, we can optimize the use of oxygen and we can stop the wastage of oxygen. As covid-19 is a very dangerous disease and it badly affects the working of lungs. So, oxygen saturation level monitoring is very essential most of the time. For heartbeat monitoring, heartbeat sensors are also connected in the ward. As we had seen in many cases cardiac arrest or sudden severe heart attacks are very common for COVID-19 positive patients. Temperature control is also very important for quick recovery of the infected patients. For thermal monitoring, we had created a thermal scan zone in which the temperature of the patients is recorded as many times as recommended by the doctor.
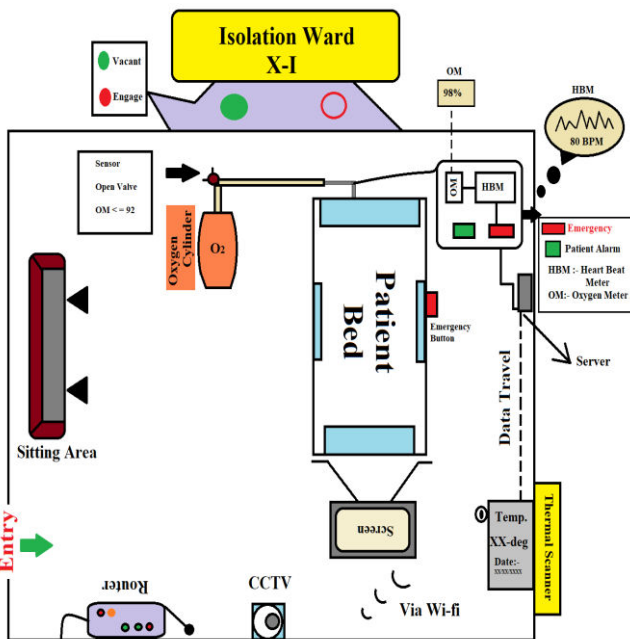

Fig.4. Isolation ward representation with multiple facilities

All these three levels for each patient are stored properly for daily analysis and these data are also shared on the website or the mobile application to the patient's attendant at home. We had also arranged a multi-utility Wi-Fi operated screen in which the patient can get his/her conversation with the doctor along with can use it for entertainment purposes. A special emergency button is available in the ward for the patient in any case of extreme urgency. Separated router and CCTV coverage are also present in the ward to have good

monitoring on the patient. In this way, we can monitor and isolate the COVID-19 positive patient and can break the chain of this virus. For any emergency case, the patient will be shifted to the special ward where furthermore required pieces of equipment are available. Fig. 5 comprises the whole proposed system and how its control is made, how it's network is established from step one. Each data of each steps are connected with different IPs at the same network by the help of server. So that each data can easily be communicated with each steps. For each steps data are stored and transferred when needed. As when video consultation is done then all related data are needed at the same time to the doctor for giving best treatment which is shown in one section of Fig. 5. For any kind of emergency our whole proposed system is controlled by the control unit connected in the system. This system can give an alarm whenever it's needed. When each step data is shared with each other then we can make less human intervention and more accurate also.
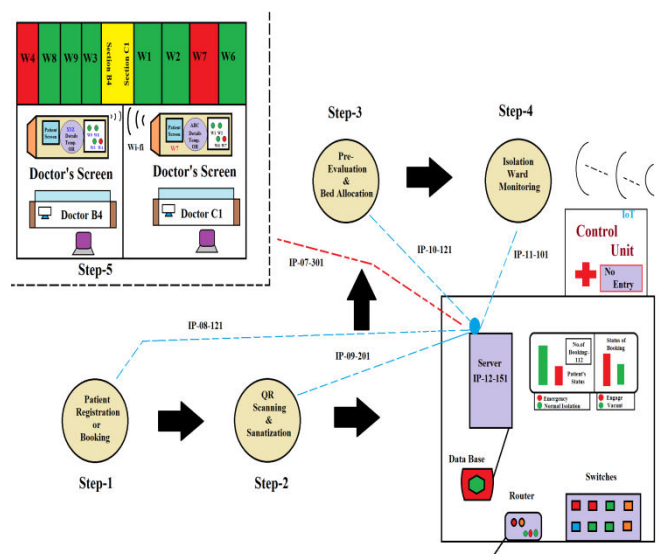

Fig.5. Network setup with online monitoring of each ward by the doctors.

CONCLUSION

The proposed paper aims towards proposing a smart hospital that is useful to people with mild infections during the COVID-19 outbreak. The combination of a pulse oximeter, thermal sensor, image processing, and hybrid cloud with IoT will make this system unique. The system will have pre-booking facilities which will prevent rush at the hospitals. Only people who have pre-booked their beds will be allowed. The smart hospital will have less human intervention and will be fully automatic with the facilities of video consultation of doctors through tablets. If an emergency occurs the person will also have an alarm along his bedside to press and call for immediate help. The system is also capable to save oxygen and avoid its wastage by self-monitoring and providing oxygen only when it falls below 92. All the data will be updated regularly on a website that will be accessible not only to doctors but also to his family members. In the pandemic time when there is a shortage of hospitals and doctors, this proposed system will try to fill

the gap and help the patients with mild symptoms as well as prevent further spread of infections as well.

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