Interconnected Hospitals Using IOT

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Abstract. The internet of things' (IOT) applications are expanding quickly. IOT is widely employed in the medical industry. The use of IOT in interconnected hospitals is covered in this paper. When patients are unable to schedule an appointment or reserve an ambulance from their local hospitals, they will be given one at the next closest hospital or given an ambulance from that hospital with the help of interconnected hospitals. In places with high population densities or where healthcare facilities are far away, interconnected hospitals might be extensively employed. In the case study, we learned how IOT and interconnected hospitals may enable a mobile application to guide patients to the closest hospital and also help them book ambulances from the nearest available hospitals. In a later section of this paper, we discussed the difficulties interconnected hospitals face now and their potential future.

Keywords: interconnected hospitals · Internet of Things · healthcare · application

1 Introduction

Disease prevention and life quality improvement are aided by high-quality healthcare. The objective of healthy people is to increase the standard of healthcare and guarantee that everyone has access to the services they require. Some people are unable to receive the necessary medical treatment since it may not be offered in their neighborhood pharmacies or hospitals. Bad care quality causes more deaths than a lack of access to healthcare; in India, 1.6 million people died in 2016 as a result of poor treatment, roughly twice as many as a result of not using healthcare facilities [1]. Patients may experience issues if they don't have enough information about physicians, hospital beds, medications, etc. A person in need of quick medical attention searches for an ambulance but is unable to reserve one because the closest hospital is currently not offering any ambulance services. However, there might be a hospital in his neighborhood that offers ambulance services, so they might have driven him there immediately. There were not enough hospital beds and oxygen tanks available during the pandemic. The number of COVID-19 patients that the hospitals could accommodate was limited. Additionally, those who

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had COVID-19 were unable to purchase oxygen cylinders or reserve any beds. Due to a lack of knowledge regarding the availability of hospital beds and oxygen cylinders in other hospitals, the situation was a complete disaster. Many people struggle to locate a physician who can treat them for a specific ailment. They are unsure of which hospital will have the best physician available to treat them or which hospital will have open seats for an appointment. This might postpone medical care, and later, something terrible might occur. Additionally, the neighborhood drug stores might not always have all of the medications you need. In light of all these issues, we have developed the concept of interconnected hospitals.

According to this idea, the hospital will upload data to a shared server, such as the number of beds available, the best doctor in each department, the number of ambulances available, etc. A number of hospitals' information will be on the server. After that, a mobile application with the help of IoT (Internet of Things) will compile all the data and present it to the user in a structured manner.

Informing patients about the healthcare options offered in several neighboring hospitals, this idea will be of tremendous use to them. Help will be given to the person in need right away. Instantaneous updates will be made to the application's data. Depending on availability, the user can also reserve ambulances, doctors, and beds from various hospitals. The user will be promptly moved to the next best option if a booking is canceled. Additionally, new hospitals can use the application to register themselves and exchange their data. Doctors from all around the world will be connected if the app is accessible worldwide. They will be available for online consultation by users. The user will be able to make an appointment in another state or nation if a certain medical therapy is unavailable in their own states or countries. This mobile application can also be used widely in highly populated hospitals where there is a lack of beds and ambulances in certain hospitals and in areas where the healthcare services are present very far away from the settlement. The app will be able to notify the user of which hospital doctors are available in their area.

2 Application Scenarios and Characteristics

The proposed model is going to be quite helpful in the scenarios where there are very large populations or the health services are pretty far away from the settlement. For example, when talking about the places where there are very large populations, the hospitals present in the area will not be sufficient because whenever there is a rush, it is not a guarantee that the optimum required facility will be available in that area, so in order to counter this, the app or website that will be given to the people can be very useful, because they will know exactly what they want and where they can find them, which will save time, which is very important in case of medical emergencies.

Now coming to the part where there are very few health facilities in any given area, this will also provide the same health to the people by telling them where to find the required facility, which will be very beneficial for the individual. The characteristics of the model being that it will always be available on the cloud, with constant updates from all the given hospitals in an area, and the app providing the details to the people of that area can reduce the casualties by a certain amount, which is actually very useful in the

field of medical emergencies. Now considering the situation like COVID, which had a number of deaths because of the poor management by the hospitals, this system can be effective because it will actually tell the required individual that in their area which bed is available and where the conditions This will result in a lower number of deaths and more effective treatment of the people, which will be very useful for the patients as well as the doctors, as the system and the allotment will become more effective and the hospitals in the areas will have to work together to reduce the workload and the number of casualties.

Now considering if there is a single person, this entire setup provides an ease of access to the user because they will be able to look up on the app for their disease, and may be able to identify them, and take necessary precautions beforehand. Now also considering situations like COVID, the user will also be shown how far the nearest hospital with an empty bed is to admit the patient from them, which will be very helpful in saving the life and any further casualties. The purpose is to keep the user up-to-date with all types of medical facilities which are available to them in case of any type of emergency.

3 Architecture

The architecture of the proposed model consists basically of a software that runs on a very specific computer at any given hospital which in turn communicates with the stored server at that hospital and also at the cloud, the cloud being a very dedicated server that is responsible for storing the data as well as the running of the app. For any given area, there has to be a separate cloud so that they can run effectively in any given scenario [14].

The cloud will also serve as a medium between the intercommunication of the hospitals, which is very much required in certain or some medical cases. The software present at the hospital will also be responsible for updating the stats of the hospital, the availability of the medicines, and one of the important things, Ambulances, it will also provide an effective map so that the nearest ambulance can reach the required destination the shortest amount of time possible as well as bringing the casualty to the nearest hospital as soon as possible, the location of every ambulance in the area being updated in real time, so that the working staff or people can know where is the required ambulance (Fig. 1).

The app will show all the available hospitals in a given area that have the available facilities and the type of treatment they will be offering for a particular disease, which will be quite beneficial to the people. The hospitals in the areas will also be required to update their stats manually, which will also reduce the number of mistakes, and there will be an automatic management.

At any given time, the system will identify at any given time which hospital has which doctor for any specific disease and the number of beds, as well as the number of staff and medicines, as well as the list of medicines that are available in the area at any given time.

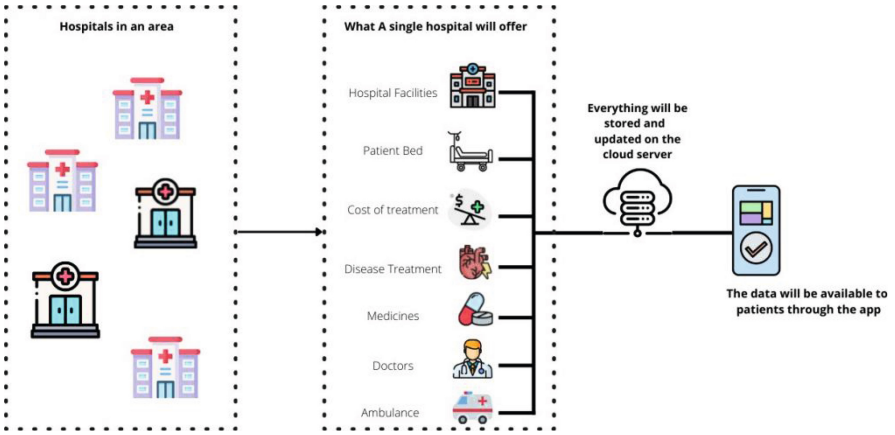

Fig. 1. Architecture of interconnected hospitals

4 Result and Analysis

Figure 2 depicts the patient's engagement with the mobile application. Patients are given access to a mobile application with a number of features, such as the ability to schedule the closest ambulances that are accessible, obtain a list of the top doctors from connected nearby hospitals, and buy drugs that are offered in the closest medical shop. The application is connected to a server that keeps track of the hospitals with whom it has affiliations, and the server database is updated each time a hospital database is updated. And it adapts for the app, enabling patient access without restriction [11].

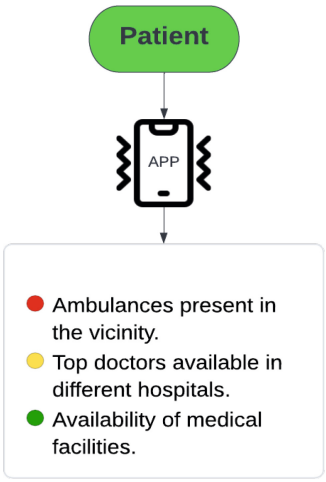

Fig. 2. Interaction between the patient and the mobile application

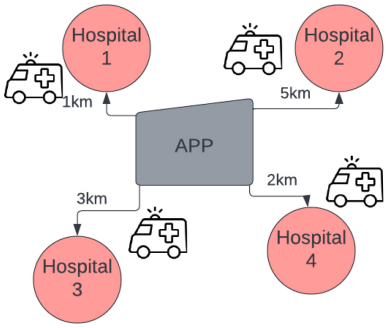

Fig. 3. Interaction between app, hospitals and ambulances

A mobile application that connects to hospitals 1, 2, 3, and 4 at the same time and receives updates from the server is shown in Fig. 3. Patients may now travel the shortest distance by ambulance and visit hospitals with facilities available by using the app, which will now display the status of ambulances, how far they are from hospitals, and whether or not those hospitals have amenities available. And through this engagement process, the patient may more quickly find the hospitals they need with the use of the app.

In Fig. 4, a cloud links many hospitals together. In the cloud, hospitals communicate all of the information related to hospital beds, the availability of ambulances, physicians, and nurses, as well as the price of procedures and medications [11]. Through a mobile application, patients have access to data that also includes information about the expertise of the doctors and nurses, as well as information about the infrastructure, safety, health, and cleanliness of the hospital. Patients can also access record data about prescription drugs, disease treatments, cost of treatments, patient beds, etc.

Figure 5 depicts a map of a neighbourhood with nine hospitals h1, h2, h3, h4, h5, h6, h7, h8 and h9. If a patient requests an ambulance from a hospital and that hospital later runs out of ambulances, the patient's request will be sent to the hospital that is closest to him or her. The same situation will apply while scheduling testing and doctor appointments. A mobile application will be used to complete all of these tasks.

Figure 6 shows a satellite picture of a neighbourhood containing nine hospitals, which are shown in Fig. 5 as h1, h2, h3, h4, h5, h6, h7, h8, and h9. The hospitals are linked, and a patient may use a mobile application to reserve ambulances from any hospital.

5 Case Study

Prioritizing this idea of connected hospitals is our study's goal. We put a lot of emphasis on getting the patients to the hospital quickly. Next, we must determine whether the hospital has the necessary resources for the patient, including doctors, nurses, medications, equipment for treating diseases, and emergency beds. Because patient life during a crisis is our first priority.

Here, in the above illustration, Fig. 7, H1, H2, H3, H4, and H5 indicate how many hospitals there are. A1, A2, A3, A4, and A5 indicate the number of ambulances. The

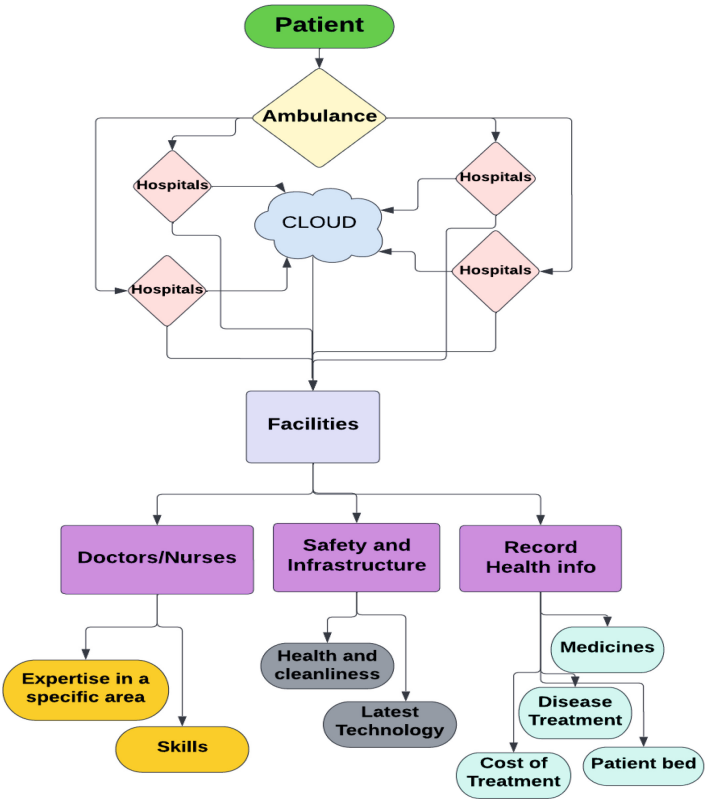

Fig. 4. Interaction between the hospitals

Fig. 5. Cupcarbon based IOT simulator

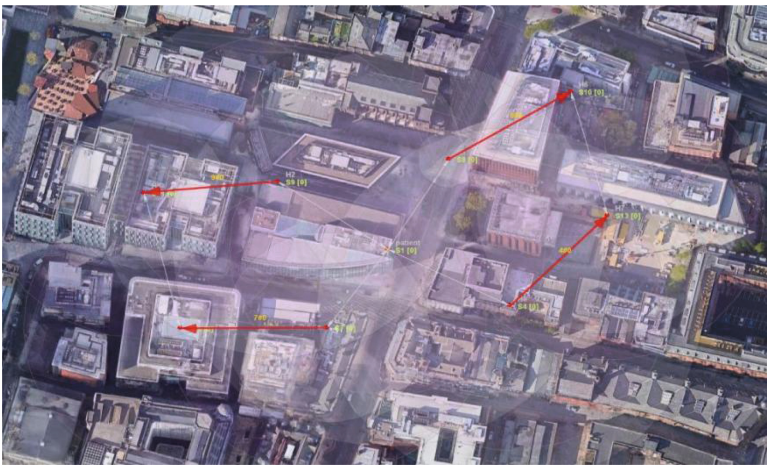

Fig. 6. Cupcarbon based IOT simulator (Satellite View)

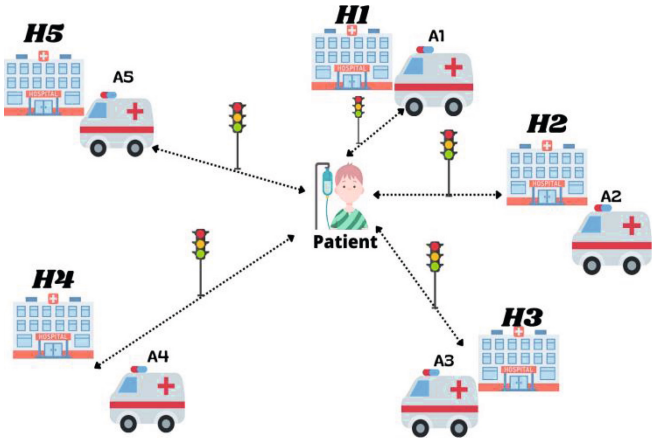

Fig. 7. Interlinked health centers and ambulances

first study is to determine the most effective approach to getting the patient to the closest hospital with the use of the preceding diagram. First, we must determine whether or not the patient's needs can be met by the facilities. Then, since ambulance 1 is closest to the patient in the diagram above, we must provide all of the necessary information to it. As a result, the patient can use and access ambulance 1 first and promptly arrive at hospital 1, which is the closest facility.

Second, there is a chance that the ambulance will become stopped in traffic and not arrive on time [2]. Using Google Maps, we can estimate the traffic so that the ambulance can choose the fastest and most optimal route to the neighboring hospital.

The next step is to search the database to see if a bed is available for the patient in a nearby hospital, i.e., Hospital 1, which is the closest. If a patient needs immediate

medical attention and there isn't a bed in the closest hospital, hospital 1, we can move the least recent patient there to hospital 2, 3, 4, or 5, and we'll provide the bed to the emergency patient in hospital 1 first.

6 Performance Measure

India's healthcare industry has grown significantly in both employment and income. Hospitals, medical devices, clinical trials, outsourcing, telemedicine, medical tourism, health insurance, and medical equipment all fall under the category of healthcare. The expansion of coverage, services, and rising spending by both public and private entities are all contributing to the rapid growth of the Indian healthcare industry [13].

The public and private sectors make up the two main components of India's healthcare delivery system. The government, or public healthcare system, concentrates on establishing primary healthcare centres (PHCs) in rural areas while maintaining a small number of secondary and tertiary care facilities in major cities. The bulk of secondary, tertiary, and quaternary care facilities are run by the private sector, with a focus on metropolises and tier-I and tier-II cities.

The abundance of highly qualified medical personnel in India is a competitive advantage. India's costs are competitive with those of its neighbours in Asia and the West. Surgery in India costs roughly a tenth of what it does in the US or Western Europe [5].

Apparently, India has the second-largest population. Since 2014, public health spending has been on the rise as a result of the country's growing population, with a growing portion of the GDP going toward public health care [6]. Public healthcare in India cost an estimated trillions of rupees in 2018.

According to research findings, India's healthcare industry is worth millions of U.S. dollars and is expected to rise to even more dollars. It has overtaken other industries as one of the greatest in terms of employment and profit, and it is expanding quickly (Fig. 8).

During COVID, interconnecting hospitals were quite useful. It was integrated with the "COWIN" application, which allowed users to schedule vaccination appointments at various hospitals. The user must first input the address of the place where they want to make an appointment. They will then receive the names of the hospitals in their area, along with information about the sort of vaccines on hand and the number of open spots. The user can then reserve his or her spot appropriately. The information provided by the hospitals will alter in accordance with reservations and be displayed on the application. When a user visits a specific hospital to receive vaccinations, the hospital sends information to the server, and the server updates the "COWIN" application with the user's vaccination status [12].

7 Challenges and Future Direction

– *Data Breach*: According to our research, data security and privacy should come first. Attackers may attempt to steal user personal information during transmission or other processes via bugs and gaps, or they may hack the server through the illegal data hijacking method [3]. As a result, it is important to regularly check websites and applications for vulnerabilities [8].

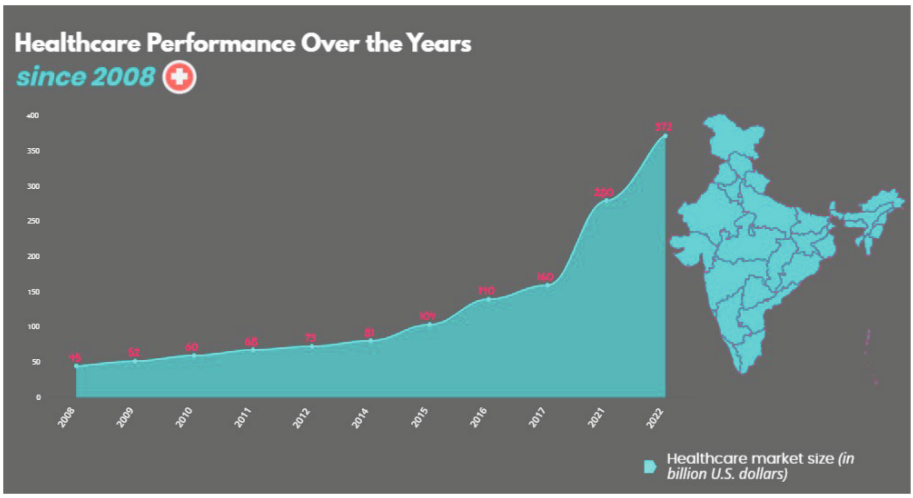

Fig. 8. Healthcare performance over the years

- *Effective Architecture for Ambulances*: If an ambulance is unable to reach a patient due to congestion or other emergency circumstances, it can instruct the neighboring ambulances to get to the patient by using a network of interconnected ambulances [9].
- *Fatal Server Glitches*: Sometimes there could be a few server issues, making it impossible to update the information that the hospital is operating at full capacity. The patient doesn't have access to the necessary facilities at the present hospital. It searches the database in order to find the closest hospital with the facilities. The database indicates that the hospital has room for additional patients, but in reality it is already full. So a team should be established to tackle this problem and ensure that the systems and database are constantly checked for these problems [10].
- *High-cost and Expenses*: We have a sizable database of affiliated hospitals because we are aware that private healthcare facilities are expensive. We may inform patients or their families of the going rate for comparable care in all local hospitals so they can make an informed decision based on their financial capacity.
- *Overcrowding and population*: A huge population in many places has contributed to hospital overcrowding, which makes it difficult for people to wait in line for assistance in an emergency. According to studies, elderly adults endure anxiety, dyspnea, and chest pain in crowded settings[7]. Therefore, hospitals with several connections give a large population of people more options for healthcare than those congregating in one hospital. Many patient populations, particularly the elderly, who would benefit from being in a comfortable setting, should have the option of receiving therapy at home [4].

8 Conclusion

In the modern world, the IoT is undergoing a tremendous industrial revolution. In this paper we have suggested the idea of interconnected hospitals using Internet of Things(IoT). Our strategy is built on the use of hardware and software sensors, data collection and storage in a database server, and restful web services. The system is pre-loaded with data such as the number of available beds, the best doctor in each department, and the number of ambulances available at the moment; all of this information will be available on the server. There will be an application with two ends, one for users and one for hospitals. The user end will have all of the selection options based on their needs, while the hospital end will feature new hospitals registration and frequent updates. It is a two-way app that will notify both parties from time to time.

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