

Sensors Based Smart Healthcare Framework Using Internet Of Things (IoT)

Hitesh Kumar Sharma, J.C. Patni, Prashant Ahlawat, Siddhratha Sankar Biswas

Abstract: Technical advancement in healthcare sector has various dimensions to enhance. Computer vision, image processing, machine learning, Internet of Things (IoT) etc. are the most important technical domains for contribution in healthcare sector. Automation for capturing the human health parameters and based on those parameters finding illness has tremendous demand for the prevention, management, and treatment of human health. IoT is contributing with very high speed to automate this process in healthcare sector. Sensor-based modules are used to capture real time data of human body and simultaneously data processing models provides real time insights of human health. Although IoT is already made its presence in healthcare sector over the last few years, still the progress is not satisfactory. Today automation in healthcare domain has drawn significant amount of attention. Using IoT with supporting technologies can be used to design a complete system which can be used by the doctors to precisely monitor the health of a patient so that the healthcare service provider can analyze and monitor the patients, who are either hospitalized or performing their usual day-to-day life fuss. Integrating IoT with mobile computing technologies can come up with a solution where visiting of healthcare professionals to the patients constantly drops. It will happen because of statistics or records regarding patient's health straightly comes to healthcare professional's smartphone over an android/ios or other application, no matter wherever the patient is settled. Also, based on this record, healthcare providers could diagnose numerous lives by providing them a swift and valuable service.

Index Terms: Biomedical, Cloud Services, Healthcare, Internet of Things (IoT), Mobile Application, Mobile Computing, Patient, Sensors,

1 INTRODUCTION

In today's world, many lives are affected as the patients are not monitored and properly diagnose. Also for real-time parameter values are not precisely monitored in clinic as well as in hospitals. In some particular situations, it even becomes difficult for healthcare service providers or professionals to frequently check patient's health status. Recently, the patient's health monitoring systems is one of the most considerable development because of its enhanced technology. Currently, there is requirement of a modernized approach in healthcare sector. In the traditional approach, the healthcare professionals and service providers plays the supreme role as they need to visit the patient's department or ward for required care, diagnosis and guidance. There are two basic issues associated with this approach. One is the healthcare service providers must be available at the patient's location, thoroughly and another is the patient remains admitted in a hospital, bedside biomedical appliance, for an interval of time. To resolve these such types of issues [1], we have designed an IOT based application, which can be used in hospitals or patient's residence for measuring and monitoring various health parameters of patient like temperature, heartbeat, real-time position etc. and healthcare service provider would be able to see the real-time vital parameters of patient and as well as his/her real-time position on a Google Map over the android based application. The same functionality is available on web dashboard, which is deploy on cloud based platform such as AWS S3 service.

- Hitesh Kumar Sharma is currently working as Assistant Professor (Selection Grade) in Dept. of Cybernetics, School of Computer Science, University of Petroleum & Energy Studies (UPES) EnergyAcres, Bidholi. Dehradun- 248007, Uttarakhand, India E-mail: hksharma@ddn.upes.ac.in
- Jagdish Chandra Patni is currently working as Assistant Professor (Selection Grade) in Dept. of Virtualization, School of Computer Science, University of Petroleum & Energy Studies (UPES) EnergyAcres, Bidholi. Dehradun- 248007, Uttarakhand, India E-mail: icpatni@ddn.upes.ac.in

Over the web dashboard, there is a feature resides through which healthcare professionals can download the full report of patient's health record, which will be available in PDF format. By doing this research work, we have understood that how we can implement an Internet of Things based application in healthcare sector, which is going to help the doctors and healthcare professionals to analyze patient's real-time health status.

2 LITERATURE REVIEW

In the era of ever-expanding competition and progressing patient's demands in different geographic locations, healthcare professionals or service providers be in a need of innovation and need to plan for digital conversion. In the developed countries, they should be prepared and provisioned to diagnose an ever-increasing community whereas in the developing countries, a big problem still is how to outreach more and more people in regions and communities with not enough healthcare professionals or service providers. Traditionally, there was no such design or method which could be used in hospitals or patient's residence for measuring and monitoring various health parameters of patient and the end-user or healthcare professionals were be able to see the real-time vital parameters of patient and as well as his/her real-time position over the smartphone. Consider a situation, where there is a patient to whom a doctor is assigned to monitor and diagnose his/her health. and suddenly, the doctor has to visit some other places to check other patient's health or for some personal reason, it would be difficult for them to monitor their earlier patient's health record on the real-time basis. And what if that particular patient needs to be diagnose on that very moment. So, the question is, how to overcome this problem Healthcare service providers have to take digital transition on board to expand their services and outreach to more communities, places and area where there are not enough healthcare service providers and professionals to monitor, diagnose and treat a growing figure of ever-increasing patients. To triumph, they have to get the correct procedure in point and merge with foremost class infrastructure and technologies. As the healthcare vertical reforms, there are advance concerns

about privacy and price management. To attain heights of coherence, precision and perfection while securing the patient's privacy and protecting regulatory compliance, healthcare professionals or service providers require real-time perceptible into diagnostic data, patient records, health alerts, and more. Our design provides the right solution to help healthcare professionals and service providers efficiently award their time to patient care. The fundamental concept of IOT or (Internet of Things) is to connect modern devices or things to the Internet in an explicit way. This focuses to an interchange of information between all objects or devices, and bring users data in a more protected way. Cisco Corporation anticipated that Internet of Things will be like 50 billion objects or things connected to the Internet by 2020 [3] and it is foreseeable that many hardware devices, like computers, sensors, will be distributed with individual label or address and the facility to transit information, from the common day-to-day movement to medical records, in a protected way. The IOT or Internet of Things explicitly transformed the healthcare sector, expanding precision, decreasing price and creating the focus back on efficient patient healthcare. Along with this, Internet of Things is expanding from threads of automation and device-to-device interaction to the smallest wearable sensors. Internet of Things, facilitates a connected procedure for all hardware devices that consists of embedded based technologies to be logically connected and authorize them to interact and sense with the physical world, and also among each other". The Internet of Things or IOT is a concept that's explains a "connected set of anyone, anything, anytime, anyplace, any service, and any network.

3 EXISTING SYSTEM

In existing hospitals the doctor will checks the patient daily whether is patient health is in proper condition or not. In this system the doctor have to visit the patient daily to checks the patient's health. But checking the patient at every time is not possible as doctors will be busy and frequently go to another locations for surgeries etc. At this time anything happens to the patient the doctor have to hush the hospital to check patient health. Another one is heart patients in the house. As daily routine everyone present in the house goes for the work. The heart patient will lone in the house if anything happen to the heart patient like suddenly increase in the pulse rate of the patient. There is no alert system to alert or any system to check the heart beat remotely from any location To overcome this type of the problems we designed health monitoring system in our system we use sensors for continuously motoring the health of the patient. Sensors we used is pulse sensor and another one is body temperature sensor. Pulse sensor continuously monitories the heartbeat of the patient and sends pulse values to the android app. Similarly, body temperature sensor will also sends the data to the android app The sensors data in android app updated in real time. Using android app, doctor can monitor the patient health form anywhere and can inform patient or nurse what precautions should be taken. We also design an alert system in your app. When body temperature or the pulse rate of the patient is exceeded than the limit android app immediately alerts the doctor so the doctor can immediately contact the nurse/patient and instruct them for prescription. As an outcome, visits of healthcare professionals to the patients constantly are drop as the statistics or record regarding patient's health straightly comes to healthcare professional's android smartphone over an android application, no matter

wherever the patient is settle. Also, based on this record, healthcare providers could diagnose numerous lives by providing them a swift and valuable service. Similar we applied this system to the patients who lives in the house. Here, instead of doctors, the android app is installed on the non-healthcare professional's phone. So the non-healthcare professionals also can monitor his/her close ones who have health problems while working in the office.

4 MOTIVATION

The reason for doing this research work is that traditionally, there was no system or device which monitors the patient health and shows the data on android in real time and alerts the doctor if the patient condition's is critical. If there was a situation, where patient plus rate or body temperature increases sudden when doctor is away then doctor is unable to threat the patient because there is no such system through which doctor can monitor the patient health ,so here patient relining on doctor to come and threat them. As an outcome, visits of healthcare professionals to the patients constantly are drop as the statistics or record regarding patient's health straightly comes to healthcare professional's android smartphone over an android application, no matter wherever the patient is settle. Also, based on this record, healthcare providers could diagnose numerous lives by providing them a swift and valuable service.



Fig. 1.1. IOT in healthcare

By doing this research work, we will understand of how we can implement an Internet of Things based application in Health Sector, which is going to help the doctor to monitor their patients' health . It will be a great contribution to the world and the Internet of Things world community, so that someone can do more research on this work and will be able to build even more secure, efficient and robust module or device which will help the consumer in a great way.

5 PROPOSED SYSTEM

An Internet of Things based application is develop, which can monitor the patient heath of in real-time and display patient position on Google Map. The doctor will be able to see the real-time health data on a web portal, which is deploy on cloud platform (Microsoft Azure/AWS) and we also have developed an Android Based App, which will show the same real-time health data and position of the patient on the doctor smartphone, ease to use We will be using Firebase cloud API's (Database as a Service) to store the patient health record and his/her real-time location. Firebase is a web service which is

maintained by Google, operate on the Hypertext transfer protocol (HTTP) over the network or via a Local Area Network (LAN). Firebase APIs facilitates the logging of information from numerous sensor or applications data, even real-time location tracking applications status, and a community related applications data along with status updates. We will be requiring plus sensor and body temperature for monitoring the patient health. Pulse sensor monitor the heartbeat of the patient and body temperature sensor monitoring body temperature. This sensors data will be sent to the Firebase database using Wi-Fi or AT commands by activating General Packet Radio Service (GPRS) and HTTP protocol. The GSM module will be use to send the latitude and longitude coordinates to the Firebase database using Wi-Fi or AT commands by activating General Packet Radio Service (GPRS) and HTTP protocol. For the microprocessor like a Raspberry pi to work, we need to run the code or the business logic (Python Programming) for the real-time tracking system into the Raspberry pi. For writing the code, we need to install raspbian OS in raspberry pi and access raspberry pi through our system using LAN cable or Wi-Fi connection. In Raspberry we will use preinstall python IDE through which we will compile & run the code in Raspberry pi. Raspberry will provide an interface to access the GPS module to get the latitude and longitude coordinates in real-time and sensors to get the patient health data. Pre-build Wi-Fi in raspberry pi or GSM module, for sending real-time data to Firebase database. The sensor's we will using gives analog data. There is no analog pins in the Raspberry pi, so will be using Arduino or ADC module to get this analog data from sensors. Connect this Arduino or ADC module to Raspberry pi to push the analog to the raspberry. In this way we will send the analog data to digital and sends to the Raspberry pi

5.1 Objectives

The objectives and their flow has been shown in Fig 1.2,

Objective 1: Collecting the components

Objective 2: Implementing the design process

Objective 3: Writing business logic

Objective 4: Development of an android application and web dashboard

Objective 5: Testing the device

Objective 6: Deployment of web dashboard on AWS

Designing an automated patient's health monitoring system, we need to accomplish those six objectives. As an outcome, visit of healthcare professionals to the patient's health constantly drops as the statistics or record regarding patient's health straightly comes to healthcare professional's android smartphone over an android application, no matter wherever the patient is settled. Also, based on this record,

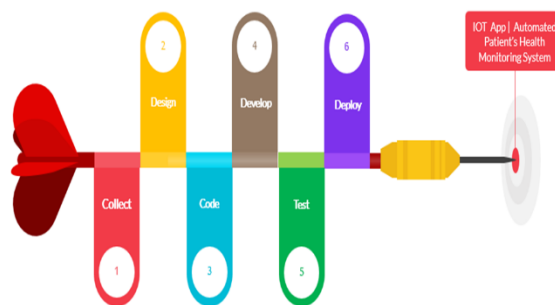


Fig. 1.2. Main Objectives

Healthcare providers could diagnose numerous lives by providing them a swift and valuable service. According to Fig 1.2, levels.

5.1.1 Collecting the components:

The very first task is to work on the requirement analysis section. Need to analyze, how many modules or devices and what kind of modules are required to design the IOT based application, Automated Patient's Health Monitoring System. After going through the requirement analysis of automated patient's health monitoring system. We need to buy/purchase or gather these boards or hardware modules. Along with this, we have to make sure that the cost of the entire implementation should be less as the prime objective is to make the application very cheap, so that it will be feasible for everyone to buy the application [2].

5.1.2 Implementing the design process:

According to design pattern (Fig 1.3), Arduino no/ADC will get the data from wearable sensors [9] that heartbeat sensor and patient sensor which then push this data to Raspberry Pi 3 board [4].

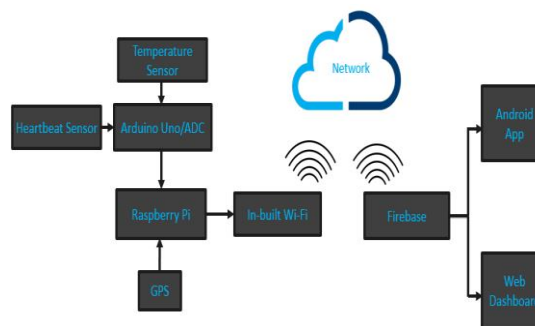


Fig. 1.3. Design Process

Now Raspberry Pi fetch real-time location from GPS sim 28M module and send all this data along with fetched data from Arduino Uno/ADC to Firebase using in-built WIFI over the network. From Firebase, the real-time data will be pushed to android app and web dashboard simultaneously. For the connection between the devices, we will refer the design pattern. Raspberry Pi 3 will provide platform through which we can access the GPS sim 28M to access the real-time location. But here is the problem, Raspberry Pi 3 got no analog pins at all and heartbeat and temperature works with analog pins only as they provide analog values which can't be accept by digital

pins as Raspberry pi got 40 general input/output pins. Therefore we can use Arduino or Analog to Digital Converter (ADS1015). If we use Arduino Uno, the board will provide an interface through which we can access the heartbeat sensor and temperature sensor. And the data will be pushed to Raspberry Pi 3 through the serial communication in which data will be transmitted bit by bit. Moreover, we are using printed circuit board stands which will lift the hardware modules a little above the ground so that there soldering plate won't touch the surface. For powering the Raspberry Pi 3 board, we are using power bank with a battery configuration of 5200 mAh which will provide 5V, 2A to power Raspberry Pi. For GPS SIM 28M Module, we will provide power of 5V from Raspberry Pi 3 itself. The power will be provided from the power pins of Raspberry Pi 3. The power to Arduino Uno will be given from the Raspberry Pi's USB slot. From Arduino Uno will make connections from its power pin of 5V and GND pin to an extension board through which we will get 5-6 pins each for 5V and GND. Using these pins, will turn up the power of Heartbeat sensor and Temperature sensor [6] plus making the ground (GND) common. Before giving power to GPS sim 28M [10], we need to make sure that the GPS receiver is connected to the GPS sim 28M Module because if it is not connected to the module, there might be a case where it can get damage or work not well, when we power-on the module. So, to avoid those situation, will connect the GPS receiver to the GPS Module. From Raspberry Pi 3, we will use its digital pins to make connection to the GPS SIM 28M Module using female to female jumper wires. Raspberry Pi's pin number 10 (digital pin as Rx - Receiver) will be connected to GPS sim 28M Module's Tx (Transmitter Pin), through which we will get the output from GPS [11]. Arduino Uno's pin number 0 (analog pin for reading output) will be connected to Heartbeat sensor's analog pin. Arduino Uno's pin number 1 (analog pin) will be connected to temperature sensor's analog pin. Power pins of the heartbeat and pulse sensor are connected to that extension board and plus their ground (GND) pins are connected the ground section for ground common. Consider a situation, if there is no internet connectivity available in the hospitals or patient's home, will extend our application by adding another hardware module that is GSM sim 900A. We can push the real-time data over the GPRS to Firebase (Database as a Service) from which can push real-time data to android application and web dashboard simultaneously. For getting the effective, accurate and precise results from the GSM sim 900A Module, we will use a rechargeable battery with a configuration as 12V and 2A and will connect it with Raspberry Pi 3 for pushing the data over GPRS using a sim card [1],[5].

5.1.3 Writing business logic

For accessing the Raspberry Pi 3 board, we need to install Raspbian Operating System, which will provide graphical user interface using a SSH protocol and Windows Desktop Connection application. From where we write code for fetching the data from Arduino Uno serially and real-time location from GPS sim 28M module. Using Arduino IDE, we will burn or upload the created business logic on the Arduino Uno. There is a socket given on the Arduino Uno connected to system through one of the comm port from which we can burn or upload to the Arduino Uno. We need to make sure that the code should be burn before making the connections with other devices. Now will send fetched real-time data from wearable sensors to the Raspberry Pi 3 serially. In Raspberry Pi 3 board,

we also make the business logic for pushing the data to Firebase using Firebase APIs and implementing it in python programming language. For running the python scripts in Raspberry Pi 3, we will use python runnable environment variables. By using the Windows Remote Desktop Connection Application on the android phone, we can access entire Raspberry Pi 3 board using the SSH connection and through which can run scripts over the smartphone itself.

5.1.4 Development of an android app and web dashboard

After writing the business logic for automated patient's health monitoring system, we are using end-point services of Firebase APIs, which will provide those real-time data and location data to the web dashboard & an android application simultaneously. The end-user or healthcare service provider would be able to see the real-time vital parameters of patient and as well as his/her real-time position on a Google Map over the android based application. We have design a web dashboard, which have five frames, first frame will show the patients details, second frame will show the patient's real-time heartbeat. Third frame will show the patient's real-time temperature. Fourth frame will show the real-time position of patient using Google Map APIs [1]. And last frame will show a feature through the healthcare professional can download the patient's full report. We will code for web portal in HTML, CSS, and JavaScript. Later on, we will deploy the web dashboard on Amazon Web Service S3. Along with web dashboard application, we will design an android application [7], which will show the same functionality of that web dashboard application using android studio. Plus, we are also providing a feature in android application that is healthcare Plus, we are also professional can share the entire patient's log and report within their contacts so that in emergency anyone who is near too patient can reach out for diagnosis [13]. We will be implementing the user interface, which will be very user-friendly to use, both in android application [8] and web dashboard.

5.1.5 Testing the device

After the development of Automated Patient's Health Monitoring System, we will test the application/module to check its robustness and preciseness. It is the most essential part as we need to make sure that whoever using the Automated Patient's Health Monitoring System, make sure he/she gets the accurate results. We will provide the different test cases to Automated Patient's Health Monitoring System, in order to check where are the loop holes, where it requires more remedy to provide accurate vital parameters of patient and as well as his/her real-time position on a Google Map over the android based application and web dashboard simultaneously. After testing the Automated Patient's Health Monitoring System, we will analyze the application according to our pre-define assumptions. The main goal is to check that, how much our device is robust and precise and whether it is providing the accurate the data or not.

5.1.6 Deployment of web dashboard on AWS

After testing the Automated Patient's Health Monitoring System, the web dashboard will be deploy on the cloud platform, which could be Microsoft Azure App Service or Amazon Web Service. By deploying our web dashboard application towards cloud technology which provides a pay-per-use model, so it will cost us very less and it will be an easy way to use. Using Amazon Web Services S3 (Simple Storage

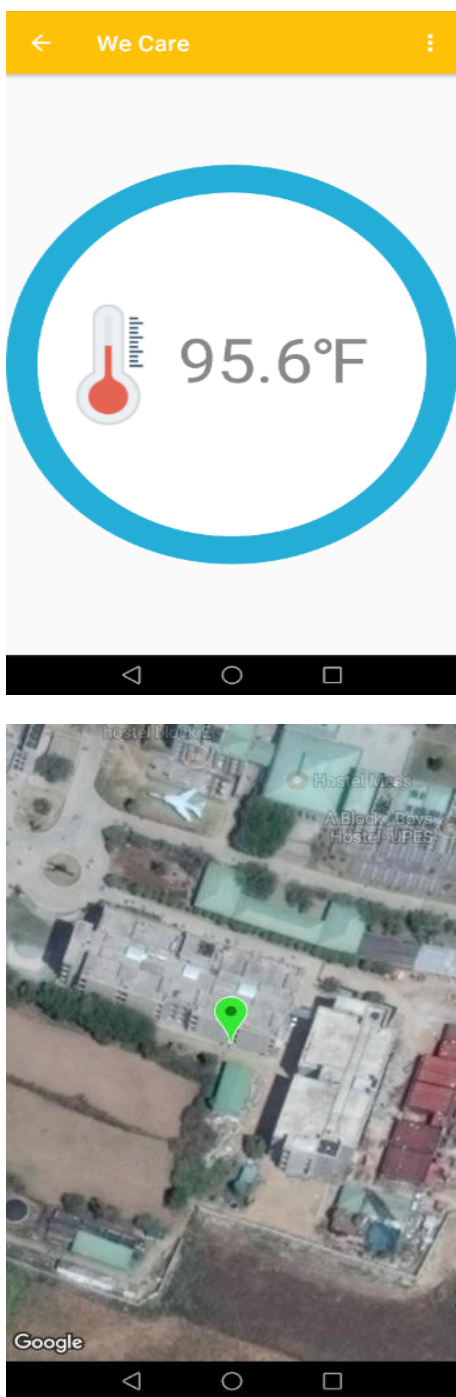


Fig 1.7. Real-Time Temperature + Location

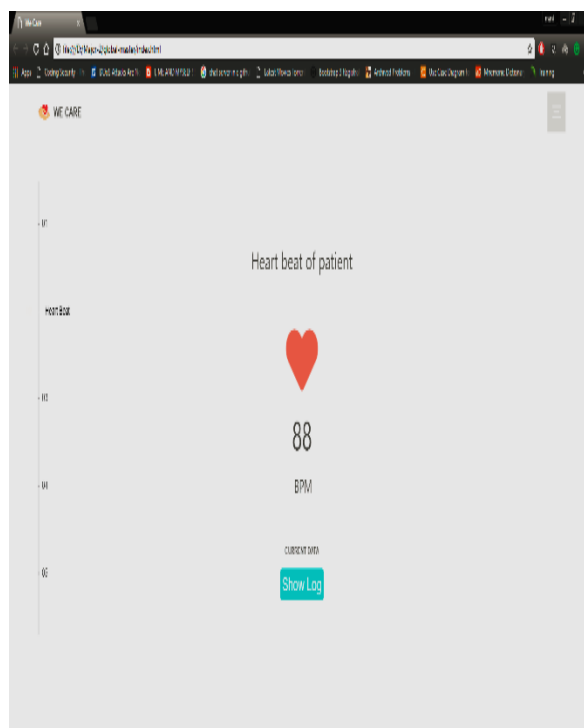


Fig 1.8. Real-Time BPM - Web Dashboard

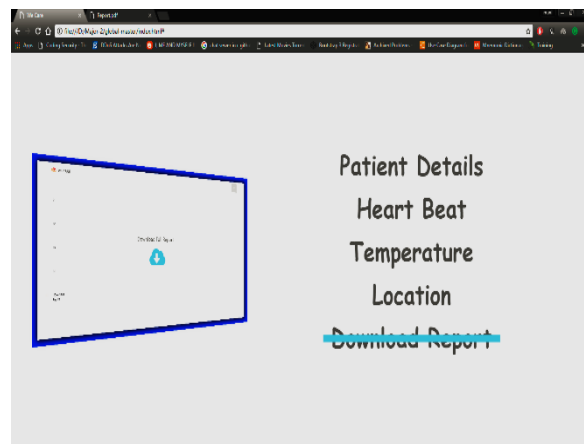


Fig 1.9. Web Dashboard, Deployed on AWS

8 CONCLUSION

Health is the biggest worldwide problem for humanity. Over the last decade the healthcare has drawn significant amount of attention. The major and supreme objective is to design a precise automated patient's health monitoring system so that the doctor or healthcare service provider can analyze and monitor the patients, who are either hospitalized or performing their usual day-to-day life fuss. Traditionally, there was no such design or method which could be used in hospitals or patient's residence for measuring and monitoring various health parameters of patient and the end-user or healthcare professionals were be able to see the real-time vital parameters of patient and as well as his/her real-time position over the smartphone. Consider a situation, where there is a patient to whom a doctor is assigned to monitor and diagnose his/her health. And suddenly, the doctor has to visit some other places to check other patient's health or for some personal reason, it

would be difficult for them to monitor their earlier patient's health record on the real-time basis. And what if that particular patient needs to be diagnose on that very moment. So, the question is, how to overcome this problem? In order to improve the above condition, an Internet of Things based application is designed, which can be used in hospitals or patient's residence for measuring and monitoring various health parameters of patient like temperature, heartbeat, real-time position etc. and the end-user or healthcare service provider would be able to see the real-time vital parameters of patient and as well as his/her real-time position on a Google Map over the android based application. The same functionality is available on web dashboard, which is deploy on cloud based platform (Microsoft Azure/AWS). Over the web dashboard, we have provided a feature through which end-user or healthcare professionals can download the full report of patient's health record, which is in a PDF format. By doing this research work, we have understood that how we can implement an internet of things based application in healthcare sector, which is going to help the doctors and healthcare professionals to analyze patient's real-time health status. As an outcome, visits of healthcare professionals to the patients constantly are drop as the statistics or record regarding patient's health straightly comes to healthcare professional's android smartphone over an android application, no matter wherever the patient is settle. Also, based on this record, healthcare service provider can save many lives by providing them a swift and valuable service.

9 FUTURE WORK

In a real-world scenario implementation, it would probably be an innovative idea, if we add a live video streaming feature to this system. A live video can be streamed and, the doctors and relatives are able to monitor the patient from any distance. We will use a camera module which describes how the live video streaming is being done. The webcam is connected to the Raspberry Pi 3 and images are taken frame by frame so that video can be displayed over the network to web dashboard as well as on an android application. Another feature that can be installed is that in further, we can implement Blockchain in healthcare sector. Blockchain, position the patient at the middle of the system, exponentially expanding reliability, confidentiality, and interoperability of healthcare information. For an instance, healthcare service provider may have numerous discrete method to insert the patient's birth date. Technically, blockchain could associate patients to their status or record, rather than to their personality. Efficient information exchange among different healthcare professionals and providers enlarges the probability of precise diagnoses, more efficacious treatments, and the overall increased ability of healthcare providers to offer cost-efficient care.

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