

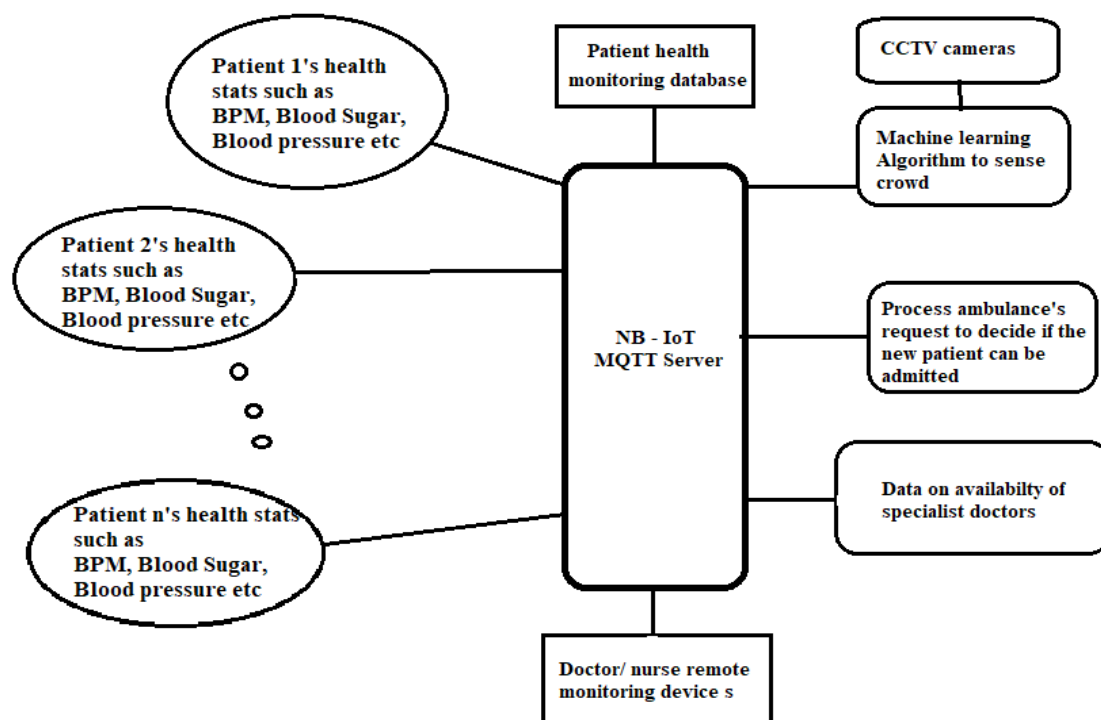
## Smart Hospitals using IoT

### Abstract:

In this modern world of rapid industrialization and growth, Internet of Things (IoT) enables us to connect multiple smart devices, providing more data interoperability methods for application purposes. The use of IoT, especially as wearable devices plays a vital role in improving quality of medical care and bringing convenience to the patient and the doctors in an efficient way. Many times, due to poor crowd management ambulances are directed to move to a different hospital after reaching one hospital, this causes a lot of discomfort for patients. So, a novel way to detect the crowd in hospitals using CCTV cameras and communication with ambulances is proposed.

Also, due to a large number of patients, individual care for everyone is not possible. So wearable devices can be used to monitor health status of patients in real-time. The use of NB-IoT(Narrow band -IoT) ensures handling such high connection densities comfortably at very low power consumption. Using narrow band IoT technology also eliminates the need for batteries used for powering sensors by opening doors for using Po-Wi-Fi(Power over Wi-Fi) technology.

### Proposed solution:



The primary aim of a smart hospital must be to reduce manual labour and any error caused by humans, at low cost with devices that are robust and low power consuming. The following sensors may be deployed for monitoring health of a patient, bearing all the aforementioned requirements:

- Heart rate monitoring sensor
- Blood pressure and sugar level sensors
- Smart ECG devices
- Body temperature sensor
- Infusion monitoring module
- Body posture sensing module

Due to a high density of sensors, Narrow band IoT (NB-IoT) is used which is capable of supporting thousands of connections at very low power consumption, low cost and for a large duration. A case study conducted by Haibin Zhang et al. [1], on infusion monitoring system using NB-IoT and edge computing provides solid evidence that using NB-IoT can be very effective in smart hospitals. Using lower frequencies, allows us to power sensors through Wi-Fi eliminating need for batteries [2][7].

Data acquired by all the sensors is transmitted to the server using a lightweight MQTT connection. As clients, with remote devices nurses/doctors can view the state of the patient in real-time. The server would also alert the staff if any sudden abnormality in body condition is observed using deep learning algorithms.

Another major function executed by the smart hospital is communicating with an ambulance in real-time. CCTV cameras are used to sense the crowd densities using computer vision and deep learning models, in emergency wards for determining if a new patient can be admitted to the hospital or if the ambulance must be redirected. Also, if the patient in the ambulance needs a specialist's attention [5] the server would alert the specialist to be available, or redirect the ambulance in case the specialist is unavailable.

Implementing this model will also alert the staff on availability of drugs used usually for the disease. The patient's stakeholders can also monitor the physical condition of the patient in real-time. This model hence ensures a greater level of transparency.

## **Why NB-IoT?**

1. High connection capacity
2. Low power consumption
3. Low cost
4. Wide coverage
5. Higher possibility of using Power over Wi-Fi technology

However, using NB-IoT also means poor latency, high signal interference and low security due to the large number of devices connected. To address these problems edge computing is introduced [1].

## **Why MQTT?**

MQTT is a light weight subscribe and publish open standard protocol, with low bandwidth and power consumption. It is used in this model because of its advantages over HTTP. This protocol is also found to improve the latency, which is very important for real-time transfer of data.

## **Crowd density detection**

CCTV cameras can be used for detecting crowd densities in real-time using computer vision and deep learning. Tools such as Darknet and TensorFlow, enable us to easily implement such models. If crowd density is high in emergency wards, then the ambulance acceptance rate would be reduced by the server.

## **Challenges:**

Connecting such smart devices to an IoT network has a few challenges.

1. Wearable devices are less reliable. Their accuracies and processing capabilities are low.
2. Due to a large number of device connections on the network, security is poor.
3. Wireless communication Interference [1] because of the low frequency bandwidth chosen.

Necessity is the mother of innovation. Technology empowers us to keep pushing our limits to innovate our lives. This model is aimed at revising what has been traditionally followed by hospitals and ambulances to monitor, cure and transport patients. With IoT helping us with real-time data exchange and decision-making abilities, functioning of hospitals can be made smoother, smarter and efficient.

### **References:**

1. Connecting Intelligent Things in Smart Hospitals Using NB-IoT by Haibin Zhang et al (IEEE 2018) .
2. <https://thenewstack.io/delivering-power-with-wi-fi-signals-to-the-next-billion-devices-no-batteries-required/>
3. Smart Hospitals Using Internet of Things(IoT) by Pooja Kanase, Sneha Gaikwad (IRJET 2016)
4. Smart hospital using IoT by Jinal Shah et al (IOSRJEN 2018).
5. <https://www.verywellhealth.com/how-do-paramedics-choose-a-hospital-1298357>
6. Towards an Implementation of Smart Hospital: A Localization System for Mobile Users and Devices by Antonio Coronato, Massimo Esposito (IEEE 2008)
7. Powering the Next Billion Devices with Wi-Fi by Vamsi Talla, Bryce Kellogg et al (CoNEXT 2015)
8. <http://news.mit.edu/2019/converting-wi-fi-signals-electricity-0128>