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An intelligent Medical Monitoring System using Narrow Band IOT

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ABSTRACT

With the emergence of technology, the healthcare sector has seen tremendous growth, providing creative ways to improve patient care, increase productivity, and save expenses. Of these developments, the Internet of Things' (IoT) incorporation into the healthcare industry has emerged as a key component for developing intelligent medical systems that are able to remotely and in real-time monitor patients' health problems. Narrowband IoT (NB-IoT), a low-power, wide-area network (LPWAN) protocol created expressly to meet the expanding demands of the IoT ecosystem, particularly in healthcare, is one exciting technology facilitating this shift.

Vital health indicators including heart rate, blood pressure, glucose levels, and oxygen saturation can be tracked by healthcare practitioners with the help of an NB-IoT-enabled smart healthcare monitoring system, which can monitor patients continuously and remotely. By providing more timely and individualized care, decreasing hospital stays, and enabling faster reaction times, this technology has the potential to completely transform the healthcare industry.

Keywords: WBANs, IOT, Smart Health care system, NB-IOT

1. INTRODUCTION

[1]Wireless Body Area Networks (WBANs), which integrate the newest protocols and technology for smooth, real-time monitoring of patients' health data, are continuing to transform health monitoring in the rapidly changing healthcare scene. A range of wireless communication protocols are built into these systems to guarantee secure, dependable, and effective data transfer.Wireless Body Area Networks (WBAN) and other technologies are used by smart healthcare monitoring systems to continuously check on patients' health. These systems gather physiological data, including body temperature, blood pressure, heart rate, and other vital signs, using wearable technology or sensors. The data is then sent to medical professionals for real-time analysis. The efficient, safe, and low latency transmission of data is guaranteed by the usage of protocols.[1]

[5]Wireless Body Area Networks (WBAN), which allow for continuous, real-time monitoring of patients' vital signs, have the potential to completely transform the healthcare industry. The monitoring system's range, power consumption, and efficiency are all directly impacted by the communication protocols that are used, including IEEE 802.15.6, BLE, Zigbee, and LoRa. In this context, let's take a closer look at the most recent protocol implementations used in WBAN for smart healthcare, especially those that have recently surfaced to address the challenges of scalability, security, and low-power, low-latency data transmission. A well-designed WBAN-based system, coupled with strong security

protocols, can improve healthcare delivery, particularly in remote and underserved regions.[5]

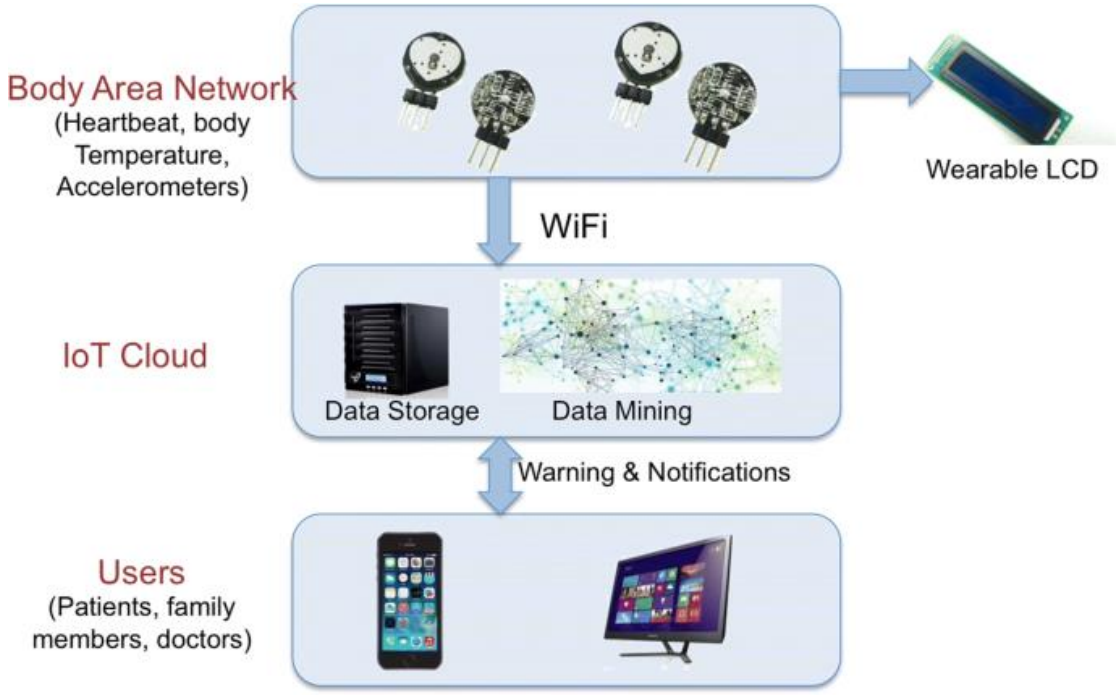


Fig.1-Wireless Body Area Networks

2. AN INTELLIGENT MEDICAL MONITORING SYSTEM:

Cellular-based technology known as narrowband IoT (NB-IoT) is best suited for M2M and Internet of Things applications that need low-power, long-range communication. The 3rd Generation Partnership Project (3GPP) created NB-IoT, which uses licensed frequency bands and is intended to give low-throughput devices in difficult-to-reach places more coverage, more capacity, and a more dependable connection.

[6]Healthcare professionals can remotely monitor chronic ailments by using NB-IoT to enable wearable health monitoring devices (such as glucose meters and heart rate monitors) to send periodic health data to a cloud-based system

The salient characteristics are:

- NB-IoT is perfect for battery-powered IoT devices that must run over extended periods of time without needing to be recharged frequently because of its exceptionally low power consumption architecture.
- Where standard cellular networks might have trouble, it offers superior coverage in rural and subterranean locations.
- NB-IoT modules are reasonably priced in comparison to other wireless communication protocols, which makes them a good choice for widespread implementation in healthcare systems.
- NB-IoT is suitable for large-scale IoT network deployments, supporting up to 50,000 devices per cell.
- For healthcare applications where patient data is important, NB-IoT provides a secure communication channel and comparatively low latency.[6]

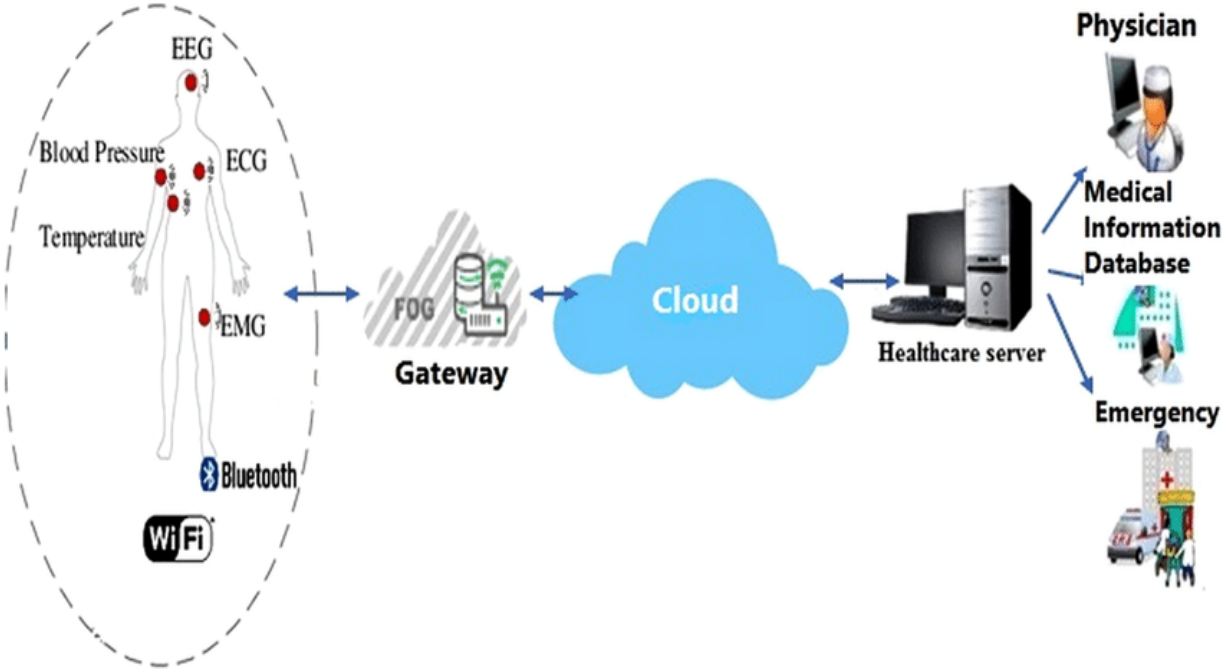
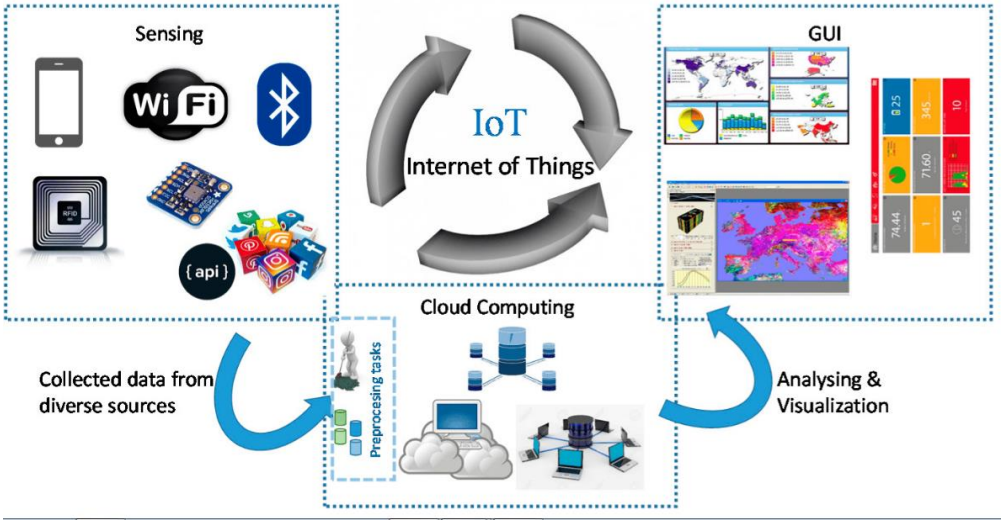


Fig.2- Intelligent Medical Monitoring System

3. ELEMENTS OF AN NB-IOT IN MEDICAL MONITORING SYSTEMS

1. **IoT Devices/Sensors:** These comprise wearable medical equipment that collects patient data, such as smartwatches, blood glucose monitors, ECG monitors, and oxygen sensors.
2. **NB-IoT Connectivity:** These gadgets send the gathered health data to the servers of the cloud or healthcare provider via NB-IoT technology.
3. **Cloud/Server Infrastructure:** After being sent from patient devices, the data is processed, stored, and examined on a central server or cloud platform.
4. **Data Analytics & Decision Support Systems:** Algorithms using AI and machine learning examine the gathered data to forecast health trends and give medical professionals useful information.

Fig-3 Elements in NB-IOT



5. Healthcare Provider Interfaces: Physicians and other health care providers can monitor patient conditions by using web or mobile applications to retrieve data and send alerts

4. ANALYSIS

[4]A low-power, wide-area network (LPWAN) communication protocol called NB-IoT (Narrowband Internet of Things) was created to link a large number of IoT devices across extended distances. Because it is specifically designed for low-bandwidth, low-power, and long-range communication, it works on existing cellular networks and is perfect for applications that need to send data infrequently over large geographic areas.

Parameter	Existing Protocols (IEEE 802.15.6, BLE, LoRaWAN)	Proposed Protocols (5G, NB-IoT, Wi-Fi 6)
Power Consumption	Very Low (ideal for wearable devices)	Higher (especially for 5G)
Latency	Low (1–50 ms)	Ultra-low (1 ms for 5G,

Table-1: Proposed and Existing Protocols

Because of its modest data rates and great dependability, NB-IoT is appropriate for applications like smart meters or healthcare sensors that require devices to send tiny amounts of data on a regular basis.However, it is not appropriate for applications that need high-speed, real-time data, like video streaming. [4]

Narrowband IoT, or NB-IoT, is perfect for applications like asset tracking, smart agriculture, and remote medical monitoring because it can connect IoT devices over vast distances while using little power. These IoT devices can effectively interact over cellular networks thanks to a number of essential components in the NB-IoT architecture.

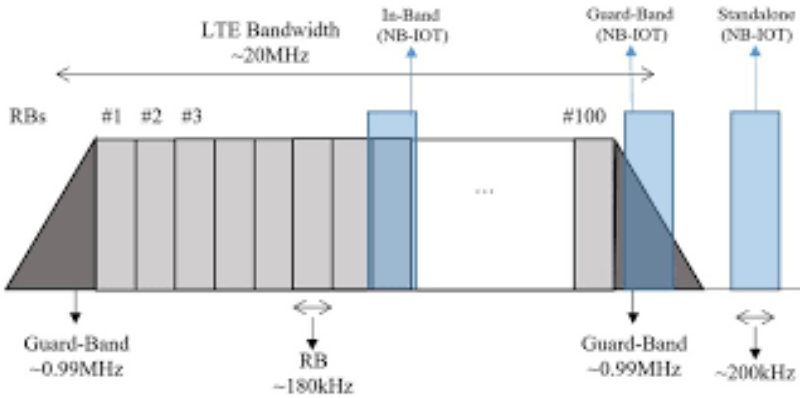


Fig-4. Data Transmission

5. IMPLEMENTATION

[10]Since NB-IoT can provide continuous, low-energy connectivity over long distances with safe and dependable communication, it provides the perfect solution for developing a smart healthcare monitoring system. AES encryption and IPsec tunneling are used by NB-IoT systems to safeguard private health information while it is being transmitted.

As an illustration, a patient with diabetes utilizes an NB-IoT-based glucose meter, which transmits data about their blood sugar levels to a cloud-based medical system on a regular basis. If the glucose level is abnormal, the system notifies the doctor so that prompt action can be taken.[10]

[2]This technology can improve healthcare services in the following ways:

1. Patient Monitoring at a Distance

Healthcare professionals can remotely check patients' vital signs in real time, no matter where they are, thanks to NB-IoT. Through NB-IoT, devices like wearable sensors, smart glucose monitors, blood pressure cuffs, and heart rate monitors may securely send data to healthcare servers on a continual basis. This enables physicians to remotely monitor patients, identify them early, and take appropriate action in the event that any abnormal signals are found. Furthermore, remote monitoring lessens the need for patients to travel frequently to medical facilities, increasing access to care, especially for older patients or those living in remote places.

2. Alerts for Emergencies

When serious health events like heart attacks, strokes, or sharp reductions in blood oxygen levels occur, NB-IoT can be utilized to automatically notify emergency services or healthcare practitioners. The likelihood of a successful treatment is increased by the ability of NB-IoT-enabled medical devices to identify anomalies and provide immediate notifications, guaranteeing a timely response from healthcare providers.

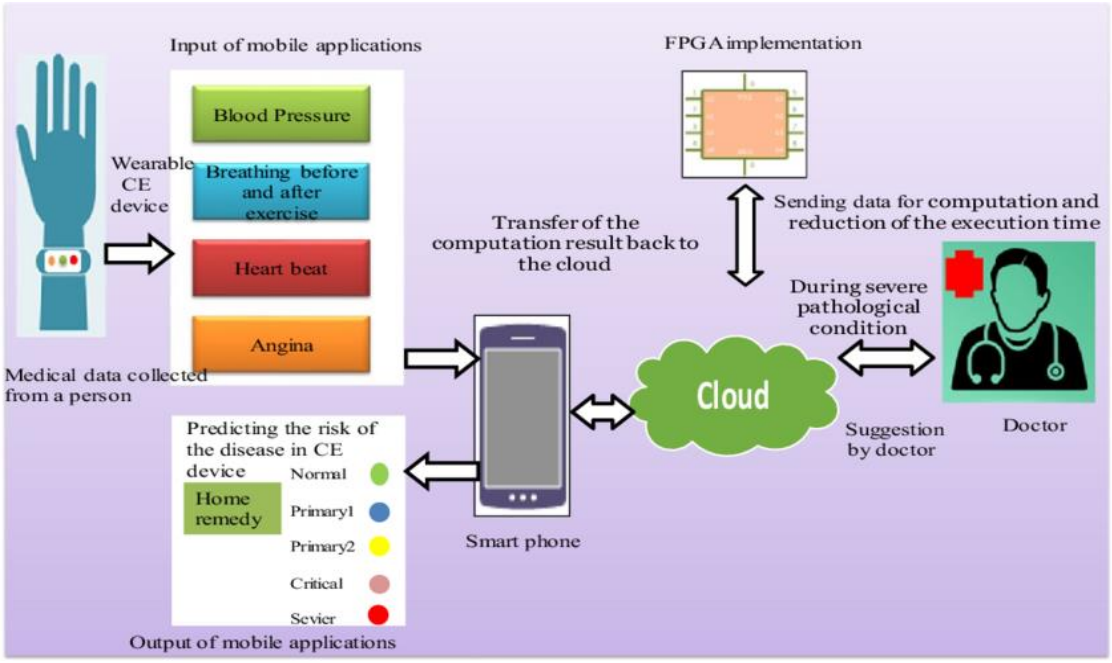


Fig-3. Process flow of an intelligent medical monitoring system

3. Management of Chronic Illnesses

Continuous monitoring is essential for patients with long-term diseases like diabetes, hypertension, or asthma. Regular monitoring of vital metrics including blood pressure, heart rate, and blood sugar levels is made easier by NB-IoT. This improves the management of chronic diseases by empowering medical professionals to make well-informed judgments regarding therapy modifications without requiring patients to attend the clinic frequently.

4. Economical Medical Care

Because NB-IoT is designed for low-cost devices that run on small batteries, it eliminates the need for costly infrastructure. This makes it possible for healthcare organizations to implement more affordable systems for extensive monitoring, particularly in settings with limited resources or in developing nations. Additionally, NB-IoT-based systems can reduce hospital readmissions and emergency visits, which in turn can minimize healthcare costs by enabling proactive care and reducing the frequency of hospital visits

5. Making Decisions Based on Data

To produce insightful information, the constant stream of patient data gathered by NB-IoT sensors can be combined, examined, and processed. Clinical decision-making can be aided by the use of artificial intelligence (AI) and advanced analytics tools to spot trends and forecast future medical events. Healthcare professionals may deliver individualized care based on each patient's distinct health profile thanks to this data-driven approach.

6. Electronic Health Record (EHR) Integration

Electronic Health Records (EHR) systems can be easily integrated with NB-IoT-enabled devices, allowing for real-time patient condition updates to be sent straight into the patient's digital health record. This guarantees that medical professionals have instant access to current, reliable information, facilitating quicker and better decision-making.[2]

6. ARCHITECTURE OF NB-IOT IN MEDICAL MONITORING SYSTEMS

1. User Equipment, or NB-IoT Device

These are the sensors or Internet of Things devices that are connected to the NB-IoT network. These gadgets could include asset trackers, smart meters, environmental sensors, wearable health monitors, and more. They gather information and send it to the network.

2. eNodeB, or NB-IoT Base Station

The base station that links NB-IoT devices to the cellular network is called the eNodeB (evolved Node B). It is a crucial component of the LTE (Long-Term Evolution) network architecture's evolved packet core (EPC).

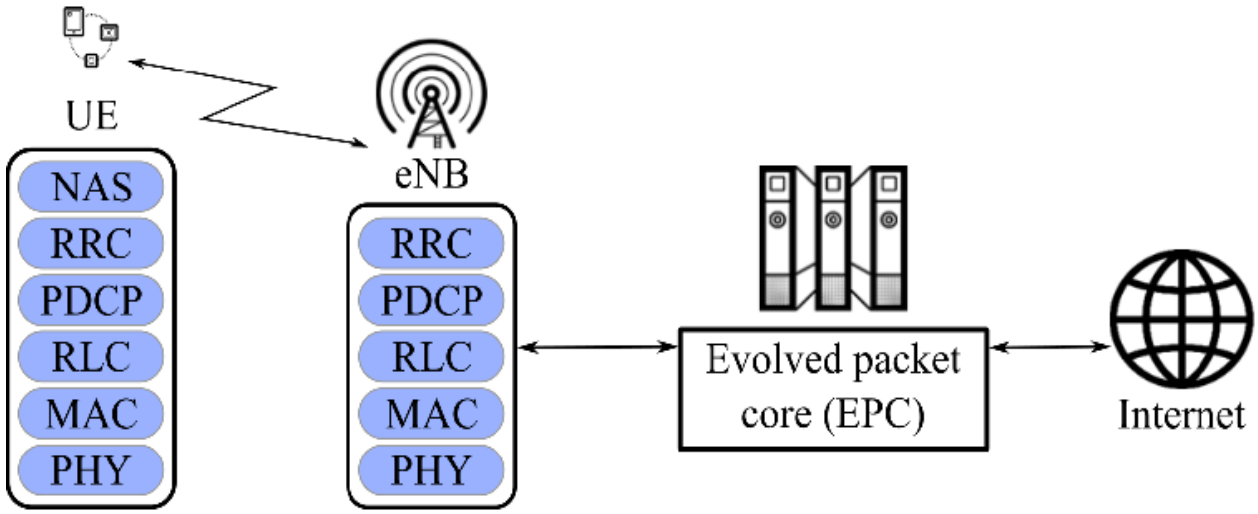


Fig.5-Architecture of NB-IOT

3. EPC (Evolved Packet Core) Core Network

The NB-IoT network's core is the EPC. It is in charge of controlling the data flow between external apps and NB-IoT devices. It carries out tasks like data routing, device authentication, and general traffic control.

4. Servers for applications

The data sent by the IoT devices over the core network is received and processed by these servers. The endpoints that communicate with IoT applications—such as healthcare platforms and smart city infrastructure—are known as application servers.

5. The Protocol Stack for NB-IoT

To facilitate communication between devices and the network, the NB-IoT protocol stack is separated into many layers.[3]

7.ADVANTAGES

1. **Better Patient Outcomes:** Serious health events can be avoided with early identification of health problems and ongoing monitoring, which improves patient outcomes.
2. **Improved Accessibility:** Patients in underserved or remote areas can receive high-quality medical treatment thanks to remote healthcare monitoring.
3. **Time and Cost Efficiency:** It saves patients' and healthcare professionals' time by eliminating the need for in-person consultations and hospital stays, which also lowers healthcare expenses.
4. **Personalized Healthcare:** By making it easier to gather vast volumes of patient data, NB-IoT enables medical professionals to give more individualized treatment depending on each patient's unique health circumstances.
5. **Scalability:** high-scale health monitoring is made simpler by NB-IoT networks' ability to grow to handle a high number of linked devices.[7]

8.OBSTACLES AND RESTRICTIONS

1. Security and Privacy Issues: Protecting patient privacy and data security is essential when sending sensitive health data across IoT networks.

2. Device Compatibility and Integration: It might be challenging to integrate different IoT devices and make sure they work with the current healthcare infrastructure.[9]

3. Regulatory and Standardization Issues: Because the healthcare sector is highly regulated, it is imperative that NB-IoT-based systems adhere to healthcare norms and laws in order for them to be widely used.

4. Battery Life: Even though NB-IoT is made to use little power, it can still be difficult to make sure that gadgets have enough battery life for extended use, particularly wearable and mobile devices.[8]

Key Metric	NB-IoT in Healthcare	NB-IoT in Agriculture	NB-IoT in Smart Metering	NB-IoT in Smart Cities
Battery Life	Several years	Several years	5–10 years	5–10 years
Data Transmission	Real-time, reliable	Periodic, low data volume	Real-time, periodic	Real-time, periodic

Coverage	Remote locations	Remote areas	Urban and rural areas	Urban, indoor, remote
Cost Efficiency	Low-cost devices	Low-cost sensors	Low-cost, scalable	Cost-effective infrastructure
Security	High (Encryption)	High (Encryption)	High (Encryption)	High (Encryption)
Scalability	Moderate (limited by device density)	High (tens of thousands of devices)	High (thousands of meters)	High (tens of thousands of devices)

CONCLUSION

[11]For a variety of IoT applications, NB-IoT provides an extremely effective, scalable, and economical option, especially in remote locations or applications where low power consumption is essential. It ensures that devices may send small amounts of data for extended periods of time without requiring frequent maintenance or recharging by combining cutting-edge low-power techniques with LTE-based protocols. Because of this, NB-IoT is being quickly embraced by sectors including healthcare, agriculture, smart cities, and utilities, and its use is only anticipated to increase as IoT installations get larger.[11]

Narrowband IoT (NB-IoT) is revolutionizing the healthcare industry by offering dependable, scalable, and reasonably priced solutions for remote patient health monitoring. Healthcare providers may lower costs, enhance patient outcomes, and provide prompt, individualized care by utilizing NB-IoT's capabilities. The use of NB-IoT-based healthcare is growing as technology advances. monitoring systems is expected to grow, making healthcare more efficient, accessible, and patient-centric.

REFERENCES:

1. Majid, M.; Habib, S.; Javed, A.R.; Rizwan, M.; Srivastava, G.; Gadekallu, T.R.; Lin, J.C.-W. Applications of Wireless Sensor Networks, and Internet of Things Frameworks in the Industry Revolution 4.0: A Systematic Literature Review. Sensors **2022**,22, 2087. [CrossRef] [PubMed]
2. Akyildiz, I.F.; Su, W.; Subramaniam, Y.S.; Cayirci, E. Wireless sensor networks: A survey. Comput. Netw. **2002**, 38, 393–422.[CrossRef].
3. Ahmed, R.; Ali, R.W.; Ain, T.A. Machine Learning for Wireless Sensor Networks Security: An Overview of Challenges and Issues.Sensors **2022**, 22, 4730. [CrossRef] [PubMed]
4. Madaan, S.; Kumar, D.; Khurana, R. An Enhanced Approach for Synchronization in WSN. Int. J. Comput. Appl. **2014**, 94, 51–56.[CrossRef]
5. Jabeen, T.; Ashraf, H.; Ullah, A. A Survey on Healthcare Data Security inWireless Body Area Network. J. Ambient. Intell. Humaniz.Comput. **2021**, 12, 9841–9854. [CrossRef] [PubMed]
6. **Atzori, L., Iera, A., & Morabito, G.** (2010). "The Internet of Things: A Survey." Computer Networks, 54*(15), 2787-2805*.
7. **Islam, S. R., et al.** (2015). "The Internet of Things for Health Care: A Comprehensive Survey." IEEE Access, 3, 678-708.
8. **Gubbi, J., et al.** (2013). "Internet of Things (IoT): A Vision, Architectural Elements, and Future Directions." Future Generation Computer Systems, *29*(7), 1645-1660.
9. **l-Sayed, M., & Ali, M.** (2019). "IoT-Based Healthcare Systems: Challenges and Solutions." Journal of Healthcare Engineering, 2019, 1-12.

10. **Mao, S., & Cheng, S.** (2018). "Smart Healthcare Monitoring System with IoT Integration: A Case Study in the Elderly Care System." *Wireless Personal Communications, 100*(4), 1715-1729.
11. **Patel, V., et al.** (2017). "Smart Healthcare Monitoring System using IoT." International Journal of Computer Science and Information Security, *15*(12), 34-39.