International Journal of Engineering Research and Advanced Technology (IJERAT)

DOI: 10.31695/IJERAT.2023.9.2.1

E-ISSN : 2454-6135

Volume.9, No. 2
February - 2023

Study of Infant Health Care using IoT Devices: Future Scope and Challenges

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ABSTRACT

The IoT is quickly emerging as the most revolutionary exciting technology available today. It is a computer procedure in which sensors are used to create or support communication. IoT has become particularly effective in the healthcare sector in recent years, helping to raise the standard of patient care. Giving every member health help is crucial because health problems are becoming more prevalent. Due to their hectic lives, people today often neglect to take care of their health. Some individuals don't even care for their health. The patient's digital identification has been maintained by the healthcare system, which only recently began to communicate with IoT devices. Because mobile apps have increased doctor-patient communication, IoT in healthcare has been increasingly effective in recent years. Companies create these apps so that doctors can keep tabs on their patients' health. If any problems emerge, the doctor approaches the patient and provides the necessary treatment. Parents' top worry is that their children will pass away at any moment; hence this thesis lays a specific emphasis on neonatal healthcare. Therefore, the traditional approaches to baby care are first explored in this thesis. The patient's health can then be monitored using an experimental setup that is then designed and put into action. A commercial product that continuously monitors a baby's heartbeat, oxygen levels and sleeping position has been found during this evaluation. If the infant has any issues, the information will get to the smartphone application, which was developed by a company and sold. The recorded data is then examined by conducting a sample field test on a baby. The mobile device receives data after analysis, and with help of a base station, processes it.

Keyword: Health care, Internet of Things **(**IoT), Smart home.

1. INTRODUCTION

The term "Internet of Things (IoT)" has recently acquired prominence in communication technologies. It has undergone extensive development and is referred to as the next frontier. IoT is predicted to alter a variety of aspects of our lives and the world. In the future years, it is projected that number of IoT devices would dramatically rise. Currently, there are more than 12 billion Internet-connected gadgets, but by 2020, it's predicted that there will be 26 times as many linked items as there are humans [1]. Everything around us may now connect to the internet and communicate with other things, including cars, vending machines, and other home appliances. The word "IoT" refers to goods or products that can interact with Internet using hardware components, sensors and network connectivity, as seen in (Figure 1) [2].

Figure 1: Numerous physical goods and devices are linked by the Internet of Things [2].

IoT creates intelligent products that will eventually act as the foundation for the creation in cyber physical intelligent universal structures. It is intended for the billions of physical things and objects that will be equipped plus different types of sensors and actuators and connected to internet via various access networks using different technologies, such as wireless sensor networks (WSN), radio frequency identification (RFID), and real-time and semantic web services. IoT enables seamless communication between various sorts of devices, including medical sensors, surveillance cameras and home appliances [3]. Keeping all of these factors in mind, there are a number of IoT applications that have been created, in which every physical object is connected to the Internet using sensor devices [3]. Sensors built into participating devices facilitate collaboration. The detection of signals requires of use sensors. Sensors are utilized in a wide variety of current applications, such as smart devices, automotive systems, climate monitoring, industrial control, and healthcare. IoT has recently improved its productivity in the field of healthcare systems. In the healthcare sector, IoT especially uses sensors, microcontrollers to analyze and communicate sensor data to cloud and ultimately to caregivers (doctors). The care provided to both children and elderly patients is improved by integrating IoT elements into medical equipment. IoT in healthcare might monitor the digital data in thousands patients and provide them access their information whenever they want. It is now possible for patients and carries more portable health sensing devices for monitoring. Since the patient's health monitoring gadget is connected to it, the doctor can always see how the patient is doing. The patient's health status may be determined at the appropriate moment so that appropriate action can be done thanks to IoT assisted patients being accessible over the Internet. The majority of underdeveloped nations have relatively subpar healthcare systems. If the health sensing device is made to work with portable devices like smart phones and tablets then cloud communication is theoretically possible. These portable communication gadgets, which are increasingly affordable, are accessible to anyone [4]. Patient treatment is now more dependable thanks to the healthcare sector. The doctors and caretakers can keep an eye on the patients' real-time data by using handheld computers, which are analyzed and recorded.

1.1 IoT in smart home system:

Internet of Things (IoT) is a massive and open network in intelligent devices with the capacity to self-organize, share information and resources in addition react and act in reaction to circumstances and alterations in the environment [5]. IoT has become a popular topic in scientific, commercial, and social circles because its concept has the potential to change how we live and how we work. The fundamental idea is to link any equipment with an on/off switch to Internet. Phones, fridges, lamps, washers, coffee makers, alarm clocks, and internet-connected sensors are a few examples of devices that could act as a channel of communication between people and themselves. People and things are all connected through a massive network known as Internet of Things [6]. Globally, the development of smart home system working with IoT there has accelerating in order to bring comfort, intelligence, safety, and an improvement in quality of life [7]. Currently, Smart shoes, smart TVs, smart washing machines, and other home gadgets all often used [8]. However, it is still a relatively new idea to use these items through a software interaction that unites various devices or through a solution that does so. The following are the primary features of a smart home [9]: Alert, Monitor, Control and Intelligence.

The smart home system's ability to sense its surroundings allows Alert to alert the user. The user could receive this alert function by email, tweets, messages, or other social media on a regular basis at a set time. A smart home's monitoring feature is crucial since it maintains track of household activities. For instance, monitoring might be carried out using a variety of sensors, which could then provide alerts for purposes like turning on air conditioning when temperature rises above a preset level. A smart home's ability to control the house by enabling users to do things like open and close windows, lock and unlock doors, and turn on and off lights is another feature. Using a mobile app, for example, controls allow users to easily and conveniently operate a variety of devices. The ability to reason is related to making choices on a variety of occurrences' likelihood automatically. As a result, it makes use of a system-integrated artificial intelligence method. For instance, it enables the coffee machine to prepare coffee automatically when visitors arrive, or the fridge might order food automatically when there is a scarcity of it. With help of Internet of Things (IoT), users of smart homes may automate, monitor, and manage household appliances at any time and from any location using any type of Internet connection [10]. IoT could be used to create a smart house that offers increased security, comfort, and energy savings [11]. The IoT smart home is valuable because it might provide homeowners with a comfortable environment and possibly result in cost and energy savings. Additionally, it might offer a potent way to assist those who require particular assistance, such as the elderly and those with impairments, in monitoring and regulating household equipment [5]. The home environment is monitored and managed using a low-cost wireless smart home system that is presented in this study. Future users of the system, including those with impairments and pet owners, should find it friendly and simple to use. Consequently, our IoT smart house has the following attributes:

- Use of sensors for efficient temperature and humidity monitoring.
- High security with RFID use.
- Pulse sensor-based health monitoring.

DOI : 10.31695/IJERAT.2023.9.2.1

- The use of smoke sensors for home life safety.
- Monitoring elderly, disabled, and pets with a robot automobile.

1.2 Baby and infant IoT applications

Nothing is more crucial for parents than ensuring their child's happiness and health. Babies are unable to communicate their needs, such as being hungry or feeling hot, cold, or drowsy. IoT wear ables can now make a significant effect. In order to assist parents, IoT has recently been developed for newborns and infants. Parents may remotely check on their child's health thanks to the many Internet of Things wearable, devices, and smart sensors that can continuously monitor the baby's or infant's vital signs and send that data directly of mobile device (for instance, via Bluetooth technology) [2]. A newborn monitor can continuously capture data and deliver authentic updates on the infants.

1.3 Existing methods of smart home automation systems

1.3.1 Bluetooth-based solution for home automation

Systems for automating the home that use Bluetooth, an Arduous board, and a smartphone are safe and affordable. A suggested Bluetooth-based home automation system by [12]. A computer or smartphone serves as the receiver device in the Bluetooth system. It can be used as a real-time system because of its fast transmission rate, excellent security, and inexpensive cost. One of the biggest drawbacks of home automation by Bluetooth-based systems is their limited range of 10 meters, which prevents smartphones from controlling appliances if they are outside of range.

1.3.2 Home automation based on voice recognition

Studies conducted by [13], that conceived and implemented a home automation system based on voice recognition. Bluetooth technology is used for the wireless communication between the smartphone and the Arduino UNO. This will be more useful for elderly and disabled persons who want to use voice commands to operate appliances. This system's fundamental flaw is that it depends on signal to noise ratio (SNR) for communication between user and the voice recognition tool; if the voice signal is noisy, this can have a significant impact on communication and cause the system to perform inaccurately.

1.3.3 Wireless home automation system based on Zig-Bee

The researcher [14] studied a Zig-Bee-based wireless home automation system. Zig-Bee is a Bluetooth-like technology. With a modest data rate and power, it is one of the widely used transceiver standards. Its physical range is 10 to 20 meters, however using direct sequence spread spectrum, that range can be increased to 150 meters (DSSS). The perfect for creating prototypes and other research-related tasks.

1.3.4 Home automation system based on GSM

Utilizing the Global System for Mobile communication (GSM), a smart home automation system [15]. Text messages are used GSM-based home automation systems to communicate with appliances. The primary flaw in GSM-based home automation systems is that no assurance that text messages will always be delivered to the system, making them unreliable.

1.4 Healthcare and IoT

IoT allows for the transformation of medical data into insights that improve patient for care. The focus of contemporary healthcare is on connecting diverse components and is more technologically sophisticated. IoT is absolutely essential to the healthcare sector. All of the patient's data can be kept in cloud using tools like wearable sensors and other linked devices, making it easy for the doctor or caregiver to monitor it in real time. By gathering information from bedside devices, viewing patient information, and diagnosing the complete patient care system in real-time, IoT can assist applications in the healthcare sector that could potentially save lives (Figure 2). There is a problem with the widespread operation of healthcare equipment nowadays since it can result in data loss and incorrect diagnosis. This will be avoided by storing the acquired data on the cloud.

DOI : 10.31695/IJERAT.2023.9.2.1

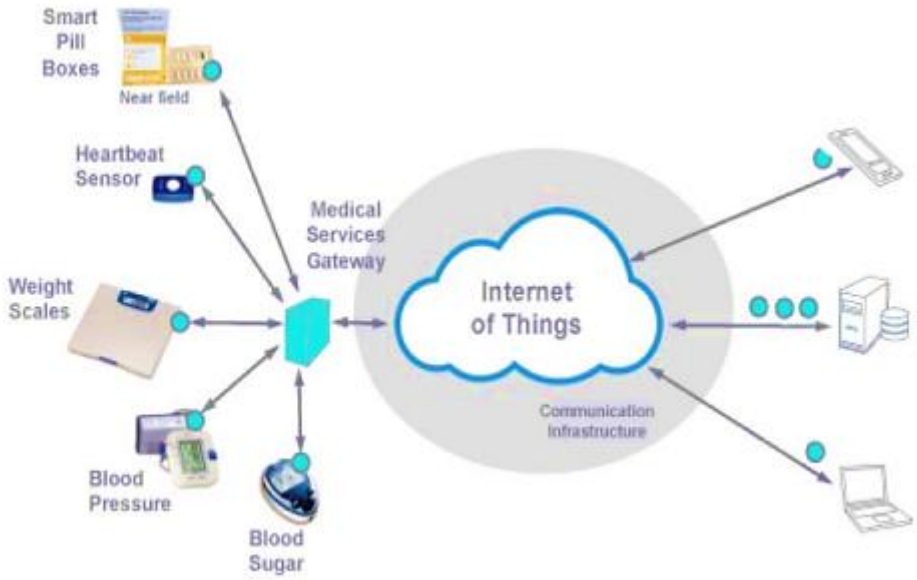

Figure 2: IoT in healthcare in general [2].

The doctors or caretakers may simply control the patient's health while also preserving valuable time each day. The doctor, caregiver, or specialist can track the medical resources and make a remote diagnosis without physically seeing each patient. The appropriate hospital department can be found while retrieving sensual information using the sensors and Wi-Fi [16]. A sensor powered by the Internet of Things is used to continuously monitor the patient. The patient needs close attention because their physiological status is being monitored noninvasively. The sensor that gathers the patient's physiological data for analysis using gateways keeps track of the patient's status. The data gathered will be kept on the cloud [16]. As seen in Figure 3, this data is subsequently wirelessly transmitted to the doctors and caretakers for additional analysis. As a result, the patient will pay less while receiving higher-quality care.

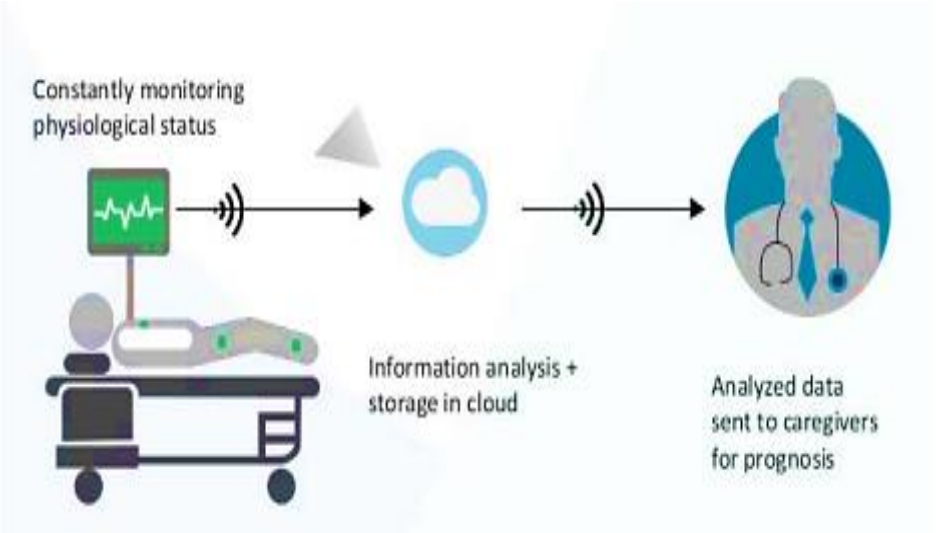

Figure 3: Technology for clinical care that continuously checks physiological status [2].

2. HEALTHCARE IOT USE CASES

2.1 Remote Patient Monitoring (RPM):

The sort in remote telehealth service called remote patient monitoring (RPM) makes use of medical equipment to monitor and treat patients from a distance. Therefore, this system monitors patient's vital signs in real time and reacts with there a health issue. As seen in (Figure 4), a device is attached to the patient, and it communicates information about the patient's vital signs from that location. A hospital and the transmitter are linked via a communication network [16]. Additionally, since the wireless network can accomplish both, RPM services lessen the need for patients to travel in order to detect ailments or receive checkups [17]. By

DOI : 10.31695/IJERAT.2023.9.2.1

connecting the sensors through the wireless network, a wireless sensor network (WSN), a type of Internet of Things (IoT) system that uses sensors designed to collect data [18].

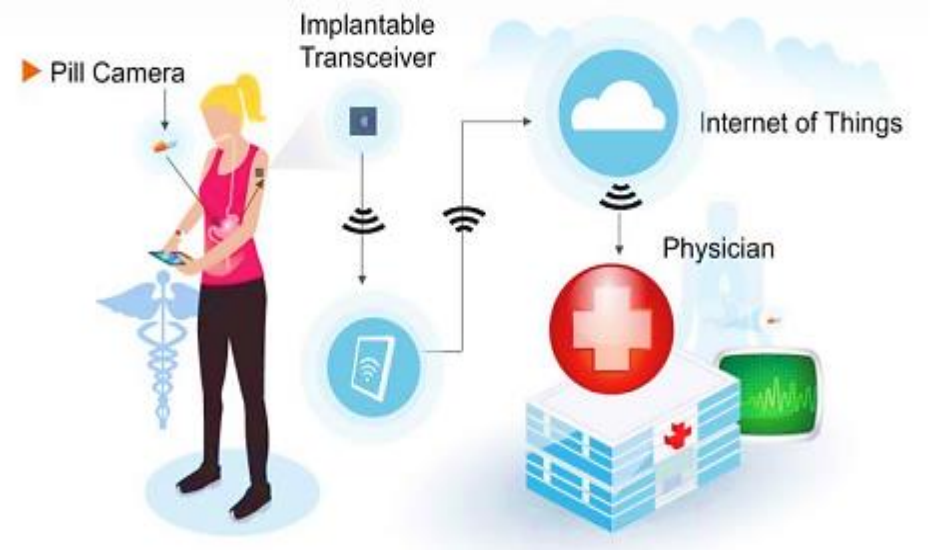

Figure 4: Remote health monitoring system [16].

In doing so, it develops a sensor network for a wide range of unprocessed data. Using the data gathered from its wireless sensors, healthcare services use architecture to develop an RPM service. Service quality of the RPM is enhanced by this strategy. Faster data transmission speeds are produced through the network's utilization of simple sensors. The service enables true date sensing with monitoring as a result. The suggestion made by the use of better-optimized sensors to enable less energy usage and longer operation times [19]. RPM services can use less energy and resources by employing sensors that are straighter forward and application-specific. Their research demonstrates the benefits of collecting and delivering real-time data using compressed sensor. Due to its effective construction and low processing requirements, the envisioned RPM service has longer battery life as a result of this design. Another illustration of a suggest framework with an RPM system that makes use of WSNs [20]. They use LoRaWAN to build a community-based WSN to expand the RPM service's reach. They can use it to do medical examinations for ailments, particularly urinary tract infections (UTI). The ability to observe patients from a distance already helps RPMs. They nevertheless develop a service that can serve their entire town thanks to LoRaWAN's extensive area coverage and the WSN's ease of use. This concept demonstrates how scalability in IoT for healthcare helps users and enhances the networks over all reach.

2.2 **Smart Hospital**

In smart hospital, medical devices link over the wireless network to expand with improve their assistance. This is an example of an IoT use case in the healthcare industry. This establishes an ecosystem where these devices can perform health related tasks and operations under a healthcare server. IoT-enabled services offered by smart hospitals can increase their efficiency and cut down on healthcare costs [21]. Since the system may automate tasks of monitoring treating patients become more self-sustaining with this architecture. Using smart hospitals is one suggestion for lowering the risks of the COVID-19 epidemic [22]. They recommend utilizing smart technologies to lessen the risk of direct communication and physical contact. These gadgets can be used by a system with wireless capabilities in place of physically monitoring their patients. The ability to automate the monitoring procedure in medical treatment is advantageous for these services as well. A discussion of how to use smart hospitals to enhance the caliber of care provided to and for the elderly [23]. The majority of hospital patients are elderly people with mobility issues, which make getting about more difficult. To bring the treatment to the patient, they advocate the employment of smart technologies. By using it, a patient's location is added to the virtual hospital, enabling the clinic to provide the user with appropriate care. Medical facilities may customize each treatment to address specific diseases and conditions thanks to smart computing and automation.

2.3 **Mobile Health**:

A healthcare IoT use case called "mobile e-health" puts more of an emphasis on the wireless technology connecting mobile devices for medical services [24]. Its architecture includes fixed transceivers known as cell towers as stationary gateways. Each tower is sizable antenna that installed overland in a planned manner to increase network coverage. This technology is used by the healthcare industry to provide long-distance service. a mobile computing-based health monitoring system [25]. In order to connect with patients to their healthcare services, it makes use of the extensive geographic coverage offered by mobile networks. Medical

DOI : 10.31695/IJERAT.2023.9.2.1

services can monitor communicate with their patients via mobile health. In regions that only cellular networks can access, it is useful. As a result, particularly in times of emergency, medical centers can reach their patients. Its design also includes wireless sensors in addition to its network of mobile gadgets. As a result, its design emphasizes how each IoT use case's component elements may be switched out. These systems are flexible designs without any inflexible restrictions. With the use of this design, the medical industry may put new ideas together to raise the standard of healthcare. Another uses a mobile network powered by 5G to boost its remote healthcare services [24]. The mobile network and smart gadgets are combined in this architecture. It blends mobile e-distance health's coverage and a smart hospital's automation features. Additionally, it emphasizes how the Internet of Things (IoT) can be used to extend remote healthcare and services.

3. IOT APPLICATIONS IN HEALTHCARE

3.1 Blood Pressure Monitoring

One of the most significant physiological factors affecting a person is their blood pressure and monitors that secure and easy use has become widespread [26]. As the healthcare system has developed, IoT devices and sensors have been integrated into the equipment and systems to provide easier communication between patients and medical professionals. An internet of things (IoT) sensor that captures real-time data on patient blood pressure levels is connected to an electronic blood pressure monitor.

3.2 Rehabilitation System:

In order to mitigate issues associated with aging populations and a lack of medical professionals, a rehabilitation system can improve with restore the functional capacities of those who have certain disabilities and their quality of life [26]. An efficient treatment is offered via a community-based smart rehabilitation system. An ontology-based automation designing technique coupled with an Internet of Things (IoT)-based smart rehabilitation system can provide in convenient suitable interaction with resource allocation for medical care of accordance with patient needs [27].

3.3 Oxygen Saturation Monitoring:

The pulse oximeter is a tool that continually and painlessly measures the patient's blood oxygen [26]. Medical sensors are very popular today thanks to wireless networks' numerous advancements in communication technology, which means low power consumption and minimal loss. In many medical settings, continuous monitoring pulse oximeters are utilized to measure both the heartbeat and the blood oxygen saturation levels (HR). The patient's heart rate and oxygen levels monitored and sensed by IoT sensor, which can restrict the patient's activity [28].

3.4 Wheelchair Administration:

People who have physical limitations or illnesses that prevent them from walking typically use wheelchairs. Wheelchair users can employ wireless body area networks (WBANs), which link smart devices with the Internet, as a people-centric sensing (sensor) device. When a person is getting out of a wheelchair, a pressure cushion (a resistive pressure sensor) will be able to detect it. A second accelerator sensor on a smart wheelchair senses the wheelchair dropping [29]. Data about the patient can be continuously monitored by the doctor or caregiver from the hospital.

4. IOT BENEFITS FOR HEALTHCARE

IoT's benefits for healthcare systems The main advantages or benefits of IoT technology in healthcare systems that influence its adoption are as follows:

1. Cost saved: The expense of in-person visits can be reduced by meeting and evaluating patients remotely [30]. Furthermore, many patients can now be hospitalized and monitored at home because to the development of home care equipment.

2. Opportunity to treat: The data is stored in cloud and regularly given to the doctor because monitoring is constant, continuous, and automated; the treatment procedures were followed exactly. Adopting this tactic can make sure that medical attention is given as soon as feasible monitor the healing process [31].

3. Disease management: The consistently recording and reporting of person's health indicators, diseases can be discovered and treated before they progress [32].

4. Failure reduction: By collecting accurate, exact data automatically and without human error, it is possible to drastically lower the frequency of medical errors and the consequentially high expenses that go along with them [33].

DOI : 10.31695/IJERAT.2023.9.2.1

5. Patient satisfaction: is influenced by a number of aspects, including the focus on the patient's needs, data accuracy, prompt treatment, cost savings, fewer repeat visits, documentation of the recovery process, and, most significantly, the patient's active involvement in the healing process [34].

6. Medication management: IoT helps people use medications correctly, and it also helps pharmacies and healthcare institutions avoid wasting medications [35].

5. HEALTH CARE IOT DISADVANTAGES

- Because there presently no standard for monitoring with the sensors, there is a compatibility issue for the IoT in healthcare.
- The major concern with IoT in healthcare is privacy and security; all patient and doctor data must be secured.
- Personal data may be misused if the software is compromised by other users. In the IoT, there are countless options.

6 CONCLUSION

The Internet of Things concept might be used in our homes in the future. In this study, the systems that might be used in this future home provided along with a model of how they would be put into practice. Our home automation system that leverages IoT has successfully proved that it works as intended by installing simple and affordable devices that can be operated remotely over the Internet. This low-cost technology may be accessible remotely to enhance the lives of elderly, people with disabilities, and pet owners. With this framework, the system might be improved to include home security features, such recording a person's face as they move about house and uploading data to the cloud. In hospitals and assisted living facilities, for example, this kind of technology might be used to monitor people with disabilities more closely and boost their sense of security and freedom. Additionally, there are a lot of advantages of incorporating IoT devices and assistive technologies into healthcare services, but there are also some challenges. The issues with patient privacy, data flow, service intractability, device restrictions, and scalability are covered in this article. It was required to look into comparable frameworks and implementations in order to discover solutions for these issues. IoT devices, in general, open doorway to participative, secure, and effective system when used properly. Due to the capabilities of medical technology, there are more opportunities for study and development of healthcare services.

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