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Intelligent Neonatal Monitoring System Based On Android Application Using Multi Sensors

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ABSTRACT

The purpose of the project is to develop an Intelligent Neonatal Monitoring System based on temperature and pulse rate data. In the Neonatal Intensive Care Unit (NICU), there are premature babies and other ill babies who need extra care from the doctors, nurses as well as medical supplies. Therefore, an intelligent neonatal monitoring system should be a good solution in order to help them to observe neonates frequently and consistently. This system transmits the vital signs of the neonate such as body temperature and pulse rate to the Internet of Things (IoT) called Blynk. This develops system will providing efficiency and reliability which will play a vital role for better care. The body temperature and heart rate are important parameters to monitor the neonatal situation. Neonatal need to be monitored closely in Neonatal Intensive Care Unit (NICU) to allow quick actions by physicians when any problems occur. The lack of systems that able to alert and indicates any warning condition of neonatal in NICU is one of the problems faced by most of the hospital. To reduce the complexity of the system at the NICU for monitoring the Neonatal condition from time to time, the health monitoring system using the Android app has been introduced. This system was introduced to improve the existing system to give alert and warning sign so that early precautions can be done. The project involves the LM35 temperature sensor and pulse sensor which is controlled by the nodeMCU microcontroller with the help of instructions C / C ++, and Wi-Fi networking system. This allows the user to monitor the baby's condition through applications that use blynk networking system. Users must have the application that can be downloaded on Google Play. Furthermore, this system is not only applicable for the physicians but also for others to monitor the condition of Neonatal even though they are outside of the NICU.

INTRODUCTION

Each Neonatal Intensive Care Unit (NICU) has their own equipment for controlling neonatal health which is helpful in monitoring the neonatal health conditions. One of the neonatal health controller equipment is the incubator where newborn baby will be placed and the temperature in the incubator will be adjusted according to the mother's body temperature around 36.5°C - 37.0°C. Incubators are usually equipped with temperature sensors and humidity sensors. The new baby incubator design has LCD monitors to display digital values such as body temperature values. This allows the nurse to observe the data from the LCD monitor without having to check the neonatal body temperature manually. However, relying only on the temperature monitoring system is inadequate to indicate the neonatal health condition as the body temperature able to change rapidly.

Other signs like heart rate are also an important parameter for monitoring neonatal conditions. The rate of heartbeat obtained will be used as a reference for nurses and doctors to identify the normal condition of the baby. According to Apgar score,

the normal heart rate for neonatal between 80-120 per minute.

It is recommended based on previous study that neonatal heart rate is one of the best ways to monitor neonatal condition. It should be monitored continuously to avoid any serious conditions. Other than that, wireless system has been widely used in healthcare as it promotes convenience to the users in monitoring their health. Therefore, the aim of this project to incorporate multiple sensory functions in a very small piece of garment, without making it uncomfortable for the infant.

IOT: The Internet of Things (IoT) refers to the network of interconnected devices that communicate and exchange data over the internet. These devices can range from everyday household items like smart thermostats and refrigerators to industrial machines and sensors.

The developed sensory baby garment includes fully integrated sensors for the parameters respiration, heart rate, temperature and humidity, e.g. by sweating, for the continuous monitoring of infants. It will allow early alert for potential life-threatening events as well as the recognition of the development or progression of diseases at an early stage. In this work, LM35 is placed in a baby's socks wrapped with cotton so that no irritation will occur. The pulse rate will be measured in the fingers by using optical sensors and displayed on the LCD.The transmitter sensor pair will

be clipped to one of the subject's fingers. The moisture detection sensor is used for baby's urine detection. Moisture will be identified by installing two copper electrodes that will be placed under the cloth where the baby is sleeping.It is placed in a baby's socks causing proper movement to be detected. With the help of a face-to-face GSM module, the system can send short message texts to specific parties required according to user's convenience. Figure 1 below shows the reading of neonatal temperatures, urine detection and pulse rate.

LITERATURE SURVEY

The paper by Punit Gupta, Deepika Agarwal, Jasmeet Chhabra, Pulkit Kumar Dhir Jaype focus on using the collection, integration and various other features of the IoT to enhance the health monitoring system for emergency medical services, example ICU. INTEL

GALILEO 2nd generation development board is used to implement this concept. The main motive behind the development of this concept is to reduce the number of visits the patient have to make to doctor for minor reasons such as checking heart beat rate, blood pressure etc. this will help the doctors to spend more time on serious patients or those who are in emergency. The system will collect the above-mentioned details and will alert the doctor with patient's details and other medical information. A web application was developed for viewing the various details by doctor. Internet of Things Ne work Management System Architecture for Smart Healthcare Farag Sallabi, Khaled Shuaib. The main focus of this paper is in developing system architecture for "Smart Healthcare".

The TMN model is used in this paper for defining various components such as smart healthcare network management, the TMN functional management areas, fault, configuration, accounting, performance and security (FCAPS), and ITIL v3. These components were combined to form the proposed system architecture. Even though the concept mentioned in this paper is ongoing research work they have concentrated on not only patient and doctor but also on the management process. Sensing, actuation and control are main functions used for describing and analysing the situation and also for making decisions either in predictive or adaptive

manner based on the data. The paper on Internet of Things Based Free Parking Space Management System by S. M. Farhad, Irfan Alahi, Md. Mubassher Islam displays a conclusion to-end parking spot administration framework utilizing remote sensor systems. The stopping space is furnished with remote sensor bits having four sensors to recognize vehicle nearness in a parking spot. The nearness and nonattendance status of each parking spot is put away in a worldwide database. The framework is utilizing late sensor bits and open-source working frameworks and conventions to help IoT engineering.

This paper proposed calculations to distinguish vehicle nearness and the framework is tentatively fruitful for 98% vehicles. It is obvious that such a framework utilizing wired framework options would be profoundly costly in contrast with the proposed framework. An Autonomous Wireless Body Area Network Implementation Towards IoT Connected Healthcare Applications by Taiyang Wu, Fan Wu, Jean-Michel Redoute, Mehmet Rasit Yuce is to implement an autonomous WBAN, a wearable sensor node. This wearable sensor hub with solar vitality gathering and Bluetooth low vitality transmission that empowers the usage of a self-ruling WBAN. Various sensor hubs can be sent on various places of the body to quantify the subject's body temperature dissemination, pulse, and identify falls. An online cell phone application is likewise produced for showing the sensor information and fall notification. Results demonstrate that the wearable sensor hub functions admirably when controlled by the sun powered vitality reaper.

The proposed framework with sun-based vitality collecting shows that long term therapeutic checking in light of WBAN is conceivable given that the subject remains outside for a brief timeframe in a day. Various techniques for neonatal monitoring have been studied by various researchers. Wireless sensor systems for neonatal monitoring system are also proposed by Chen, Wei, et al. Chen, Hongyu, et al. proposed a wearable sensor system for neonatal seizure monitoring. Yeh, Kuo-Hui proposed a secure IoT based health care system.

The IIoT is an innovative technology, directly interconnecting a set of sensors and devices (such as smartphones) to collect, record, transmit, and share data for possible analysis. The IoT has a wide range of emerging applications. Among them, the most revolutionary potential application is healthcare monitoring, where patient healthcare data are collected from a number of sensors, analyzed, delivered through a network and shared with healthcare professionals for evaluation of patient care. A more comprehensive survey of IoT for healthcare applications can be found in. IoT-enabled healthcare applications, including IoT-driven ECG monitoring, are discussed in the following studies. Li et al. presents a health monitoring service as a platform for ECG monitoring using adaptive learning analysis model to detect abnormalities. Mohammed et al. developed a remote patient monitoring system using web services and cloud computing. In particular, they designed an Android application for ECG data monitoring and analysis. Data can be further

analyzed by third-party software if needed; however, there is no option for the cloud server to extract features and classify the signal to assist the health professional at the time the signal is received. In our proposed framework, the cloud server extracts feature and classifies the signal, so that a preliminary analysis decision from the cloud can be sent to the healthcare professionals to facilitate good patient care.

Hassanalieragh et al. discussed the opportunities and challenges of health monitoring and management using IoT. Some challenges include slow processing, handling big data, presence of too

much heterogeneous data, and data integrity. In our proposed framework, the ECG signal is watermarked on the client side before transmitting through the Internet to authenticate against any attacks. Data processing is also distributed between the client side and the cloud side to make the overall processing faster. Jara et al. present a remote monitoring framework using IoT by proposing a protocol, called YOAPY, to create a secure and scalable fusion of multi-modal sensors to record vital signs. A cloud-based speech and face recognition framework was developed to monitor a patient's state remotely.

Xu et al. developed a ubiquitous data accessing method in an IoT-based system for emergency medical scenarios. They proposed a semantic data model to store data, and a resource-based data access method to gain control of the data ubiquitously, concluding that their method could be significant to assist decision-making in emergency medical situations. Zhang et al. introduced an architecture of mobile healthcare networks, incorporating privacy-preserving data collection and secure transmission. The privacy-preserving data collection was achieved using cryptography with secret keys and private keys. Secure transmission was gained using attribute-based encryption, where only authorized users would have access to the data. These methods are generally worthwhile; however, the main problem is computation complexity.

Granados et al. proposed web-enabled gateways for IoT-based eHealth with an option for wired or wireless services. To take advantage of wired gateways in terms of power-efficiency and low cost, the authors used the wired gateways in a small room or building, where movement is restricted. Radio frequency identification (RFID)-based eHealthcare systems were proposed in. In the authors proposed a system that would capture the patient's environmental conditions, such as temperature and humidity, by RFID, and transmit them to the cloud for a more detailed understanding of ambient conditions.

Catarinucci et al. proposed an IoT-aware architecture to monitor and assess a patient's situationautomatically by integrating ultra-high-frequency RFID functionality. Sawand et al. identified three types of threats in an eHealthcare monitoring system. These are identity threat, where the identity of the patient is lost or stolen, access threat, where an intruder can access the system illegally, and disclosure threat, where confidential medical data are opened via malware or file sharing tools intentionally or unintentionally.

They offered some solutions to these threats, including biometric cryptography and an advanced signal processing scheme; however, the authors did not implement these solutions in their paper. In, emotion-aware or affective mobile computing frameworks have been proposed, and the authors investigated an architecture named "emotion-aware mobile cloud" (EMC) for mobile computing. Authors in proposed another framework, affective interaction through wearable computing and cloud technology (AIWAC).

Recently, Hu et al. introduced the Healthcare Internet of Things (Health-IoT), attempting a bridge between intelligent health monitoring and emotional care of the patient. To date, we have found no comprehensive study on cloud-assisted IIoT-driven ECG monitoring, where (i) the ECG signal is watermarked on the client side before transmission through the Internet to the cloud, and (ii) the cloud server extracts feature and classifies the signal to assist healthcare professionals in providing quality patient care

Health IIoT has ability to boost today's healthcare industry with cheap and good care by a large number of interconnected machines, devices and sensors,

and collect patient data. This HealthIIoT technology will play an important role in a number of health monitoring applications, to form a Healthcare Industrial IoT ecosystem. Fig. 1 describes a IIoTdriven healthcare system. As shown in one stakeholder is connected to another type of one type of stack holder is connected to other stakeholder to form a difficult HealthIIoT ecosystem. It also releases emergency services to the patient when required, and orders pharmacy. In the system, interconnected 'Things' are coordinated. It gives fast transfer of patient information with the stakeholders, so that patient data are available only to authorized healthcare. Finally, server based analytic enables analyzing, storing, closely monitoring, and securely sharing the data further review and advice, aimed towards fulfilling services of Industrial IoT in regard to patient care, real time patient monitoring, and avoiding hospital error. It creates a platform for interconnected devices to work with large data from anywhere. The data are actually generated by interconnected smart devices, communication software, and their usage in healthcare monitoring.

Data are collected and analyzed from health records, sensors, devices, and smartphones. This analysis attaches the decision-making power of doctors, and enables patients have a role in managing their health. Outlines how the flow of a patient's healthcare data is captured. how it is transferred through a connection to the server data for further analysis such as feature extraction, classification, verification, workload measurement. After being processed and securely stored in the server, the data is either used by doctor, or given to external systems for further industry specific healthcare IoT solutions.

The major components of the framework are given below. Healthcare staff and other related user:

Patients will upload their ECG reading with the help of ECG reading device, the device is connected with the internet and the reading will be stored in server, and from the server the health care professional will fetch the data and advice the patient according to the reading ECG signal capturing and recording service: this service is used for reading the records and storing the records from different devices and Smartphone. Secure transmission service: allows secure and protective transmission of ECG signals through the internet. We use watermarking for encryption and later it is extracted to verify the authenticity. Resource allocation manager: it will manage the resources and web services. Server system manager: it manages all machines and allocates resources through resource allocation manager, for example ECG monitoring manager, and watermarking manager.

3-SOFTWARE REQUIREMENTS

In this chapter we will discuss and software requirements for Intelligent Neonatal Monitoring System Based on Android Application using Multi Sensors.

Arduino Uno Installation:

In this we will get know of the process of installation of Arduino IDE and connecting Arduino uno to Arduino

IDE.

Step 1- First, we must have our Arduino board (we can choose our favorite board) and a USB cable. In case we use Adriana UNO, Arduino Duemilanove, Nano, Arduino Mega 2560, or Diecimila, we will need a standard USB cable (A plug to B plug), In case we use Arduino Nano, we will need an A to Mini-B cable.

Step 2 − Download Arduino IDE Software. We can get different versions of Arduino IDE from the

Download page on the Arduino Official website. We must select wer software, which is compatible with wer operating system (Windows, IOS, or Linux). After wear file download is complete, unzip the file.
Step 3 − Power up our board.
The Arduino Uno, Mega, Duemilanove and Arduino Nano automatically draw power from either, the USB connection to the computer or an external power supply. If we are using an Arduino Diecimila, we have to make sure that the board is configured to draw power from the USB connection. The power source is selected with a jumper, a small piece of plastic that fits onto two of the three pins between the USB and power jacks.
Check that it is on the two pins closest to the USB port.
Connect the Arduino board to wer computer using the USB cable. The green power LED (labeled PWR) should glow.

4-MULTISENSORS BASED NEONATAL MONITORING SYSTEM

In this chapter we will discuss about Existing/Proposed System, block diagram and methodology for intelligent Neonatal Monitoring System Based on Android Application using Multi Sensors.

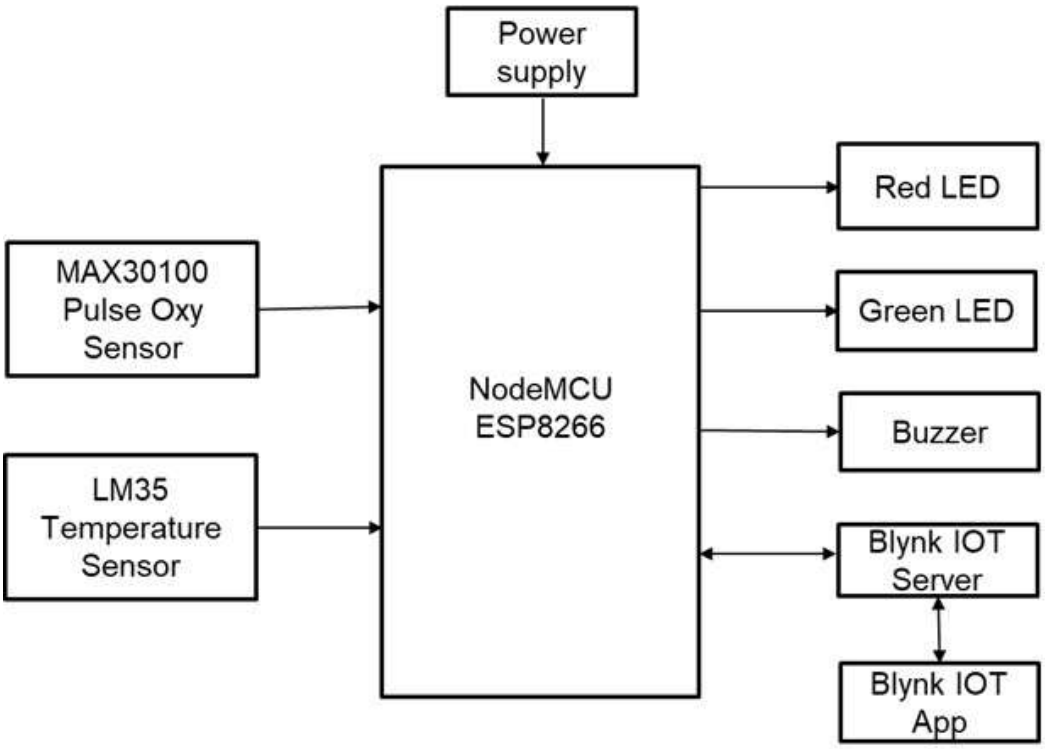
Existing System

Several existing neonatal monitoring systems have been developed to provide continuous, real-time monitoring of newborns, particularly those in neonatal intensive care units (NICUs) or at risk at home. One widely used system is Masimo's Rad-97 Pulse CO-Oximeter, which employs advanced pulse oximetry technology to monitor a baby's oxygen saturation and pulse rate. This system offers continuous, non-invasive monitoring and generates alarms when vital signs deviate from normal ranges, ensuring early detection of potential issues. Another notable system is the GE Healthcare Giraffe Incubator Carestation, which combines vital sign monitoring with environmental controls to create a stable incubator environment for premature infants. This system regulates temperature, humidity, and other factors while continuously monitoring heart rate, respiratory rate, and oxygen saturation, making it an essential tool in NICUs. Additionally, the Owlet Smart Sock is a popular consumer product that allows parents to monitor their baby's heart rate and oxygen levels using a wearable sock that connects to a mobile app, providing alerts in real time. Similarly, Angelcare AC327 employs a sensor pad placed under the mattress to detect movement and breathing, alerting caregivers if no movement is detected for a specified time. These systems, among others, illustrate the advancements in neonatal care technology, combining multiple sensor data with user-friendly interfaces to enhance monitoring and ensure the safety and health of vulnerable newborns.

Proposed System

The proposed neonatal monitoring system is designed to provide continuous real-time monitoring of newborns using an Android application connected to multiple sensors. The system integrates various sensors such as temperature, heart rate, oxygen saturation (SpO2), to track critical health parameters. These sensors communicate wirelessly with the Android app via Wi-Fi, allowing medical personnel and parents to monitor the baby's condition remotely. The app offers real-time data visualization, stores historical data for trend analysis, and triggers alerts when abnormal readings are detected. The system is also equipped with cloud integration for remote monitoring and long-term data storage. This solution enhances neonatal care by ensuring early detection of health issues, providing timely interventions, and offering a cost-effective, mobile-based monitoring solution.

BLOCK DIAGRAM



Methodology

1. **Heart Rate Sensor:** To measure the infant's pulse. Common sensors include PPG (Photoplethysmogram) or ECG (Electrocardiogram) sensor.

2. **Temperature Sensor:** To monitor body temperature and detect conditions like hypothermia or fever.

3. **Oxygen Saturation (SpO2) Sensor**: To measure blood oxygen levels, important for identifying respiratory distress or other oxygenation issues.

4. **Remote Monitoring**: The app can integrate with a cloud service, allowing medical professionals and family members to monitor the neonate remotely, even if they are not near the infant.

5-Advantages, Disadvantages and Applications

Advantages

1. **Real time Monitoring**: The system can monitor multiple vital signs such as heart rate, body temperature, and oxygen saturation continuously, ensuring immediate detection of abnormalities.

2. **Remote Accessibility**: Since the data is accessible through an Android application,

parents and healthcare providers can monitor the infant's health remotely, reducing the need for constant physical checkups.

3. **Automation and Alerts**: Automated alerts notify caregivers and healthcare providers of any critical changes in the baby's condition, allowing for quick interventions.

Disadvantages

Sensor Accuracy: Sensors, especially low-cost ones, may suffer from inaccuracies or calibration issues, leading to false positives or negatives in alert systems.

1. **Technical Failures**: The system relies on the proper functioning of multiple sensors and the Android app. technical failures such as battery drainage, connection issues, or software bugs can compromise monitoring.

2. **Dependence on Internet Connectivity**: I For remote monitoring and cloud-based data storage, the system depends on stable internet connectivity, which may not always be available.

Applications

1. Hospital-Based Neonatal Intensive Care Units (NICUs): Sensors integrated with IoT enable continuous tracking of vital signs like heart rate, respiration, oxygen levels, and body temperature in newborns admitted to NICUs.

2. Home Care for Newborns: Parents can use these systems for newborns with specific health conditions, reducing the need for frequent hospital visits.

3. Rural and Remote Healthcare: This system can be especially useful in rural areas where regular hospital monitoring is not accessible. The data can be remotely shared with healthcare professionals for regular assessments.

6-RESULTS

which the temperature detected by the sensor was more consistent. The pulse sensor was attached to neonate's sole to get the value to verify the accuracy of the sensor. The measured pulse rate of the neonate. This system can detect pulse rate range from 62-77 BPM and 169-177 BPM while the neonate was sleeping and awake, respectively which made the changes in the pulse rate influenced by the condition of the neonate. Awake state was happened because the neonate was having growth spurts during slept resulting in rapid increase of pulse rate. When the neonate having their growth spurts, they may having more or less sleep.

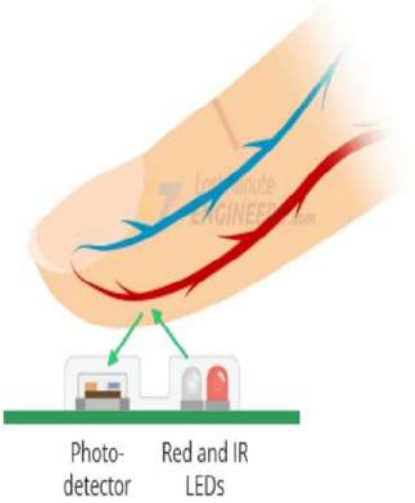


Figure5.1 Measurement of parameters

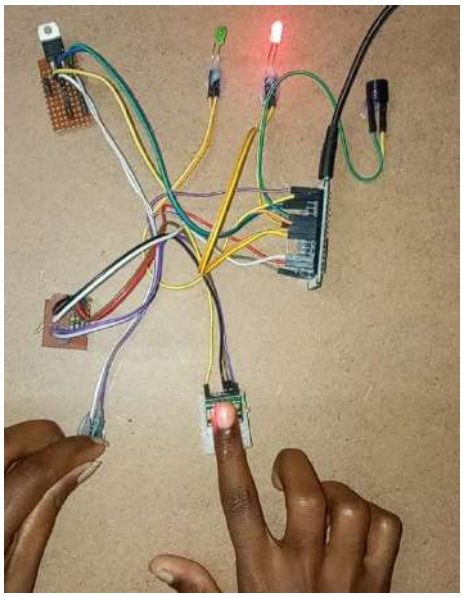


Figure5.2 LED outcome

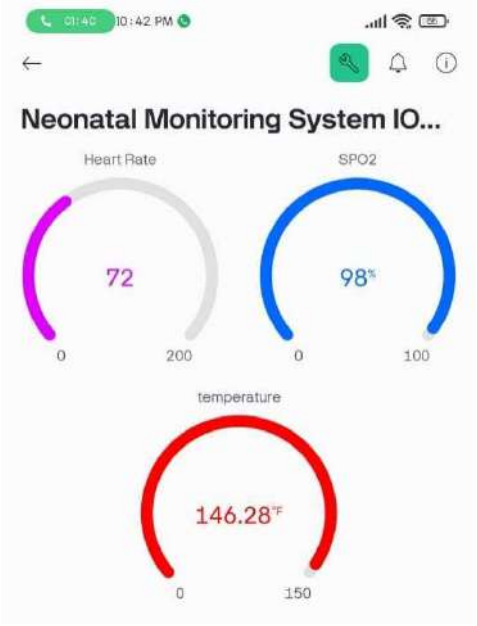


Figure5.3 Output of baby health

Figure5.4 Notification from blynk

The experiment of this project was performed on neonate. The results were obtained by using LM35 temperature sensor and pulse sensor, the LM35 temperature sensor was attached to the finger of the neonate while the pulse sensor was attached to the chest or finger to obtain the accurate data. The measured pulse rate, temperature and spo2 levels of the neonate is shown in Blynk app. By Blynk we get notification and emails when baby health is abnormal.

7-Conclusion

Main focus is on various features for monitoring neonates in NICU. Basically, the overall functionality is divided into three sub parts 1) To keep babies safe in the NICU cradle by monitoring them and sending their current situation to the end user or application 2) To monitor the temperature changes of baby by using temperature sensor and accordingly inform the guardian 3) Keeping the track of the pattern and if any disturbance witnessed then immediately informing the end user 4) Storing the data in the cloud for future reference. In the future, extending multifunctional NICU related applications can be created.

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