

Smart Infant Incubator Using IOT

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Abstract -Infants are particularly vulnerable to harsh conditions. The problems with temperature and dust might be fatal. These problems led to the creation of a newborn incubator that can mimic a mother's womb in terms of temperature and ambient circumstances while also keeping track of the infant's vital signs, including heart rate, skin temperature, internal temperature, and so on. The COVID-19 epidemic has made everyone's health a top priority. For physicians, being physically present with their patients has become a major challenge. Using IoT with medical equipment, like a baby incubator, has become one of our top priorities in these situations. It will be highly beneficial to have an app that allows you to remotely monitor the baby's condition.

Key Words: IOT Enabled incubators, Remote Monitoring App, Alert And Notification, Temperature, Data security, NetBeans, Android Studio

1.INTRODUCTION

The "portable smart incubator for babies" that we are developing will securely warm the newborns because their body fat is so low because of their premature delivery. The heating is precisely regulated. To assess the sensors and results and handle safety issues before developing a smaller version, our present prototype was made to suit one of the team members. Ergonomic textile electrodes track heart rate and breathing. A pulse oximeter that measures blood oxygen saturation in the earlobe would be built into the baby's hoodie. Use of blood oxygenation and respiration data to set off alarms can help identify hypoxemia and apnea early on. In many preterm situations, parents are under a great deal of worry; the wearable would also provide them peace of mind.

2. Methodology

The development of a smart baby incubator system integrates Arduino microcontrollers with sensors such as DHT11 for environment temperature and humidity, MLX90614 for infrared temperature sensing, and heart rate sensors. Wi-Fi connectivity through ESP32 facilitates data reading from sensors and transmission to a cloud server for storage and analysis.

A mobile application is designed to display real-time data including body temperature, heart rate, SpO2 levels, environment temperature, and humidity, providing caregivers with comprehensive monitoring capabilities. The system is equipped with an alarm feature that alerts users to abnormalities, ensuring timely interventions.

Rigorous testing and validation processes are implemented to ensure system reliability and accuracy. Ongoing maintenance and updates are conducted to optimize performance and address evolving user needs. This integrated approach enhances the safety and care provided to infants in incubator environments, combining advanced sensor technology with mobile connectivity for efficient monitoring and management.

3. Literature Survey

3.1 Controlling of Temperature and Humidity for an Infant Incubator Using Microcontroller

Hitu Bansal, Dr. Lini Mathew, Ashish Gupta.

2015

One of the most crucial, delicate, and delegated areas in the biomedical profession is the treatment of premature infants. For a preterm infant to adapt to the outside world, their surroundings must be precisely the same as those in the womb. In order to replicate the conditions seen in the womb, newborns must be housed in what is called an incubator. A baby incubator maintains consistent temperatures and relative humidity. It is necessary to keep the air at 35°C. The relative humidity should adhere to predetermined ranges based on the number of incubation days. The goal of this project is to create and put into place a closed loop control system that will allow a newborn incubator's temperature and humidity to be controlled.

Additionally, it is employed to keep an eye on and regulate the incubator's oxygen and light levels. To implement the hardware, a PID controller and microcontroller will be utilized. The incubator's steady temperature is maintained by the closed loop control system, which consists of a synchronously operating set of sensors and actuators.

3.2. Baby Incubator Monitoring System Using Global System for Mobile Technology

Suthagar S, Mageshkumar G, & K.S.Tamilsevana.

2022

Having a kid is one of life's most treasured experiences. A kid is born every second, yet not all of them are fortunate enough to be healthy. A vital medical concern is keeping an eye on the health of an infant in an incubator. To increase the safety of newborn newborns, several researchers are working in this field. Regarding the study that we conducted, there is a basic problem in determining whether or not the physician visited the emergency. In this study, a worldwide system for mobile technology (GSM)-based monitoring system for the newborn within the incubator is presented. Within the incubator, the suggested system measures the baby's temperature, heart rate, weight, and sound.

Should the aforementioned metrics alter above the threshold level, the relevant physician will receive notification via GSM. Until the doctor recognizes the baby's condition, the system will continue to transmit the alarm message to the physician every minute. By resolving the aforementioned problem, this device will improve infant safety and lower the danger associated with keeping an eye on the

newborns within the incubator. A functional verification test was conducted on a created prototype.

3.3 LOW COST PORTABLE BABY INCUBATOR

Neshwa Aysha KV

2020

The design, development, and modeling of neonatal incubators include incorporated temperature and humidity management systems. In our surroundings, temperature is a major factor. Temperature variations have an impact on the behaviour of plants, people, and even materials like semiconductors. The goal of this project is to regulate the humidity and temperature in a specific space, like a baby incubator. Incubators greatly increase survival rates by maintaining warmth and preventing heat loss. The accepted practice for giving the newborn baby at risk a consistent, customized thermal environment has been to employ air-heated incubators. Our project's goal is to create a cutting-edge, wirelessly operated, portable incubator. Stable conditions for temperature, relative humidity, and oxygen concentration are offered by an infant incubator.

Relative humidity should adhere to predetermined ranges based on the incubation day count. Our implemented system will send continuous measurement data to one or more Android phones, covering a wide range for temperature, humidity, and heart rate. In any dangerous situation, it might alert the parents. The Arduino board will command the heating pad to switch on until the temperature reaches the set point if the incubator's temperature drops below the specified point. In isolated settlements without access to typical neonatal incubators, the gadget may serve as the incubator system.

3.4 A Low Cost Baby Incubator Design Equipped with Vital Sign Parameters

Lamidi, Abd.Kholiq, Muslim Ali

2021

For premature babies, a baby incubator is a heating device that raises the baby's body temperature to that

of the mother's womb. Premature babies are those born under unusual circumstances, meaning that their gestational age has not yet reached nine months or that their physical size is smaller than ordinary. This project aimed to develop a low-cost, compact technology for an infant incubator. It can determine the premature baby's heart rate and oxygen saturation level in addition to regulating the temperature. The technology under development has the ability to identify congenital anomalies' early signs, making abnormality identification more feasible.

This system compares sensor data to a fixed point value using a threshold system to maintain temperature stability. In the meantime, the baby's finger sensor is used by the SpO₂ system to measure heart rate and oxygen saturation. A signal conditioning circuit made up of an astable circuit, filter and amplifier, LPF, and demultiplexer processes the signal received from the sensor. Testing and measurement findings show that this tool only produces a 0.13–0.182 °C difference.

The biggest error in the system is 0.517%. Measurement of skin temperature was carried out on 10 respondents with an average value of 34.825 °C. so that the difference generated from this tool is only 0.175 °C, the difference on the Humidity parameter is 0.21%. The average BPM reading of respondent 1 was 81 beats per minute and the The system's largest inaccuracy is 0.517%. Ten respondents had their skin temperatures taken, and the average result was 34.825 °C. The difference on the Humidity parameter is 0.21%, resulting in a difference generated by this technique of only 0.175 °C. Respondent 1's average SpO₂ was 97% and her average BPM was 81 beats per minute. Respondent 2's average SpO₂ was 98% and her average BPM was 83 beats per minute. As you can see, the Arduino control system module may function autonomously and modify the baby incubator's stability based on its settings.

Furthermore, the BPM and SpO₂ systems can be utilized for patient measurements because they are within tolerance.

3.5 Real-Time Monitoring and Control of Neonatal Incubator using IOT

Rasha M. Abd El-Aziz, Ahmed I. Taloba.

2021

The most significant and delicate area of the biomedical field is the treatment of newborns. Because of their birth weight or gestational age, certain newborns are more likely to die. The majority of premature babies that are delivered between 32 and 37 weeks of pregnancy die because their requirement for warmth is not met. The neonatal incubator is a tool that provides a regulated, enclosed environment for the nourishment of premature infants. The ideal temperature, relative humidity, ideal light, and the right amount of oxygen are all provided to the newborns in this incubator—conditions identical to those found in the womb.

However, due to inadequate monitoring, which results in mishaps like gas leaks and short circuits from overheating, which cause incubators to burst, infants in the incubators run the risk of losing their lives. Therefore, the goal of this work is to build a low-cost, safe technology for real-time newborn incubator monitoring in order to overcome the disadvantages of an unmonitored incubator. a cheap yet efficient device for keeping an eye on the vital signs of a premature newborn kept in an incubator, such as temperature, humidity, gas, and light levels. Through the Internet of Things (IoT), the Arduino UNO wirelessly transmits the observed data to the physicians or nurses, enabling them to occasionally take the required actions to maintain an appropriate environment for the safety of the lives of premature babies.

3.6 Baby Incubator Monitoring Center for Temperature and Humidity using WiFi Network

Furi Kristya Palupi, Sari Luthfiah, I Dewa Gede Hari Wisana, Mohseena Thaseen.

2021

Monitoring the circumstances of the premature neonates in the baby incubator is vital. Premature newborns, defined as those born before 38 weeks of pregnancy, have a higher risk of death and have a more difficult time adjusting to life outside the womb because of their undeveloped organ systems. To make sure that the premature newborns' body temperature and humidity levels are consistent enough to resemble those in the womb, the nurse must constantly check on them. The objective of this project is to quickly and practically construct a system for monitoring the humidity and temperature

in baby incubators. After various advancements, the monitoring process—which formerly involved looking straight at the baby incubator display—has changed, making it simpler to keep an eye on premature newborns as technology advances.

The findings will be displayed on the Nextion TFT display. The temperature sensor and DHT 22 utilized by the baby incubator temperature and humidity monitoring center module via the WIFI network will be communicated via WIFI ESP 32. The temperature of incubator customer 1 produced a maximum temperature error value of 2.083% at the measurement point of 32 °C, according to the measurement results. The average error of the device was determined to be appropriate for use in accordance with ECRI 415-20010301-01, which establishes a maximum permitted error limit of ± 1 °C. Nurses can avoid neglect by using the study's findings to monitor premature babies more easily.

3.7 Security And Health Monitoring System Of The Baby In Incubator

M.Subramanian, T.Sheela, K.Srividya, D.Arulselvam.

2019

The most crucial factor pertaining to the patient is safety. Premature newborns lack the ability to independently control their body temperature like healthy newborns do. The medical industry is expanding to new heights as a result of technological advancements. These developments help to control the premature newborn baby death rate. Baby incubators are essential for preserving the lives of premature infants. Here, certain conditions necessitate interactions between the health care provider and patient. These days, as the number of patients has increased, so has the health care provider's burden. By informing the newborn nurses so that preventive actions might be performed, the study offers a solution to the aforementioned issue. It keeps theft from occurring in the baby's incubator rooms. the baby's vital signs, including heart rate, temperature, blood pressure, dampness, and movement. The power outage is also reported in a brief amount of time.

3.8 Smart Incubator System for Baby Growth Monitoring

Dr. T. S. UdhayaSuriya, M. Rathna Devi, V. Indira Priyadarshini, R. Umamaheshwari.

Considerable advancements in neonatal incubator development are offering new options for newborn monitoring. Due to a lack of necessary treatment, babies born between 32 and 37 weeks gestation die. Nonetheless, the suggested tool makes it possible to identify alterations in newborns early on and to take appropriate action. Analysis of the treatment period's growth, microbe detection in the incubator, temperature, humidity, and measured factors are carried out, and the data is saved in the cloud. The LCD panel itself shows the immediate outputs. Data privacy is ensured by the suggested system.

3.9 Premise Infant Incubator

Sayali Shinde, Mr. Rajsinh Jadhav et.al

2023

An inventive tool called a "smart baby incubator" is made to give preterm or sick babies the best possible environment, increasing their chances of survival and normal growth. The incubator has several cutting-edge capabilities, including smart alarms that notify caretakers of any changes in the baby's vital signs, oxygen saturation monitoring, temperature and humidity management, and more. A user-friendly interface is another feature of the smart baby incubator that enables medical professionals to remotely monitor the infant's development and change the settings as necessary. The smart baby incubator has the potential to transform newborn care and enhance outcomes for preterm and critically ill children because to its sophisticated features and clever design.

3.10 IoT BASED INFANT INCUBATOR MONITORING SYSTEM

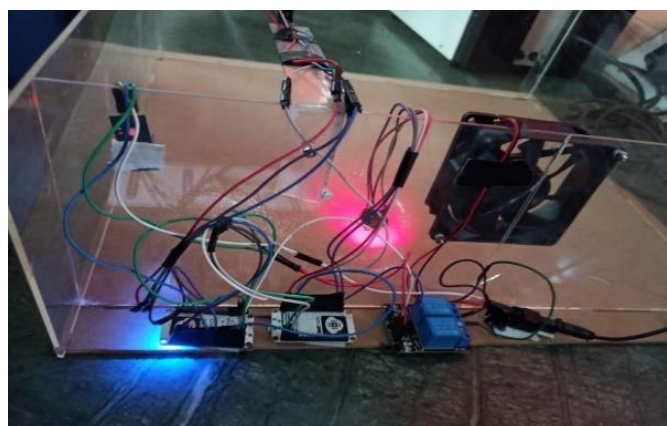
G NAVEENKUMAR , MITTAPALLI PRANAVI , PULLA SANDEEP ,NARUPALLE DEEPA , VALLEM SANTHI REDDY5 , P. ADARSH KUMAR

2022

The incubator is a device that gives preterm newborns a controlled, enclosed environment in which to grow and develop. Thermostat malfunctions that resulted in incubator overheating and newborn hyperthermia have been connected to neonatal deaths and injuries. This system uses Internet of Things (IoT) technology to monitor the baby's pulse rate, temperature, humidity, and gas detection. It also detects harmful gases like smoke, ammonia (NH₃), sulfur (S), benzene (C₆H₆), CO₂, and other gases. If any variations occur in the parameters (temperature, humidity, and gaseous), the data will be automatically sent to the doctor and family.

4.Result

Smart infant incubators are advanced medical devices designed to provide a controlled and safe environment for premature infants or babies with certain health conditions. These incubators incorporate various technologies and features to monitor and support the baby's vital signs, maintain a suitable temperature, humidity, and oxygen levels, and facilitate medical interventions when necessary. Let's discuss some of the results and advancements in Smart infant incubators



Front View of Incubator



Incubator App (Output Displayed in Mobile)

5. CONCLUSIONS

While artificial intelligence (AI), Internet of Medical Things (IoMT), cloud computing, and machine learning have recently drawn attention from academics, these technologies have the potential to transform intelligent healthcare systems by enabling the detection of even minute changes and thereby eliminating the need for human resources. However, the primary goal of this project was to create a newborn incubator that was affordable, easily operated, and easily accessible. Thus, a clever baby incubator was created that can assess the health of the infant and, should something go wrong, will trigger the system on its own to restore normalcy. In addition, we incorporate it with IoT and a mobile app so that medical professionals may monitor the baby's status from a distance. Additionally, the suggested incubator offers a comprehensive and regulated environment.

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