
Design of a Portable Baby Incubator with Health Monitoring System

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Abstract

This paper presents a unique design of a prototype baby incubator with a health monitoring system. The traditional method used in incubators involves measurements and observations which can be time-consuming, prone to errors and potentially risky for the infants. This prototype incubator is capable of monitoring the baby's health in real-time as well as through a mobile app. It can monitor baby weight, body temperature, moisture Oxygen achromatism (SpO₂), heart rate and oxygen level. For a healthy existence, the normal SpO₂ should be between 96 to 99. The beat rate should be 120 to 160 beats per nanosecond. It may be slower when a child sleeping.

A chip named Design of Temperature Moisture Detector (DHT11) is utilized to monitor the moisture level and temperature. MAX30100 chip is utilized to monitor the baby's heart rate, baby position and SpO₂ level. Wireless technology and the internet of things (IOT) are adopted for the design of this smart incubator. The key advantage of this design is to monitor and manage the baby's temperature, SpO₂ level, heart rate, baby position and moisture level from a remote place. Monitoring the signs of infants in time including heart rate, temperature and oxygen saturation is crucial, for detecting any signs of deterioration at an early stage.

Index Terms- Temperature, Humidity, Baby's weight, Arduino uno, Baby's voice, LEDs.

I. INTRODUCTION

The use of incubators is essential for the survival and development of premature babies. However, keeping an eye on the well-being and safety of these infants. The traditional incubators pose a difficult challenge that demands constant attention from healthcare professionals. The traditional method of monitoring babies in incubators involves measurements and observations which can be time-consuming, prone to errors and potentially risky for the infants. To tackle these concerns, an IoT-based system for ensuring safety and monitoring the health of infant incubators has been suggested as a solution[1].

A newborn baby before 37 weeks must be kept in an incubator. The incubator is a safe, clean and caring place for a baby. The continuous monitoring of the baby's health at this stage makes sure the reduce death rate and other complications –[2], [3]. Due to the advancement of technologies, optimization techniques were used to optimize the operation of devices in different fields like in power systems, medical, etc. [4], [5]. All of these technologies use microprocessor-based. The problem with these technologies is the slow working. The probabilistic load flow analysis techniques also have computational burden[6], [7], [8].

The Internet of Things (IoT) technologies are a milestone in the development of fast and real-time monitoring. IOT makes a revolution in different fields like medical, energy and control sector [9], [10], [11], [12], navigation system —[13], [14] artificial techniques[15] and application in industry[16]. An outperforming of IOT offers a platform to establish real-time monitoring systems that gather and transmit data from sensors in the incubator such, as temperature, humidity levels, oxygen levels and other vital signs. This collected data can then be processed instantly enabling healthcare providers to monitor the well-being and safety of babies more effectively and efficiently[17], [18], [19].

IoT-based safety and health monitoring systems, for infant incubators are anticipated to offer advantages compared to

monitoring approaches [20]. Firstly, it has the capability to promptly and efficiently notify healthcare professionals in time. If there are any irregularities enabling them to take effective action. Furthermore, it offers the capability to remotely monitor and manage the incubator granting healthcare providers increased flexibility and convenience [21].

In the end it has the potential to enhance the precision and dependability of the monitoring procedure while minimizing the likelihood of mistakes and unfavorable incidents[22], [23], [24]. This unique prototype baby incubator uses IoT to monitor the safety and health of children. The system will undergo testing and validation, in a neonatal care environment to showcase its feasibility, effectiveness and potential advantages. The research paper will also include an examination of the existing studies that focus on using incubators in care. It will discuss the difficulties involved in monitoring the health and safety of infants in incubators well as explore the potential solutions offered by IoT-based monitoring systems. Overall, the proposed Internet of Things-based system, for ensuring safety and monitoring health in baby incubators has the potential to revolutionize care by enhancing safety measures, efficiency and overall quality of the monitoring process. The development and evaluation of this system will contribute to the expanding body of literature on IoT based healthcare monitoring systems.

Creating a portable baby incubator with an integrated health monitoring system holds promise for improving neonatal care, especially in areas with limited healthcare infrastructure. The portability feature enables its usage in underserved regions where access, to healthcare facilities is scarce. The incorporation of a health monitoring system further enhances the functionality and effectiveness of the incubator. Monitoring the signs of infants in real-time including heart rate, temperature, moisture level, baby position and oxygen saturation is crucial, for detecting any signs of deterioration at an early stage. This system allows healthcare professionals to intervene promptly mitigating complications and enhancing outcomes.

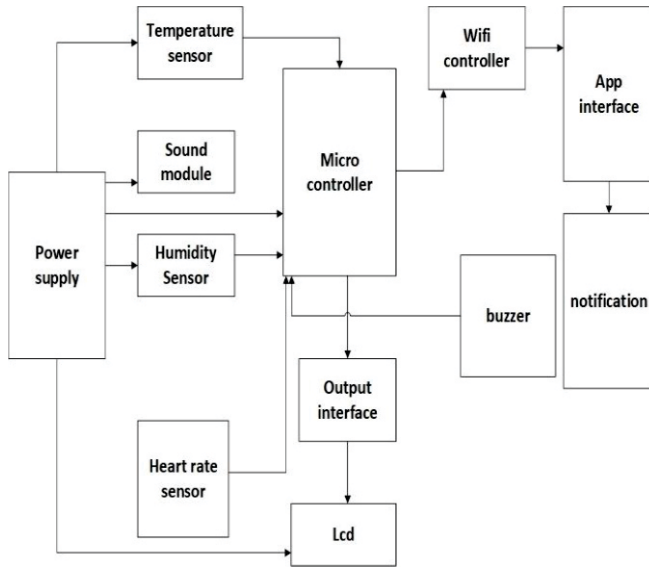


Fig. 1 Baby Incubator Operation Flowchart

II. METHODOLOGY

This endeavor aims to employ technology in order to create, build and evaluate a prototype system for monitoring the safety and health of child incubators.

Components:

- Power supply
- Heart rate sensor (MAX30100)
- Temperature and humidity sensor (DHT11)
- Sound module sensor (Lm393)
- Weight sensor (load cell 20kg)
- TF18B20 for Baby temperature
- Arduino UNO (microcontroller)
- NODE MCU ESP8266
- Wi-Fi module Power supply
- Mobile application for monitor and control the system

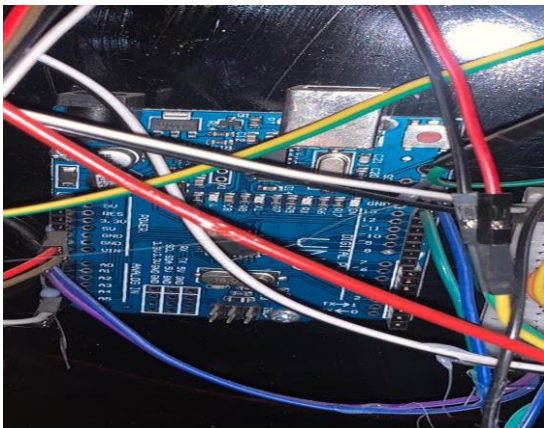


Fig. 2 Microcontroller working

III. HARDWARE COMPONENTS

The hardware of baby incubator has many components, their function and attributes are discussed as:

A) Microcontroller:

The microcontroller is the brain of the system which controls all other components. You can use a cheap microcontroller like Arduino or Raspberry Pi to build an IoT-based incubator. There are four pins used for LCD connection. This microcontroller is based on the ATMEGA328P. It can communicate in any manner with anything that is electrically powered. It is also capable of interacting with electromagnets, sensors, and motors. In other words, this board can be used to create devices that respond and react to their surroundings. We may sum up thousands of projects by saying that Arduino is their brain.

B) Temperature And Humidity Sensor

The temperature sensor is used to measure the temperature inside the incubator. The humidity sensor is used to measure the humidity inside the incubator. You can use a capacitive or resistive humidity sensor like the DHT11 to measure humidity. The temperature range of DHT11 is from 0 to 50 degree Celsius with a 2-degree accuracy. The humidity range of this sensor is from 20 to 80% with 5% accuracy. The sampling rate of this sensor is 1HZ i.e., it gives one reading for every second. DHT11 is small in size with operating voltage from 3 to 5 volts. There are three pins: pin one is Vcc (voltage common collector), pin two (data), pin three (ground).

C) Display

The display can be used to show the current temperature and humidity level inside the incubator. It can be a simple LCD or an OLED display.

In order to facilitate the easy connection of LCD 16x2 with external devices, the pin configuration of LCD 16 X 2 is tackled below. Attached to the ground terminal is Pin 1 (Ground). The LCD's contrast is selected by Pin 3 (VE). When an MCU's data pin is connected to Pin 4 (Register Select), it receives a 1 or a 0.

D) Node MCU ESP8266

The Wi-Fi module can be used to connect the IoT-based incubator to the Internet. This allows the user to remotely monitor and control the incubator using a smartphone app or web interface. The ESP8266 has several GPIO (General Purpose Input/Output) legs that can be used for a variety of purposes. GPIO0 is used for flashing firmware and as a charge mode chooser. GPIO1 is used for UART communication and can be used as a general-purpose GPIO pin.

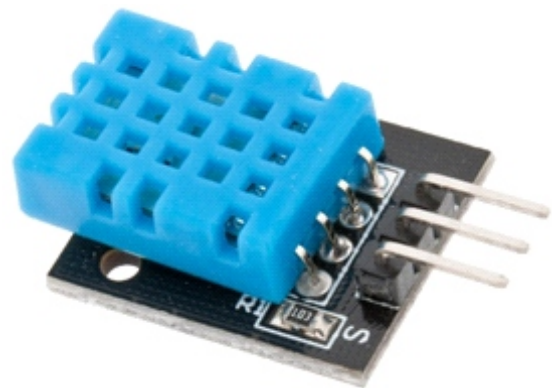


Fig. 3 Temperature and Humidity sensor used in baby incubator



Fig. 4 Display of Baby Incubator

GPIO2 is used for the I2C interface and can also be used as a general-purpose GPIO pin. GPIO3 is used for the SPI interface and can also be used as a general-purpose GPIO pin. GPIO4 is used for the SPI interface and can also be used as a general-purpose GPIO pin. Other legs include the ADC (Analogue to Digital Converter) leg, the reset pin, and the power legs. These legs can be configured and used for different purposes, depending on the operation.

E) LCD Screen

TV Screen In our prototype 16 X 2 television module is used. It has 2 rows and 16 columns therefore total 32 characters are displayed. It has two operation modes; one uses all 8 legs and the other uses only 4 of them. The 4-bit mode was used to manage the television screen. All sensor affair is displayed continuously as it's being measured.

F) Circuit Testing

As seen in this section, the circuit has been installed completely. LED, LM35, eyeblink sensor, Arduino Uno, TV, and ESP8266 WIFI module are installed components of this circuit. The power source for this circuit must be 5V. The line that connects the element is womanish and masculine. After putting a real circuit on the prototype and turning on the circuit, the element's led illuminates. This is done to ensure that all of the components are functioning as intended.

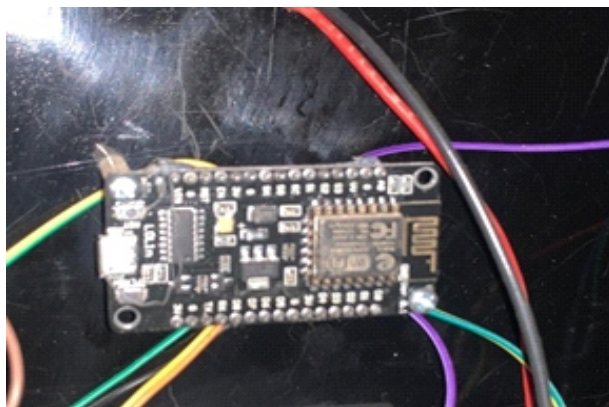


Fig. 5 WIFI Module used in Baby Incubator



Fig. 6 LCD screen of baby incubator

G) Power

A power supply is required to power all components of the IoT incubator. You can use a DC power supply or a battery to power the system. Once all the components are assembled, the microcontroller can be programmed to control the temperature, humidity and other environmental factors inside the incubator. The user can then monitor and control the incubator using a smartphone app or a web interface. All in all, an IoT-based incubator can be a great project for those interested in IoT, microcontrollers

IV. RESULTS AND DISCUSSIONS

The baby incubator is equipped with sensors to measure factors such, as the temperature and humidity (DHT11) weight (load cell 20kg) heart rate (MAX30100) sensor and the baby's temperature (TF18B20). Additionally, it monitors the child's core temperature. It monitors the moisture level and weight of infants inside the incubator. Even include a speech module, for communication.

The microcontroller is programmed to read data from the sensors and send it to the communication module. It is also programmed to control the incubator's heating and cooling systems based on the temperature readings.

The Wi-Fi or Bluetooth module is integrated with the microcontroller to transmit the data to mobile application.

A mobile application is developed for monitoring and controlling the system. It displays the real-time temperature, humidity, and gas levels inside the incubator and sends alerts when any parameter goes beyond a safe range. It also allows the user to control the temperature of the incubator remotely.

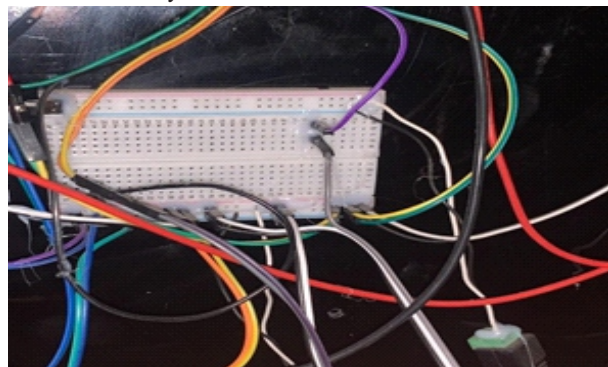


Fig. 7 Breadboard Testing

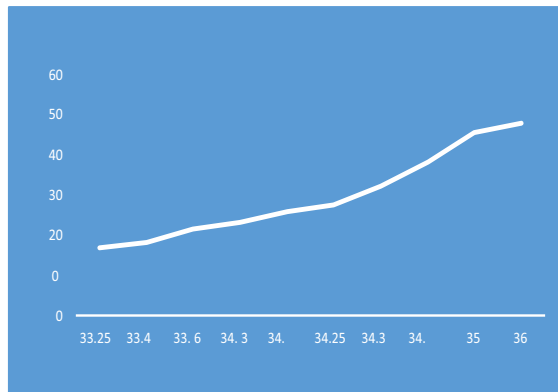


Fig. 8 Incubator humidity and temperature control

The system is powered using a suitable power force and installed, it continuously monitors the safety and health of the baby inside the incubator and sends caution to the stoner if any parameter goes beyond safe limits. This helps incising the safety and well-being of the baby and provides peace of mind to the parents or caregivers.

Temperature and humidity graphs would show the fluctuating temperature and humidity levels in the incubator over time. The system would be designed to maintain a stable and optimal level of temperature and humidity for the health and safety of the child. Any deviations from ideal levels would therefore be indicated by the graph.

If the temperature and humidity levels go beyond limits the IoT-based monitoring system will immediately send alerts. These alerts will be received by personnel or the child's parents, through an app or other communication channels. This quick notification system ensures that any abnormalities are addressed promptly guaranteeing the child's safety and well-being.

Moreover, analyzing temperature and humidity graphs from the IoT-based monitoring system for baby incubators provides insights. It helps healthcare providers identify patterns, trends and potential issues related to temperature and humidity levels. With this information, proactive measures can be taken to prevent any problems effectively.

In summary, real-time alerts from the IoT-based monitoring system play a role in maintaining conditions for infants, in incubators. By analyzing charts and taking actions based on them healthcare providers can enhance the scalability and flexibility of the system while ensuring the well-being of newborns.

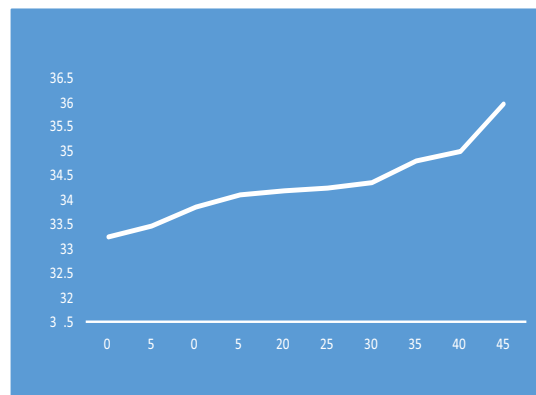


Fig. 9 Temperature and time graph in incubator

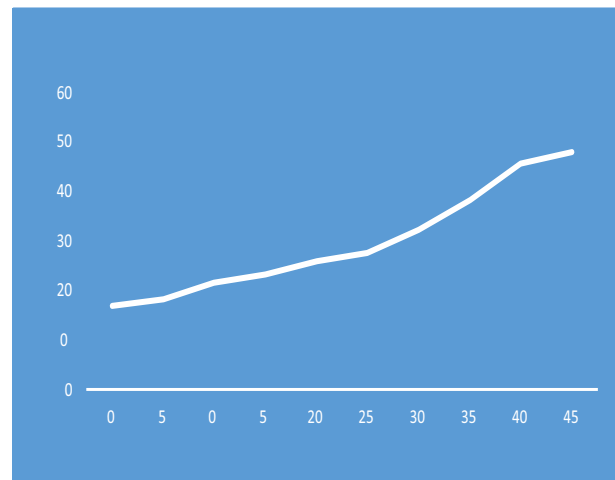


Fig. 10 Humidity and time control system in baby incubator

V. CONCLUSION

An IoT-based baby incubator can be a valuable tool for healthcare providers and parents to monitor and regulate the environment inside the incubator for premature babies. Real-time monitoring of premature babies can be ensured through sensors, a microcontroller, a Wi-Fi module and a display. This incubator can provide real-time data of the baby's temperature, humidity and other environmental factors to both healthcare providers and parents. This allows for early intervention and may improve outcomes in premature infants.

The proposed model can monitor the baby's temperature, humidity level, baby position and oxygen level from a remote area in real-time. The IOT technology is fast and cheaper as compared to traditional technologies used in literature. The proposed design can control the incubator through a mobile app as well. In future, an incubator will be designed to have the capability to sense sound. A sound sensor will be applied on this hardware and results will be evaluated. Additionally, the work can be extended by using microcontrollers and internet technology to gather for improvement of results.

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