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# SMART INFANT INCUBATOR MONITORING AND CONTROL SYSTEM USING IoT

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**Abstract:** The project proposes the development of a smart infant incubator monitoring and control system that uses IoT technology to customize the care and monitoring of premature and critically ill newborns. As the system is interfaced with advanced sensors, actuators, and connective solutions to create a smart and responsive incubator environment. The system adopts with some key components such as temperature and humidity sensor for precise check of environmental conditions, gas sensor, heartbeat sensor, sound sensor and accelerometer to monitor the infant's conditions inside the incubator and actuators such as Peltier module and humidifier are integrated to adjust the environmental conditions according to the threshold range on the processed sensor data. An LCD display provides the local feedback, while buzzer alerts the caretakers at time of critical periods. These sensors collectively provide data for the parameters as a Wi-Fi enabled microcontroller such as Arduino Wi-Fi R3 is utilized to process and transmit data which also communicates with cloud based IoT platforms. IoT application was developed using Thing speak to build an ideal communication through a Wi-Fi module, Healthcare providers can regularly monitor the infant's condition through a designed web or mobile interface. The developed IoT interface provides real-time data acquisition, and the system incorporates automated alert mechanism by integrating a GSM module. In the matter of change in normalities beyond the threshold ranges, an automated alert message will be forwarded to the attentive doctor or caretaker through GSM.

***Keywords***: Arduino Wi-Fi R3, GSM, IoT (Thing speak), Peltier Module, sensor data acquisition, sensor data communication.

## I.INTRODUCTION:

According to a recent study, every year more than twenty million babies are born prematurely or with low birth weight - and an estimated 450 of them die each hour. Premature babies are infants who are born before 37 weeks of pregnancy and have low birth weight (less than 2.495 kg) or have any medical condition which needs special attention. They are more sensitive to the environmental conditions The rise in the deaths of premature babies and low weight at birth is non-uniform across India. Moreover, high investments are needed to develop incubators and intensive care units for getting proper infant care. Slight changes in the environment can create immediate effects in them. Even though the incubators play a vital role in the lives of premature babies, it requires instrument-health caregiver interactions due to its environmental and working conditions. Due to the ratio of the number of caregivers to the number of patients not matching i.e., more patients and fewer caregivers, the workload of the instrument-health caregiver is high, which leads to improper monitoring of the incubators. Neonatal Intensive Care Unit (NICU) gives special medical attention to newborn babies in need. The babies who are admitted to the NICU are mostly premature. The current improvement in technology leads to strengthening of the medical industries and hence the death rate of premature infants is also regulated.

This can be easily prevented by using neonatal incubators for these premature babies. This life supporting machine provides adequate thermal regulation and environmental control for the baby while it uses all the available resources to complete development to attain normal size. The main objective of this paper is to keep their temperature and humidity stable throughout. In addition, in the developing countries there is a substantial proportion of primary and intermediate health facilities than there are in the developed world. All these facilities could be connected to benefit people. The incubator has a certain temperature range and humidity level to keep the babies warm. The required temperature should be surrounded around 36 to 37.5°C. Some of the premature babies in the comfort temperature shows the rectal temperature at around 36°c and the targeted humidity range should be 40%-60%. In some cases, if the temperature and the humidity levels become more than normal then an alert is sent to the doctor or the caretaker immediately, so that the doctor can take the necessary precautions.

Information technology (IT) field is developing more in the instance of sensors, nanotechnology, and bio-industries. The designed device hardware module is composed of three main parts: 1. Microcontroller, 2. Information acquisition submodule, 3. Electronic communication submodule. This research is motivated by the fact that there exists an urgent need to give health professionals a simple toolkit for real-time assessment and management of an infant's environment in incubator. The combination of a sound sensor, heart rate monitor, MQ2 sensor, DHT 11 sensor, accelerometer, Peltier module, LCD, humidifier, GSM unit is at the center of our new system. In this paper, we focus on the origins of neonatal care highlighting the importance of IoT in improving accuracy and responsiveness rate incubator systems. Each facing sensor and module is investigated based on the systematic integration showing essential details of design and development process. The research includes stringent tests, analysis and comparison with other conventional systems that will enable the understating of the practical features of our Smart Infant Incubator Monitoring and Control System.

## II. LITERATURE SURVEY:

In the paper presented by [1] Afreen Tabassum et al "Design of Hardware Module of IoT-Based Infant Incubator Monitoring with Cooling and Security System", in this they utilized Arduino Uno along with a body temperature sensor as the representation of biosensors and ambience temperature sensor, humidity sensor, and gas sensor as the representation of environment and monitoring sensors with addition of RFID sensor named EM-18 for security. The Arduino board connected with an ESP8266 Wi-Fi as a data communication submodule, the hardware module aims to automatically acquire data from sensors (biosensors and environment monitoring sensors), process the data in the microcontroller board and then send them to a database server via the Internet. The received data from the hard module is stored by the php scripts of the web and database system.

[2] Rasha M. Abd El-Aziz et al proposed a" Real Time Monitoring And Control Of Neonatal Incubator Using IoT" , proposed system consists of an Arduino UNO microcontroller, which is to be connected directly to the incubator and the Temperature and Humidity sensor (DHT11) for sensing the temperature and the humidity in the surroundings of the neonate, the Pulse rate sensor is developed to notify the pulse rate of the infant and the Gas Sensor is deployed to sense the any gas leakage and the Light sensor is used to capture any extra light emitted, if there is any gas leakage inside the incubator and if the value of light and gas exceeds the optimum range then the system alerts the caretaker regarding this through IoT.

[3] Enilson J. L. Costa et al developed a "Humidity Control System in Newborn Incubator," in this system they used a humidity controller works on the microcontroller and stepper motor, the device was inserted in the water reservoir of the infant incubator for the purpose to control the humidity. The step motor obtains a sign from microcontroller and start proceeding step of 30 degrees accelerating the windows of the humidity reservoir of arranged to his axle, whenever the parameter value of the humidity is exceeded then pre-engaged with maintaining it inside the bounds of comfort zone in the standard. The total data will be represented in the lcd display.

In paper presented by [4] Ashish. B et.al "Temperature Monitored IoT Based Smart Incubator," in this paper they proposed the external circuit consists of Node MCU which is connected to the incubator. The temperature sensor (LM35) which is integrated to the Node MCU senses the temperature of the incubator. If it exceeds more than the specified temperature range (36.5-37.2°C) monitored by a computer, then relay goes OFF and the alarm goes ON and the heater goes off. The. The HTML pages are coded to the microcontroller displays the continuous readings of the temperature and automated alerts were sent to the doctor if the temperature exceeds above the threshold ranges. Make the process easier an app was created to switch on / off the heater, or any other device connected to the raspberry pi. It was designed in a manner to receive alerts in case of emergency. And hence the doctor / nurse can take the necessary action.

In [5] Suthagar S et al. (2022) proposed "Baby Monitoring System using Global System for Mobile Technology ", the system works on monitoring of various parameters such as temperature, heart rate, weight, and sound. When these parameters are exceeded then it forwards an SMS alert to doctor and turn on the LED to indicate emergency. The alert will be forwarded to caretaker for every two minutes.

In [6] Megha Koli (2018) IEEE reported that "INTELLIGENT BABY INCUBATOR", as incubator plays a crucial role in infants it is hard to monitor and control it. In this they used Arduin uno, temperature sensor for monitoring and controlling the temperature of the infant's body. The constant temperature of 36.5-37.2° C is to be maintained. The Arduino is programmed in way to control the temperature of the incubator. Buzzer is used as an alert for the indication of disturbances in temperature in a neonatal home. IOT web interface is always used for regular monitoring of changes in temperature anywhere.

In the authors, [7] Savitha P. Patil, and Manisha R. Mhetre, proposed an "Intelligent Baby Monitoring System" in 2014. This system captures pediatric parameters such as body temperature, heart rate, moisture condition, and motion of an infant. Temperature is measured using the LM35 temperature sensor, while pulse rate is measured from the finger using optical sensors and displayed on an LCD screen. Moisture is detected by a moisture sensor, and the accelerometer used in the system is the ADXL335, which is a small, low-profile package used for motion detection. These sensors are interfaced with a PIC 18f4520 8-bit microcontroller, and the GSM module is used for communication. The results are displayed on the LCD screen, and if the threshold value is crossed, a buzzer will sound.

In [8] Ashraf A Tahat (2009) proposed "BODY TEMPERATURE AND ELECTROCARDIOGRAM MONITORING USING SMS-BASED TELEMEDICINE SYSTEM" in this system heart rate using IR Transmitter and Receiver, respiratory rate by using Piezo film sensor placed on Patient's Chest and blood Pressure are measured, these parameters are analyzed and forwarded to microcontroller. The processed data is stored on the server and feedback is remotely displayed on the web site. In this SMS deployed telemedicine system, body temperature is verified by Infrared temperature sensor and ECG signals are obtained with electrodes connected with the microcontroller.

In [9] Abdul Latif et al (2021) proposed "TEMPERATURE AND HUMIDITY CONTROLLING SYSTEM FOR BABY INCUBATOR" in this system the temperature and humidity is measured by DHT11 sensor interfaced with microcontroller and the readings of the DHT11 sensor are forwarded to the LCD to display the reading results of temperature and humidity of the air. The temperature is adjusted in a manner to maintain the normal temperature limit of 33 °C to 35 °C and a heater is used to increase the temperature in the incubator. Whereas the humidity settings are adjusted to the normal limits of the incubator's humidity at around 40 percent to 60 percent and use a fan to reduce the humidity in the incubator

## III. EXISTING SYSTEM:

Paper presented by [1] Afreen Tabassum et al "Design of Hardware Module of IoT-Based Infant Incubator Monitoring With Cooling And Security System", in this they utilized Arduino Uno along with a body temperature sensor as the representation of biosensors and ambience temperature sensor, humidity sensor, and gas sensor as the representation of environment and monitoring sensors with addition of RFID sensor named EM-18 for security. The Arduino board connected with an ESP8266 Wi-Fi as a data communication submodule, the hardware module aims to automatically acquire data from sensors (biosensors and environment monitoring sensors), process the data in the microcontroller board and then send them to a

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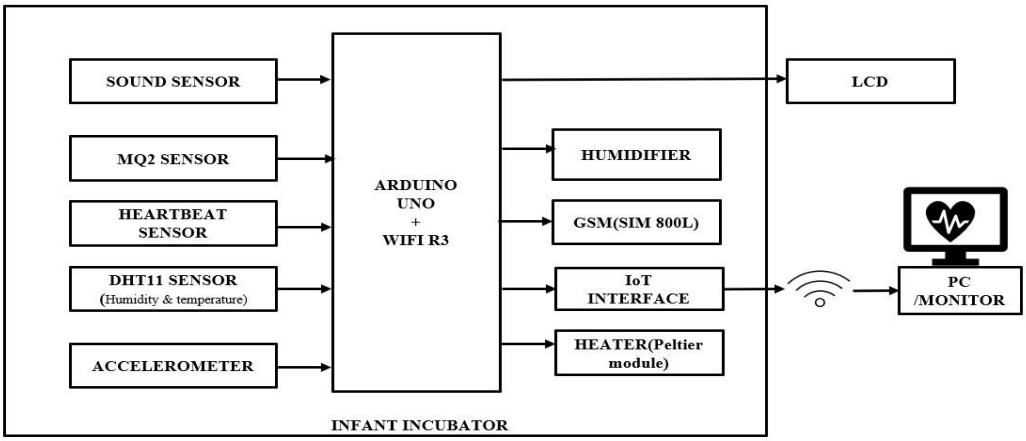
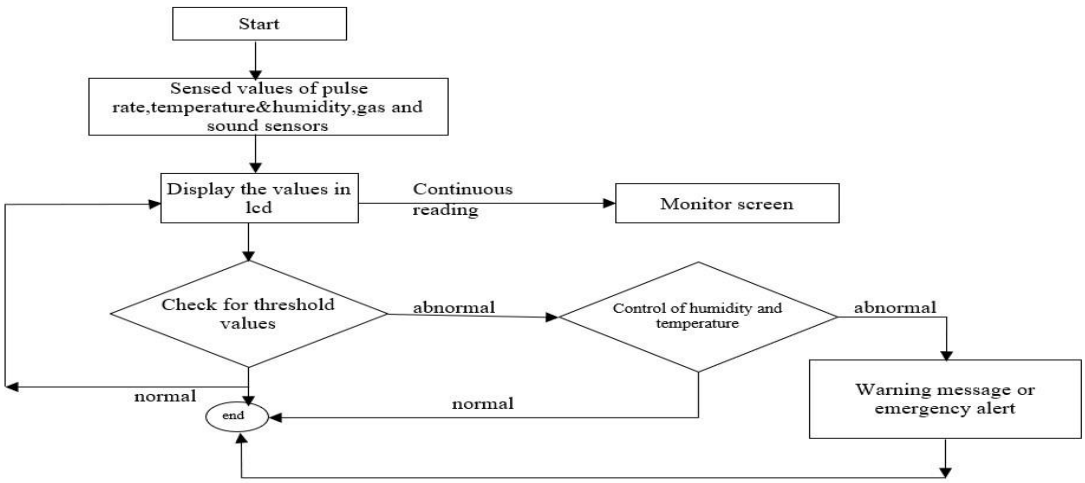
## IV.PROPOSED SYSTEM:

This paper gives out an extensive solution for monitoring and controlling of infant incubators using the enhanced IoT technology. The proposed system is integrated with various sensors and actuators, sensors including sound, heartrate, gas, temperature, and humidity (DHT11) and accelerometer to monitor the necessary parameters and environmental conditions within the bounds of incubator. The system is incorporated with actuators such as Peltier module for accurate temperature and a humidifier to maintain optimum humidity levels. If the temperature exceeds more than 36°C -37.2°Cand humidity of 60% then the microcontroller turns the Peltier and humidifier accordingly. Aside alerts are generated through a buzzer and GSM module (800L) at the time of any deviations from thresholds or critical events, it allows healthcare providers to receive real-time updates on the infant status. Data collected from the sensors are transmitted to cloud based IoT platform Thing Speak where it allows remote analysis and the condition of the infant. It is also embedded with an LCD display where the sensed values are displayed. The idea developed to maintain the regularly of temperature, humidity and to monitor the baby.

## V.BLOCK DIAGRAM:




## VI.FLOW CHART:



## VII.RESULTS:

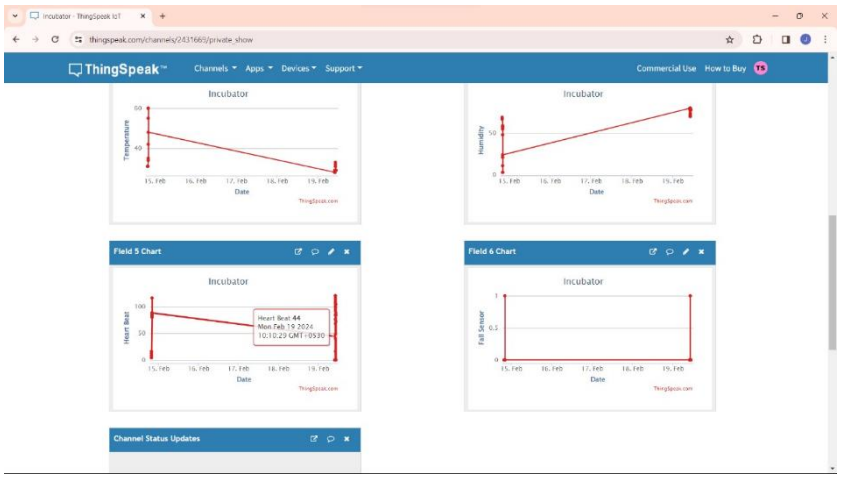



**Fig 1: Live monitoring of parameters in Thing Speak**


**Fig 2: SMS Alerts with GSM Module**

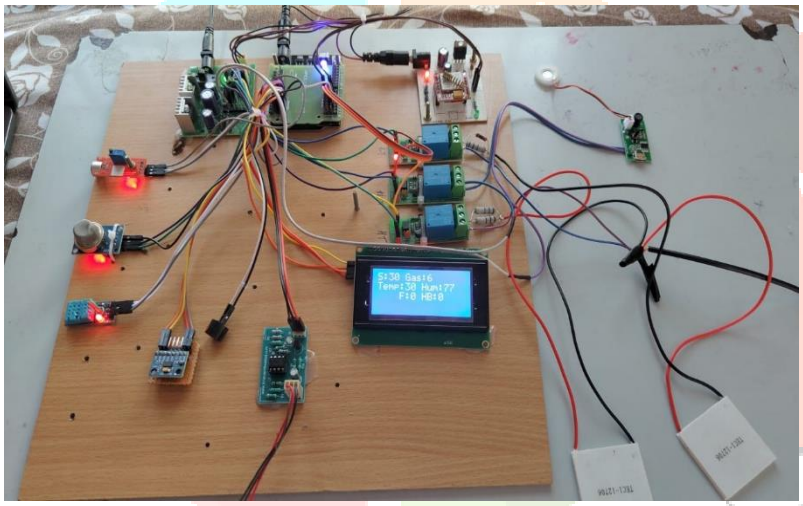


**Fig 3: Overall hardware**

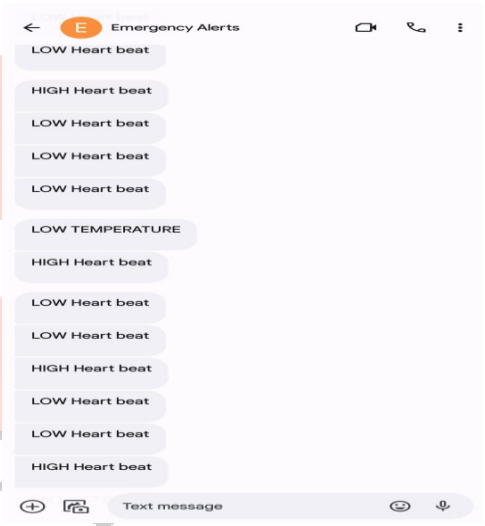



**Fig 4: SMS Alerts**

## VIII.CONCLUSION:

There were many deaths caused due irregularity in monitoring and maintaining of the infant incubator as it became major issue in health care system. To overcome this situation the development and implementation of the Smart Infant Incubator Monitoring and Control System describes a significant advancement in neonatal care, using IoT technology. As it regularly monitors the vital parameters and maintains the optimal environmental conditions and timely provides alerts to health care providers to initiate immediate action. The system contributes to reduce the risk of complications and enhances the overall health of the infant. The timely status of the infant is observed through IoT deployed web interface. It provides an improved quality of care for infants.

## IX.FUTURE SCOPE:

The system developed for the well-being of the infant's life, it can create a foundation for further advancements such as integration of AI, live monitoring of baby through cam and expansion of sensor capabilities such as oxygen level monitoring, respiratory rates. This further integration improves the efficiency and accessibility of neonatal care through IoT enabled solutions.

## X.REFERENCES: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