A Novel Incubator for Early Care of Preterm Infants

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Abstract:- Infants who born before 37 weeks of the gestation period are known as preterm or premature babies. Preterm baby requires surrounding exactly similar as in the womb to cope with the external environment. The neonatal incubator is an apparatus that provides a closed and controlled environment for the sustenance of temperature babies. Heart rate (HR) is the most important clinical indicator to evaluate the clinical status of a newborn. HR during the first minutes of life in infants needing resuscitation may be a predictor of early neonatal mortality and moderate to severe brain injury in those who survive Bradycardia is the slowing of the heart. When a baby's heart begins to slow, there is decreased blood flow to the lungs and oxygen to the tissues drops Bradycardia is an expected normal part of prematurity because the nervous system is immature. The heart is regulated by a part of the nervous system called the autonomic nervous system (ANS). Hypoxemia an abnormally low level of oxygen in the blood, is the most common cause of sinus bradycardia. Hypoxemia causes depression of the sinus node or a conduction block. Hypoxemia may be caused by congenital heart defects, lung disease or respiratory failure. But recently, many premature babies have lost their lives due to lack of proper monitoring of the incubator that leads to accidents. This project deals with the cost- effective design of an embedded device that monitors certain parameters such as baby position, temperature, humidity, light inside the incubator and also jaundice detection using deep neural network. If any variations occurs in the corresponding parameters like (temperature and humidity), than the parameters will control by using Peltier crystal which is used to produce cool/heat inside the incubator. Heart beat sensor and SPO2 sensor is used to detect bradycardia and tachycardia and update to the caretaker/physician and also displays in the OLED display using transceiver module. And the sensors will continuously monitoring in LCD and sends the details to the corresponding doctor or nurse by using transceiver module and the baby will monitors continuously via OLED display. The parents, doctors or nurse will monitor the baby from anywhere by using transceiver and OLED display. By continuously monitoring and controlling the parameters we will provide efficient and safe working of an incubator

Keywords: HR, ANS, SP02, Continuously, Oled, Incubator

I. INTRODUCTION

The increase in neonatal deaths from premature birth and low birth-weight was found to be non-uniform across India such that the death rates were more in rural areas and poorer states but lesser in urban areas and in richer states. Moreover, premature births and low birth-weight babies may require more investments in incubators and intensive care units in order to provide appropriate neonatal care. Today, technology is progressing every conceivable way, particularly in the field of wellbeing and care items particularly where the necessities are supporting life. Extra care is taken with regards to babies. Particularly if there should arise an occurrence of premature babies/Low birth weight (under 1 kg) babies, who wouldn't have built up the thermo-regulatory instrument the safety measure is multiplied. The Neonatal Intensive Care Unit (NICU) is intended to give a climate that limits weight on the newborn child and addresses fundamental issues of warmth, nourishment, care and insurance to guarantee legitimate development and improvement. In such cases babies must be kept either stripped/half-exposed in a hatchery (which has the capacity to keep up the temperature inside it and solaces.

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may require more investments in incubators and intensive care units in order to provide appropriate neonatal care. There have also been incidents of death of premature babies due to accidents which have been categorized as a technical fault in the incubators. The existing system proposes the use of a temperature sensor to sense the temperature of the incubator which is connected to the Node MCU. Any increase in the temperature beyond the specified range turns the alarm on and the heater in the incubator gets turned off through the usage of a mobile app. The temperature readings can be continuously viewed by programming the PIC microcontroller. This enables the staff to receive notification during an emergency so that necessary preventive actions can be taken. This only ensures the maintenance of temperature inside the incubator. But there are other parameters which require being monitored and controlled to provide safety to the infant. So, the main objective of this project is to overcome the above-mentioned drawbacks and provide a safe and affordable mechanism for monitoring the incubator which will help in reducing the mortality rate of neonates. The proposed system involves the use of WIFI, integrated to various sensor units, such as pulse, temperature and humidity sensors.

1.1 PREMATURE BIRTH

Babies born prematurely may need additional time to develop their lungs and other vital organs. (Their eyes and ear drums may be so sensitive that normal light and sound would cause permanent damage to these organs.) Also, babies born extremely early will not have had the time to develop fat just under the skin and will need help to keep themselves warm and toasty. Sometimes babies will have fluid or meconium in their lungs. This can lead to infections and an inability to breathe well. Newborns may also have immature, not fully developed lungs that require monitoring and extra oxygen. Incubators can reduce the chance of germs and additional infection while a little one heals from an illness. Incubators also offer a protected space where it's possible to monitor vitals 24/7 when your baby also needs multiple IVs for medication, fluids, etc.

Long or traumatic delivery

If a newborn baby has experienced trauma, they may require constant monitoring and additional medical supports. The incubator can also offer a safe womb-like environment where a baby can recover from the trauma.

Low birth weight

Even if a baby is not premature, if they are extremely small, they may not be able to stay warm without the additional help an incubator offers. Additionally, very small babies may struggle with many of the same vital functions premature babies do (i.e. breathing, and eating), benefiting from the extra oxygen and controlled environment an incubator offers.

1.2 TRAUMATIC BIRTH

Babies who have a difficult birth may not get enough oxygen or might have reduced blood flow. Doctors can treat this with whole-body cooling. This is a treatment that can help prevent brain injury that might happen when a baby has decreased blood flow. This is a breathing problem caused by immature lungs. Mild RDS can be treated by using a machine that pushes air through the nose.

1.3 INCUBATOR

It can be easy to think of an incubator as just a bed for a sick baby, but it's so much more than a place for sleeping.An incubator is designed to provide a safe, controlled space for infants to live while their vital organs develop.Unlike a simple bassinet, an incubator provides an environment that can be adjusted to provide the ideal temperature as well as the perfect amount of oxygen, humidity, and light. An incubator can include equipment to track a range of things including a baby's temperature and heart rate. This monitoring allows nurses and doctors to constantly track a baby's health status.

1.4 TYPES OF INCUBATOR

You may come across many different types of incubators. Three common incubator types are: the open incubator, the closed incubator, and the transport incubator. Each is designed slightly differently with different advantages and limitations.

Open incubator

This is also sometimes called a radiant warmer. In an open incubator, a baby is placed on a flat surface with a radiant heat element either positioned above or offering heat from below. While you may see lots of monitors, the incubator is open above the baby. Because of this open air space, open incubators do not provide the same amount of control over humidity as closed incubators. However, they can still monitor a baby's vital functions and warm them. Open incubators work well for infants who primarily need to be temporarily warmed and have their vital statistics measured..

Closed incubator

A closed incubator is one where the baby is completely surrounded. It will have portal holes on the sides to allow IVs and human hands inside, but is designed to keep germs, light, and other elements out.

Transport or portable incubator

As the name implies, these types of incubators are typically used to transport a baby between two different locations. One might be used when a baby is transported to a different hospital to get services not offered at their current location or access to doctors who specialize in areas they need additional care.

II. EXPERIMENTAL

2.1 PROPOSED SYSTEM

AIM

Our aim is to design a Novel incubator for early care of pre-term infants.

OBJECTIVE

An incubator is a piece of scientific equipment that is a self-contained unit. It provides controlled environmental conditions to a premature or sick baby, temperature can be

manually or automatically adjusted, according to the Changes in the baby's body temperature and protects them from allergens, infections, excessive light, and sound, all of which might harm them, as these babies are extremely sensitive and have low immunity.

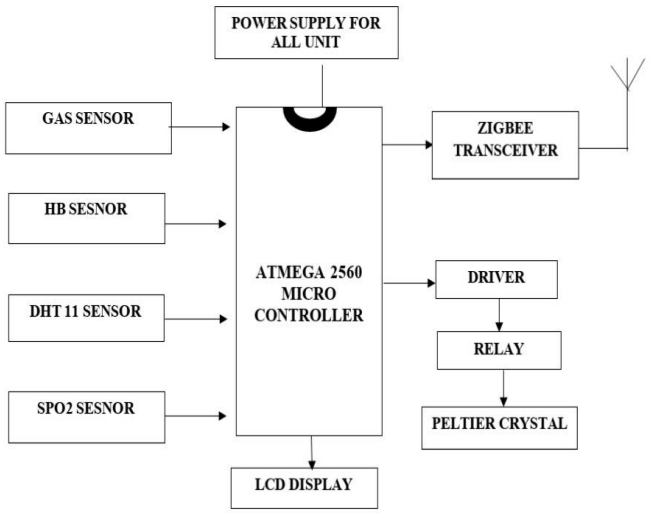

Figure 3.1 Block diagram

2.2 BLOCK DIAGRAM DESCRIPTION

The ATMEGA 2560 is a complete and breadboard-friendly device based on ATmega2560 microcontroller that is used in many medical applications due to its availability, small size, low cost, efficient interrupt structure and ease to programming with an open-source software using an integrated development environment (IDE) DHT 11 Sensor is used for measuring the temperature and humidity of the incubator and Depending upon the temperature it will turn on the peltier crystal with the help of relay driver circuit. We use peltier crystal for producing warm temperature to the baby. Two infants were included in this study with less than 30 weeks gestational age. A digital camera was placed at a distance of approximately 1–2 m away from the infants, and many images were captured at different times in a day. The image data was captured in ambient lighting using an 18-50 mm lens with a resolution of 6000×4000 and saved in JPEG file format on a computer. The selected ranges for jaundice and non-jaundice skin were used by python environment and determined the skin state and sending a digital output (1 or 0) to the microcontroller circuit that controls the blue LED circuit. The infant does not need UV therapy as his skin was normal without any yellowness (within a selected blue normal range >105), and the UV LED was OFF in this case.

2.3 HARDWARE REQUIREMENTS COMPONENTS USED

1. DHT11 SENSOR
2. GAS SENSOR
3. HB SENSOR
4. SPO2 SENSOR
5. BATTERY
6. ATMEGA 2560 MICROCONTROLLER
7. ATMEGA-UNO-328 MICROCONTROLLER
8. PELTIER CRYSTAL
9. DRIVER RELAY
10. TRANSCEIVER MODULE
11. OLED DISPLAY
12. POWER SUPPLY COMPONENTS
13. TRANSFORMER

III. RESULT AND DISCUSSION

3.1 RESULT

The proposed results shows real-time monitoring and control based neonatal incubator monitors and detects any changes in the environment surrounding the incubator like temperature, humidity, gas level and also infants pulse rate and SPO2 are measured by using respective sensors and sends those signals to the microcontroller, ATMEGA 2560 and the controller then alerts the doctors or nurses or the caretakers of the neonates inside the incubator via zigbee to take necessary and possible actions so as to maintain the health of the preterm infants within the incubator. . Temperature monitoring is done in order to keep the environment suitable for the neonate .Temperature monitoring of the infant's body will help to detect many other internal diseases like infections, common cold, and pneumonia have a common symptom of fever as the body temperature goes high . Humidity measure values also help in detecting of having internal problems like cold, dehydration. Continuous heart beat monitoring helps to detect any kind of cardiovascular disorder in the infant. It also helps to detect arrhythmia or irregular heartbeats. This system helps in preventing the unusual accidents and deaths that occurs in an incubator due to improper monitoring of it.Any Abnormalities in Paramters, Incubator Alert a Buzzer and the receiving Band Indicates the Parameter Values and alert with Vibrate.

Results(Incubator):

Results(Receiver Band):

3.2 FUTURE ENHANCEMENT

Even though the proposed neonatal incubator monitors all the essential parameters needed for the environment of a preterm baby, there is still an issue of exposure to high level of noise inside the Neonatal Intensive Care Unit (NICU). Hence the behavior of NICU should be modified so as to reduce the noise Expose. In future there is many implementation can take place, proper oxygen supply controlling and above all the controlling system will automatically on or off. In future we make a monitoring system as Smart Band like a e-watch, we make a possibilities to Monitor a Multi Incubator as one watch. As there will given a particular set point for different parameters, the controller will automatically on if the measuring value goes below the set value and the controller will automatically off if the measuring value goes high compare to the set value. There is also a possibility of replace the power source by solar cell. In rural area there is a big problem in supplying of electricity. So this problem will also overcome in future implementations.

IV. CONCLUSION

The project is designed keeping in mind the medical conditions available in rural areas. This Equipment can be effectively used by technicians in a small health care centre. It can be a lifesaving machine for low birth weight infants. The components can be easily fixed. The chamber is sufficient enough to accommodate the baby comfortably. As the electronic part is separated from the Baby's compartment baby can be assured safe. The temperature of the system can be understood. This project is simple and efficient in maintaining the temperature of the chamber irrespective of the outside temperature and is designed at a low cost.

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