Final Year Project

Smart Baby Incubator

FYP Team

Wadood Bin Habib Khan	16F-8363
Muhammad Usama Ata	16F-8390
Hassan Mansoor	16F-8399

Supervised by

Prof. Dr. Syed Ali Mohsin

Co-Supervised by

Engr. Umer Farooq

Department of Electrical Engineering

National University of Computer and Emerging Sciences Islamabad

Chiniot Faisalabad Campus, Pakistan

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Student 1

Name: **Wadood Bin Habib Khan**

Signature: ___________________

Student 2

Name: **Muhammad Usama Ata**

Signature: ___________________

Student 3

Name: **Hassan Mansoor**

Signature: _____________

Supervisor (Faculty)

Name: **Prof. Dr. Syed Ali Mohsin**

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Co-Supervisor (Faculty)

Name: **Engr. Umer Farooq**

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Student 1

Name: **Wadood Bin Habib Khan**

Signature: ____________________

Student 2

Name: **Muhammad Usama Ata**

Signature: ___________________

Student 3

Name: **Hassan Mansoor**

Signature: ______________

Date: ______________

Abstract

A baby incubator is an apparatus that provides a controlled environment for the sustenance of babies by maintaining a proper temperature. Many Premature Infant have lost their lives due to lack of proper monitoring of incubator that leads to accidents such as overheating, excessive, or less humidity, and fire due to short circuits. A smart baby incubator is designed and implemented that monitors pulse rate and temperature of the baby as well as monitoring and controlling incubator internal temperature, humidity, interior light intensity and also providing fire protection by sprinkling alarms. These readings are continuously monitored and displayed on an LCD screen and all these details are sent to corresponding doctors and nurses by using IoT system in real time. Doctors, nurses and (optionally) parents can monitor the baby from anywhere at any time by using IoT. Relevant medical personnel can also control the incubator parameters. This system ensures the efficient and safe working of incubators.

Acknowledgement

In the name of Allah, the Greatest and therefore the Most Compassionate, all praises to Allah for His blessings in carrying out this project. We pay our exceptional regard and thanks to our teachers who perfected our skills and enabled us to face difficulties and perceive things in the best possible way in our everyday social and academic life. We would like to pay our gratitude to our supervisor Prof. Dr Syed Ali Mohsin, co. Supervisor Engr. Umer Farooq for their continuous guidance, direction and facilitation. We would like to express our deepest feelings of appreciation to Prof. Dr Syed Ali Mohsin and Engr. Umer Farooq for his or her enthusiasm and encouragement throughout the work. We would also like to pay our gratitude to the whole faculty of FAST National University of Computes and Emerging Sciences Chiniot-Faisalabad Campus.

Wadood Bin Habib Khan

Muhammad Usama Ata

Hassan Mansoor

BS(EE)

FAST-NUCES, CFD Campus

Executive Summary

Project essentially includes the construction of the Baby Incubator that is Smart. In this project we designed an incubator which maintain certain environmental parameters that are very essential/required for the growth of the Premature Infant. Parameters like Temperature and humidity are required to be controlled in a certain range for the growth of Premature Babies. While some safety precautions are also included in this system for the better health, monitoring and nourishment of the infant. Parameters like controlling Interior light Intensity, measuring heart beat and lastly providing fire protection by sprinkling system and alarms. All these additional safety features are what makes our baby incubator way better than other incubator. So, after adding all these features we made our baby Incubator smart by introducing IOT in it. IOT sends all of these parameter's values to the Thinkspeak cloud which can be accessed from anywhere and which helps to ensure babies safety to its parents and doctors, in this project we have to maintain temperature of 37 C° and Humidity of 70%. For this purpose, we used two Heating Fan and a Humidifier to control the temperature and humidity inside the incubator using relays being operated by Arduino to maintain 37C° temperature and 70% humidity. For the nourishment of the Premature babies' maintenance of required temperature and humidity is required but many Premature Infant have lost their lives due to lack of proper monitoring of the incubator that leads to accidents (overheating causing short circuits and eventually, the bursting of incubators). Absence of Doctor or Nurse is a Big Problem for the safety of Premature Infant. So, for the safety purposes we have placed these safety procedures constant monitoring of infant's heartbeat, controlling of light intensity and fire protection to make the incubator safer for the infant. And lastly to make the incubator more satisfying and safer we have made the incubator smart by introducing Internet of Things (IOT) into the incubator that helps us upload all the safety and required parameters data to cloud. So, with IOT parents and the family members are less worried as they can keep in check the baby's health all the time. IOT is also helpful for the doctors/nurses to make immediate action if needed.

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Chapter 1

1.1. Problem Statement:

Many preterm infants have lost their lives due to a lack of proper incubator monitoring leading to accidents (heat that causes short circuits and finally, explosion of incubators). The absence of a Doctor or Nurse is a major precautionary measure for the premature baby because continuous monitoring of environmental boundaries is essential for the Premature Infant. In addition, incubators are used and monitor environmental barriers that increase risk.

1.2. Introduction:

4 million premature babies are born into the world. 3.9 million premature infants are less than in developing regions. Most children die due to lack of care and improper temperature regulation [1]. Premature births and low birth weight infants require very intensive care units to provide appropriate care and protection. Many premature babies lost their lives as a result of the pool of care and employment. There have also been cases of Premature Infant deaths classified as technical error in incubators.

To overcome this problem, you need an automated system that can take the natural parameters (temperature, humidity, pulse rate) inside the installer and automatically send these parameters to a cell phone, laptop, or personal computer. Therefore, in this project, we are developing and using a smart baby incubator that can take natural parameters (temperature, humidity, pulse rate) inside the installer and automatically send all of these parameters to a cell phone, laptop, or personal computer doctor and parents at a time. real. To prevent a fire in the incubator in the event of a technical error the system is also able to detect a fire in the event of a technical error and protect it by spraying and alarm system in the event of a fire in the incubator. This system will automatically enable manual operation and monitor the incubator where no human control is always required. This system will send all the parameters to a mobile phone, laptop, or personal computer in real time.

A smart baby incubator is an IoT-based device that successfully captures the parameters (temperature, humidity, pulse rate) inside the incubator. After finding all the parameters within the installer all these components send to the website using IoT servers in real time. Now all our restrictions are on the website. As far as doctors, nurses, and even parents are concerned, they can see these restrictions on your mobile phone and PC in real time.

Any increase or decrease in parameters such as temperature, humidity, heart rate in excess of a specified range turns to the appropriate controller by using a microcontroller to maintain these parameters within a specified range. This system ensures efficient and safe operation of incubators and can help provide a safe and advanced environment for Premature Infant.

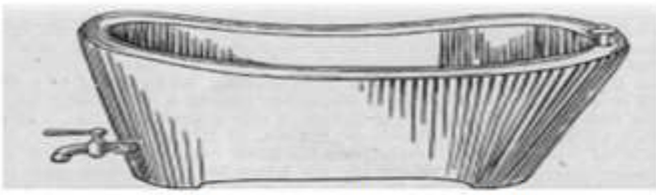
1.3. Brief description of all Existing Approaches

1.3.1. Early Technologies

Prior to the industrial revolution and the introduction of temperature and humidity, which are two important and critical parameters of the children's incubator and the control of these parameters, are necessary for the survival of the Premature Infant. But in ancient times, doctors and scientists did not adhere to these limits so when the Premature Infant was born, people cared for these children at home, most of the children died due to lack of medical knowledge and little development in the industry. the first incubator was developed "in the middle of the nineteenth century".

1.3.2. In 1857 Incubators Study

In 1857 the first incubator was developed from the French pediatrician Denucé for Premature Infant. This device, called a warm bath. This device comes in two different sizes of tubes with a large steel tube and a small metal size. A small metal tub was fitted to a large metal tub. Both tubes are heated from the top edge, this device has a hole near the top to pour warm water. Water and a pump near the bottom of the metal to drain water from the wire. The space between the baths is filled with warm water and the Premature Infant installed inside the tub is a warm water flow to keep the wire warm.

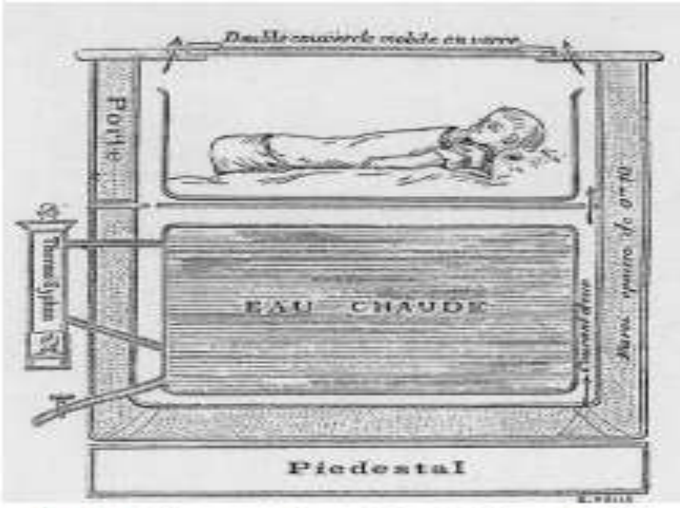


Denuce/Crede *Warmwännen*, from Julius Hess, *Premature and congenitally diseased infants*. Philadelphia: Lea and Febiger, 1922.

Figure 1.1

1.3.3. In 1883 incubators study

In 1883, another incubator was invented and the device had a double wooden box, there was space between the double walls and the space was filled with a saw. There were two parts for this device above and below. The lower chamber of the device is used to generate heat regulation temperature. To protect the baby from the manure from a gas or alcohol heater, in the lower part of the box, Tarnier used a gas-fired thermosiphon to heat the pool. The upper chamber was used for the unborn child. In the upper room was placed the baby prematurely. The air would enter the box at the bottom, be heated by the pool, and then go up through the holes to reach the baby above. The air would then pass over the heater through holes in the double-closed glass door. By monitoring the incubator temperature, a thermometer is placed in the upper room next to the baby. This thermometer allowed observers to monitor the temperature without opening the box. It is recommended by Tarnier that the thermosiphon of this device amplifier be heated three times a day for an hour in winter, and lighted twice a day in summer.



Tarnier *Couveuse*, from Pierre-Victor-Adolph Auvard, "De La Couveuse Pour Enfants," *Archives de Tocologie des Maladies des Femmes et des Enfants Nouveau-nés*, 14, October 1883.

Figure 1.2

1.3.4. In 1891 incubators study

In 1891 reports of the design of new incubators reached France. Link created by Alexander Lion of Nice. This toothbrush made by the Emperor is made of metal. Other components included in the project were glass doors in front of the heater and in hot water circulation there was a wind pipe at the bottom of the incubator. The implant was played with a suction pump, cleaned, and passed to a base. At the top of the installer, there was a fan indicating the air circulation rate. The unborn child was separated from the rest of the incubator by a separate section. In this divorce, there was a mattress and the unborn child was placed on a mattress in a basket that was placed on the sides of the utility with springs. The boiler was located on the side of the incubator and could be heated by coal, oil, electricity, methylated air, or other fuel, and the temperature was regularly controlled with a thermostat. At that time, the toothbrush was large, intricate, heavy, and extremely expensive. This installation device requires structures to be able to use it properly [2],

Incubators and Nurses, with Lion in background, at an Incubator Charity in France. From James Walter Smith, "Baby Incubators," *The Strand Magazine* (London, 12, 1896), 771.

Figure 1.3

1.3.5. In 1985 study

In 1985, most of the Premature Infant was cared for in incubators using air mode or skin servo control. Details of this process were collected continuously using a computer-linked monitoring system. In air mode control neutral temperatures which can be used to set the incubator temperature. The thermo-neutral range of Premature Infant was very small.

Skin servo temperature control of the premature baby received by the thermistor was used to control the natural temperature [3].

1.4. Recent Technologies

Due to advances in the fields of information and communication technology (ICT), Internet of Things (IoT), and sensory technology. This technology has not only helped to improve society but also in the furtherance of other fields. This technology has opened many doors for not only people of these fields but also many people from other fields. They are responsible for modernizing their territory through the use of these technologies and increasing social development.

Due to the development of information and communication technology. We can transfer our desired data in many ways but we can also control its transmission. With the help of the Internet of Things (IoT) information we have passed on to the website with the help of can. After you send this data to the website, we can store this data there - and at any time we can not only access this data but we can also use it at will.

With the advancement of sensory technology, we can capture information about anything in the physical, chemical or biological state and we can turn this information into our wish signal using different techniques. In addition, depending on the nature of our work senses it gives us real-time monitoring, reporting, and discovery and makes our work easier. Thanks to this technology some of the major challenges in the health care system have been successfully addressed. This emerging technology has not only opened many doors to modern medicine but also improved the quality of existing equipment. This technology also enhances the efficiency and effectiveness of existing equipment. Now a day, this technology is being used to develop new precision and high-quality medical equipment.

1.4.1. Temperature Control System using Pulse Width Modulation (PWM)

Temperature control at a continuous level of 37 degrees is very important in the incubator of the unborn child. Over time, more and more progress has been made in thermal regulation. In 2012 a paper was published in the Bangladesh Journal of Medical Physics related to the incubator.

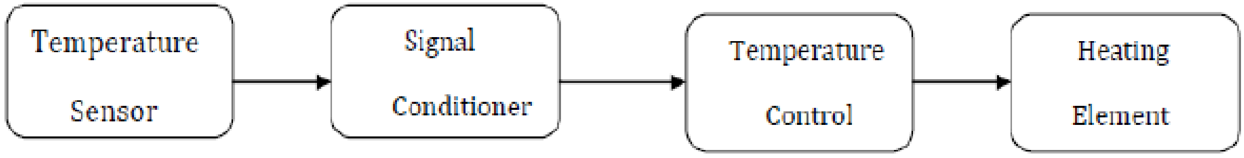


Figure 1.4

To overcome this problem, they build ON-OFF circuits using a simple Pulse Width Modulation (PWM) method using 555 integrated time calculators as shown in Fig. This region has two sections on the right side and half on the left side. The right side of this region should mean a stable or monostable state and the time of this region is controlled by Thermistor. So that the pulse width decreases in relation to the temperature. The left side of this is not in a stable position. The effect of this region travels between two unstable (amazing) states with a frequency of 100Hz. In this system left side a stable circuit triggers the monostable circuit to produced train of pulses whose width is modulated by temperature.

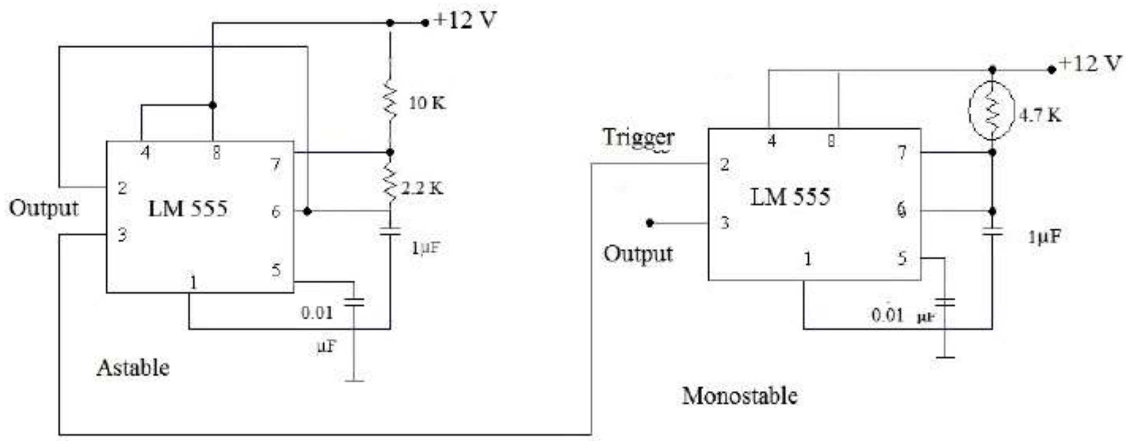


Figure 1.5

But due to the unlimited resistance of the thermistor, the work cycle of the above circuit cannot be zero. This means that after reaching the designated area the heater used for heating regulation will continue to provide heat to the incubator. For PWM control cycles they need another control circuit that can turn off the heater after reaching the designated area. Therefore, a new improved control system was developed which was a combination of PWM and a simple ON-OFF control system.

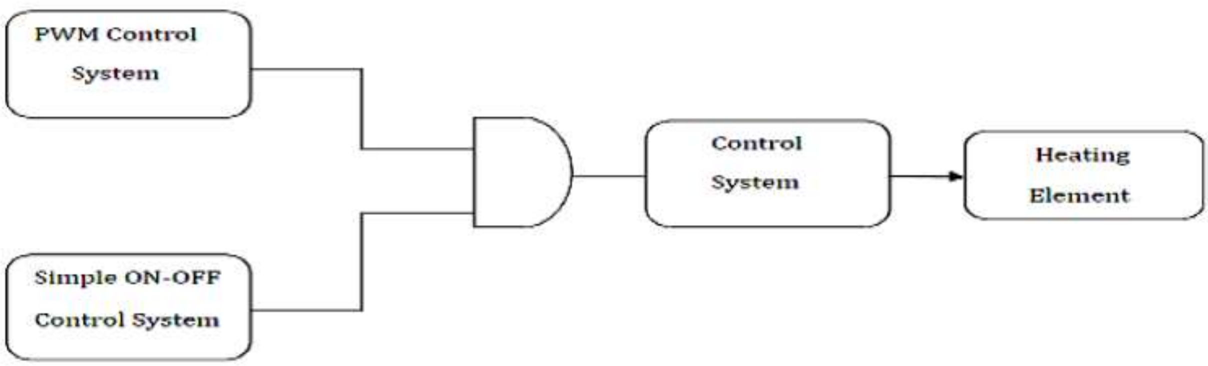


Figure 1.6

With this integrated control system when a simple ON-OFF circuit breakout is high the output of the AND gate following PWM. Therefore, in the case, the amount of heat generated is controlled by the PWM outputs.

If the temperature exceeds the set limit, the output of a simple ON-OFF circuit becomes zero; these zero results for a simple ON-OFF circuit pressing the AND out of the gate to zero, depriving PWM. When simple ON-OFF performance is higher than PWM, the heater is turned off at a constant temperature [4].

1.4.2. Temperature & Humidity Control using Microcontroller (AT89C52)

A paper entitled "Development of a Microcontroller Dependent Temperature and Humidity Controller" was published in 2015 by Infant Incubator.

This paper discusses the microcontroller-based incubator concept of Premature Infant. Including, the construction of a thermal and humidity control spray,

- Temperature Sensor (LM35)
- Moisture sensor (HIH 3310)
- Analog to Digital Converter (ADC 0808)
- Microcontroller (AT89C52)
- Temperature controller

After comparative research they chose all these sensors, Analog to Digital Converter, and Microcontroller.

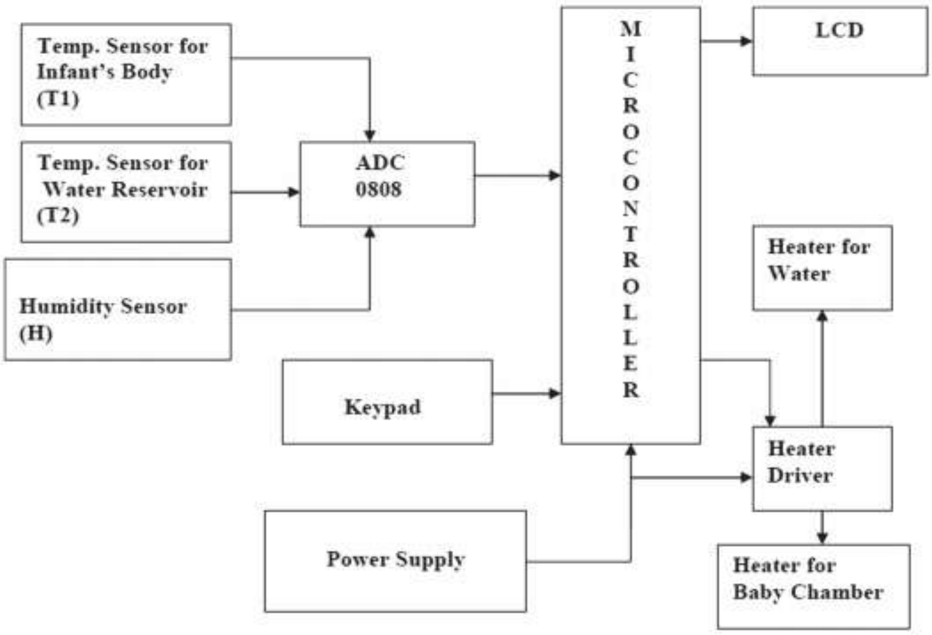


Figure 1.7

From the block diagram of this design, there is a keypad connected to the microcontroller to enter the set temperature and humidity points. Power supply power for microcontroller and heater driver. Sensors (Temperature sensor T1, Temperature sensor T1Humidity sensor) data initially provided Analog to

Digital Converter (ADC 0808) because this data is naturally analog. After converting data from analog to digital this data is sent to the microcontroller. Microcontroller analyzes the sensors and checks the temperature or humidity with the limits of definition or not. If the temperature or humidity is not within the definition limits, then it will turn on the heater to provide heat in the infant room. They will remain open until room temperature can be maintained. After reaching the set point temperature the microcontroller will turn off the heater [5].

1.4.3. Temperature and Humidity Control using Microcontroller Arduino Mega 2560

The paper "Development of the Incubator Monitoring and Control System for Infants" Published at the 2018 World Conference on Computer, Control, Electrical and Technological Engineering (ICCCEEE)

In this paper, they have provided the design of the thermal and humidity regulator insert using a different type of microcontroller (Arduino Mega 2560) and sensors. The requirements for temperature and humidity control of their system are given below.

Mode of System Operation	**Automatic Control**
Temperature Range	270C-370C
Relative Humidity	>70 % R.H
Temperature of Skin	370C
Mode of Temperature Control	Air Temperature Control
Display	LCD

Table 1.1

There are five key processes in their flow conversations to meet these needs

- Adjust the baud for serial data transmission rate and com port
- Established connection
- Sensors measured reading send to Arduino board
- Arduino board read the data send by sensors
- After reading the Sensors data these values display on the display screen.

And hardware design to achieve requirements is

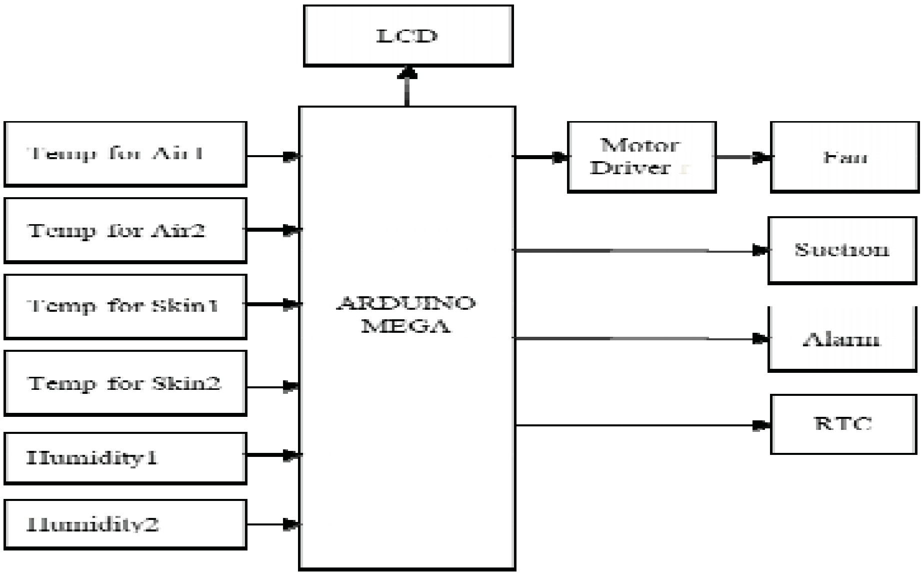


Figure 1.8

A block diagram of this project using a microcontroller (Arduino Mega), temperature sensors and moisture and other Hardware is shown in Figure 1.7.
The Arduino Mega 2560 used to receive and read data from sensors. DHT11 sensor temperature and humidity used to measure temperature and humidity and LM35 used to measure skin temperature. After reading this data microcontroller analyze the data and check whether the values correspond to the specified point or not in the event of a price uncertainty in setting the point Arduino WILL APPEAR in the appropriate control (e.g., alarm, heater), and after the data is sent to the channel intermediate controlled by personal computer. By setting the date and time they use the RTC DS130 real time clock. In this visual interface design used to display data sent or received to or from the Arduino board during operation. [6].
In 2019, another paper entitled "Smart Infant Incubator Based on Mega Microcontroller" was published at the 2nd International Conference on Engineering Technology and its Applications (IICETA) with the same function and specific modifications in system development. Where they used a microcontroller (Arduino mega) but modification and development they added additional sensors
As with the design they use the Co2 Gas Sensor (MQ-5 sensor) to check whether the level of CO2 inside the incubator is within the set limit or not. Therefore, this sensor provides information about the percentage of CO2 and this information is used to inform the level of oxygen. As the increase in CO2 levels in the incubator this will indicate that the oxygen level is decreasing and if the CO2 level drops in the incubator this will indicate that the oxygen level is increasing. And another sensor is installed in the water level structure to measure the distance between the placement point and the water point [7].

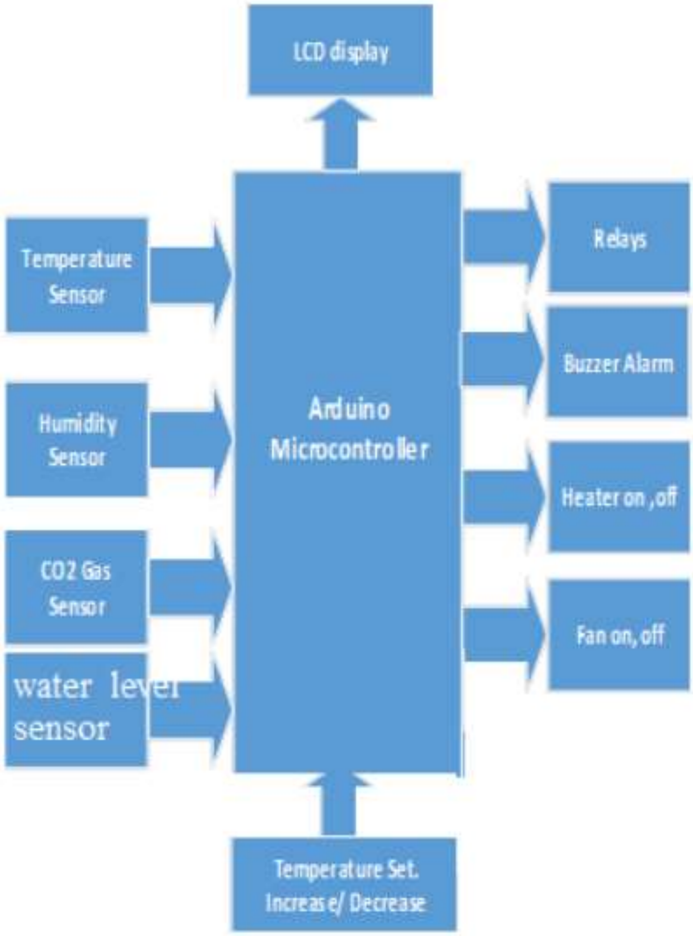


Figure 1.9

1.4.4. Temperature and Humidity Control using Microcontroller using internet of things (IOT)

Temperature and humidity control are the main and important features of the incubator, because premature baby survival depends on the specific temperature and humidity. Medical devices are advancing, with technological advances. Engineers are introducing new technologies in advance to medical devices so that they can perform more accurate and reliable tests for doctors and patients.

The paper "Remote monitoring of early childhood incubator" is published in 2020. In this paper to improve the incubator and make it more reliable include internet of things (IoT). In this paper to develop incubators and make them more reliable they are involved in the Internet of Things (IoT). The main reason for Ioot involvement is that they can provide an automated monitoring system rather than human control. For a premature baby to get a strong and reliable monitoring system and to gain an increased survival rate. In this incubator structure, they are installed,

- DHT11 sensor for data taking temperature and humidity
- Microcontroller (Arduino UNO) for sensor data acquisition
- Wi-Fi data transfer module is heard in ThingSpeak,
- ThingSpeak as an open-source interface for IoT that can store and retrieve data from sensors.

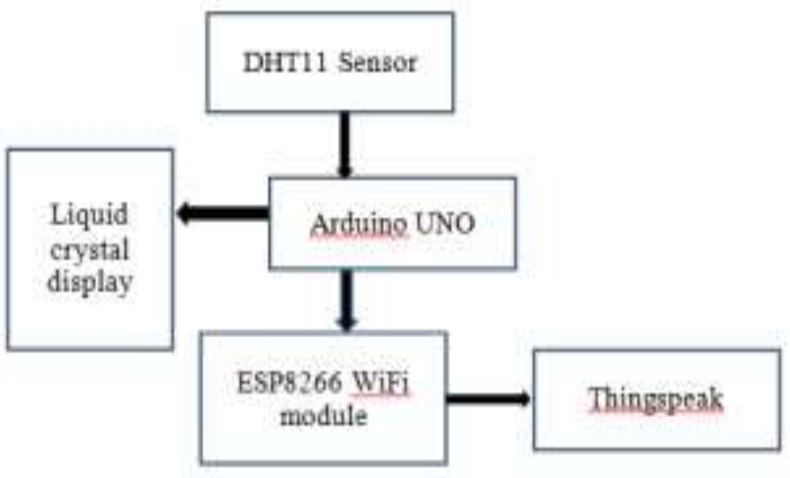


Figure 1.10

From the block diagram the first microcontroller (Arduino UNO) will receive sensor data from the sensors.
The sensor data will then be transmitted to the ThingSpeak interface via a Wi-Fi module, where we can access this data or values using a portable or personal computer (PC).

1.5. Compact Tree Diagram of Existing Approach

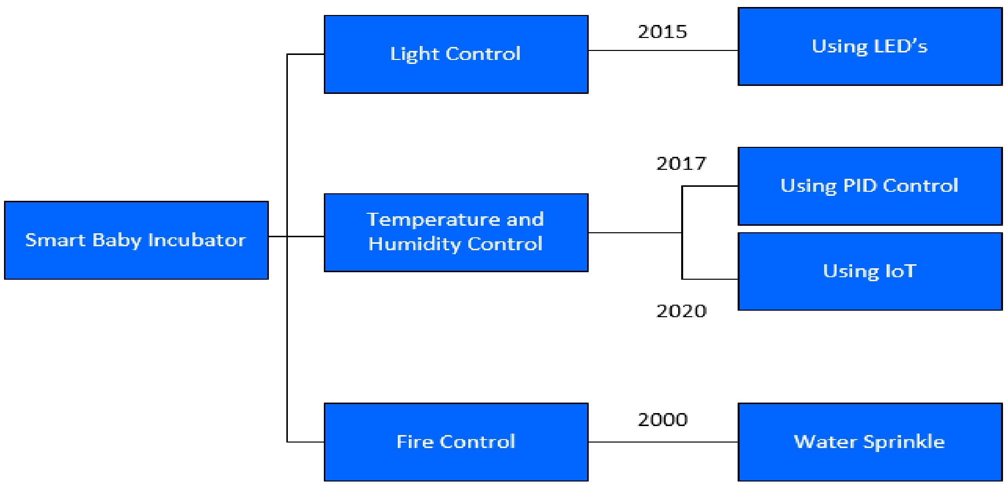


Figure 1.1

CHAPTER 2

2.1. Proposed work

In this project we introduce a smart baby incubator that provides a controlled environment to feed young children by maintaining the right temperature. We have designed and used this incubator to monitor the temperature of the pule and baby temperature as well as to monitor and control the internal temperature of the incubator, humidity, internal lighting and to provide fire protection with spray / alarms. These readings are continuously tested and displayed on the LCD screen and all this information is sent to the corresponding doctors and nurses through the ThingSpeak IoT system in real time.

2.2. Features of our project Control Parameters

2.2.1. Temperature and Humidity Control

One of the most important factors in the survival of the newborn is the regulation of the baby's temperature and humidity. A newborn baby grows up easily homoeothermic, but the limits to which this type of baby can live are different. The baby's body temperature should be maintained at 37 C. Another important factor in the incubator ahead of time is the regulation of moisture. Moisture should be maintained at all times and should not be reduced or increased from certain values. To provide a child friendly and safe environment the relative humidity should be maintained within 74% RH. With regard to the above problems related to the baby we need to create a system of such an incubator control system that controls the temperature and humidity of the environment inside the implant from which the newborn is out. Figure 2 shows a diagram of the control unit block on which the incubator will operate to determine the maximum temperature and humidity. The design requirements for an infant implant to provide the desired conditions for children are:

(1) Atmospheric Temperature of 37 C.   (2) Moisture Range 74% RH.

In this room there is a heater and a humidifier. When the relative humidity falls below 70% the moisture evaporates, as a result the water is evaporated. A fan placed behind the heater helps to blow up smoke in a small room. If the relative humidity exceeds 74% the exhaust fan placed outside the room eliminates air outside the spray. Here the humidity is felt by the same sensor of DHT22. This sensor has a great advantage because it can provide signals in both heat and humidity. [8]

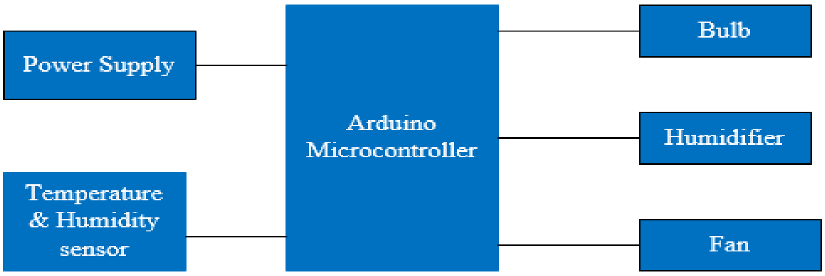


Figure 2.1

2.2.2. Light intensity

The BH1750 light sensor with 16-bit ADC built-in. The main quality of this sensor is that it provides a direct digital signal like output, the BH1750 sensor is easy to use and more accurate than a simple LDR. There is no need to do complex calculations like LDR whose output is minimal electricity and we need to advance statistics to get useful data. The BH1750 Light Sensor directly measures the power by the luxmeter. The information obtained by this sensor is directly from Lux. Light-emitting diode (LED) light source phototherapy is effective in lowering serum total bilirubin levels in amounts similar to phototherapy with compact fluorescent (CFL) or halogen light sources. At the stage of diagnosis by a doctor's diagnosis we can manually change (increase or decrease) light intensity using a potentiometer. The Potentiometer controls the current passing through the LED which also leads to a change in the intensity of the LED. [9]

2.2.3. Heartbeat Monitor

Use it to monitor heart rate Usually, if the child's condition prematurely occurs when they stop breathing or their heart rate decreases. The medical name of this province is Apnea of prematurity. Therefore, it is very important to monitor the heart rate of Premature Infant. Heartbeat sensor is a simple plug-and-play heartbeat sensor and is easy to use with Arduino. The heartbeat sensor increases the frequency of amplification and deletion of sound in the hardware. The Heartbeat Monitor is an Infrared sensor that continuously calculates the number of pulses in 60 seconds and sends it to the controller.

2.2.4. Fire Sensor

Due to the recent accidents in the incubator due to short-term electrical wiring we use a spray system to reduce fire, for this we use a fire sensor (LM 393) sensor that fire and sprinkles are installed inside the sprayer to keep the baby on fire and buzzer for alarm purposes. This scheme server as an immediate protection against fire before anyone arrives.

2.3. Circuit Layout

All sensors connected to the Arduino mega and Wi-Fi ESP 8266 module all readings are sent to ThinkSpeak which can be accessed on a mobile phone or other Electronic Devices like Laptops and Computers.

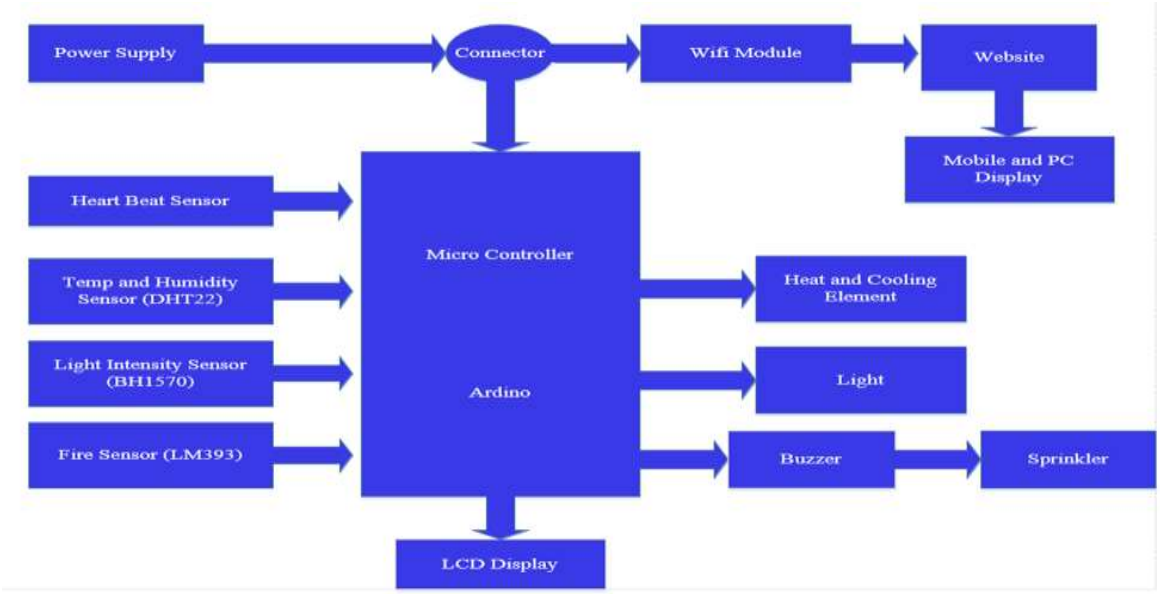


Figure 2.2

2.4. Project Deliverables and Specifications

This is a low cost but efficient operation of the smart baby incubator that controls the most important environmental parameters required by the Premature Infant. What is important about this project is that all environmental parameters are real time rented on a mobile phone or laptop and under the supervision of a doctor or related parents. The submissions and specifications of this project will be

- Control of Temperature.
- Control of Humidity.
- Control of Light Intensity.
- Fire Protection by Sprinkling system.
- Display on Personal Computer/Mobile in real time.
- Display of Pulse rate

CHAPTER 3

3.1. Methodology

There are five key processes in their flow conversations to meet these needs

- Adjust the baud for serial data transmission rate and com port.
- Established connection.
- Sensors measured reading send to Arduino board.
- Arduino board read the data sent by sensors.
- After reading the Sensors data these values display on the LCD display screen.
- Then Arduino Board Actuates the Actuators accordingly.
- Arduino Board Also Sends Data Online.

And hardware design to achieve requirements is

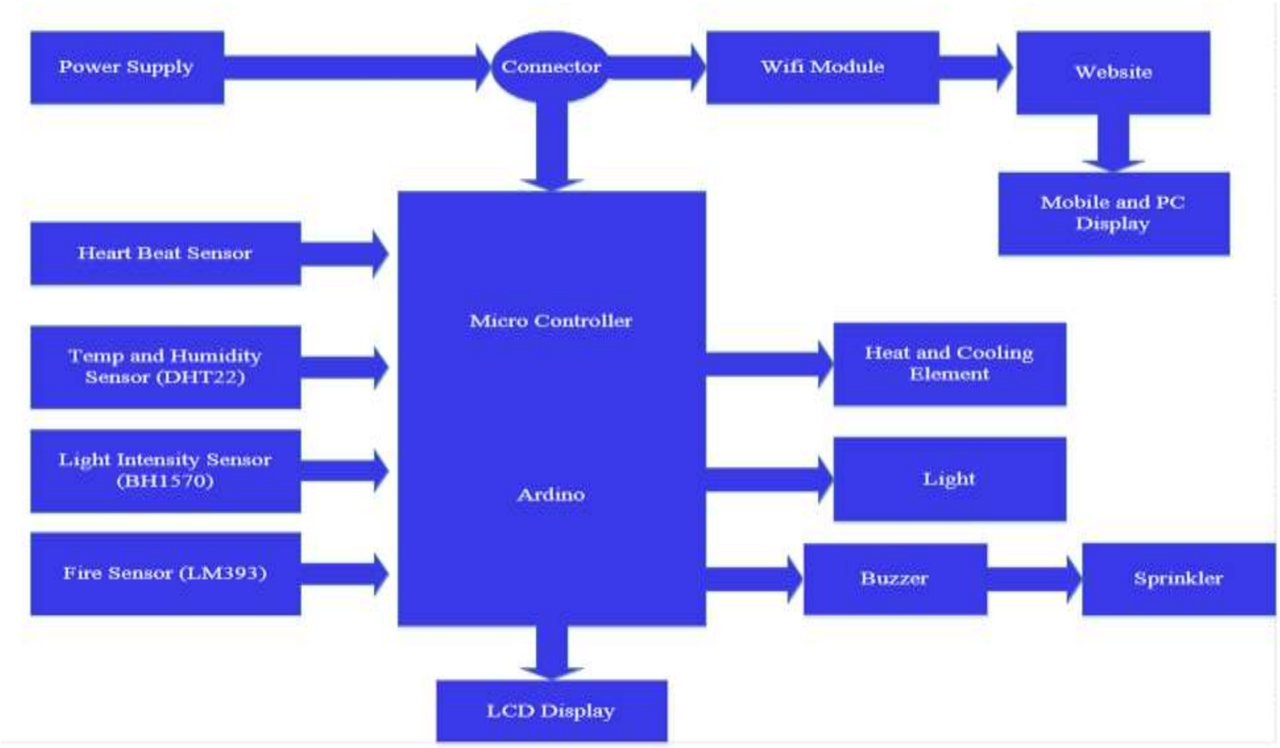


Figure 3.1

A block diagram of this design using microcontroller (Arduino Mega), Temperature and Humidity sensors, Heartbeat Sensor, Light Intensity Sensor and Fire Sensor is shown in Fig. 3.

3.1.1. Temperature and Humidity Control using Microcontroller using Internet of Things (IOT):

Temperature and humidity control are the main and important features of the incubator, because premature baby survival depends on the specific temperature and humidity. Medical devices are advancing, with technological advances. Engineers are introducing new technologies in advance to medical devices so that they can perform more accurate and reliable tests for doctors and patients.

The main reason for IOT involvement is that they can provide an automated monitoring system rather than human control. For a premature baby to get a strong and reliable monitoring system and to gain an increased survival rate. In this incubator structure, they are installed

- DHT11 sensor for the taking temperature and humidity data.
- Microcontroller (Arduino UNO) for receiving sensor data.
- Wi-Fi module for sending sensor data to the ThingSpeak.
- ThingSpeak as open source IoT interface that can store and retrieve data from the sensors.

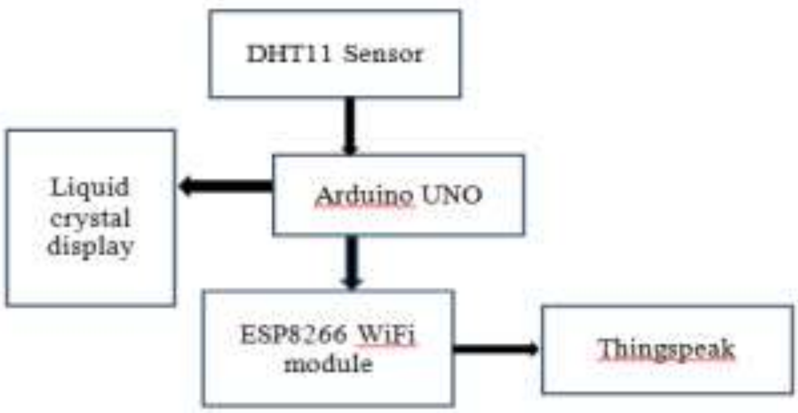


Figure 3.2

From the block diagram the first microcontroller (Arduino UNO) will receive sensor data from the sensors. This sensor data will then be transmitted to the Think Speak interface via the Wi-Fi module and the LCD Display for Display, and we can access this data or values using a portable or personal computer (PC) [10].

3.1.2. HEARTBEAT SENSOR

Heartbeat sensor is a small clean chip used to measure the electrical activity of the heart. This electrical activity is considered an electrocardiogram. This Electrocardiography mechanism is used to help find different heart conditions.

Figure 3.3

The heartbeat sensor is connected to Arduino and regularly measures the heart rate of Premature Infant sends data to Arduino and this data is displayed on LCD Display and sent online. Therefore, we can always monitor the child's heart rate.

3.1.3. IOT

IOT has evolved from a mix of new remote devices, small electromechanical components (MEMS) and the Internet. The concept can also be referred to as Internet of All. Web of Things (IoT) is the online use of physical gadgets, cars, buildings and various hardware, hardware, sensors, actuators, and a system network that empowers these topics to collect and trade information. The object, in the Internet of Things, could be a person with heart screen embedded, an animal with a biochip transponder, a sensory vehicle to introduce the driver when the tire pressure is low - or something normal or man-made - created an article that could not return an IP address details above the system. Node MCU is used for IoT in our project.

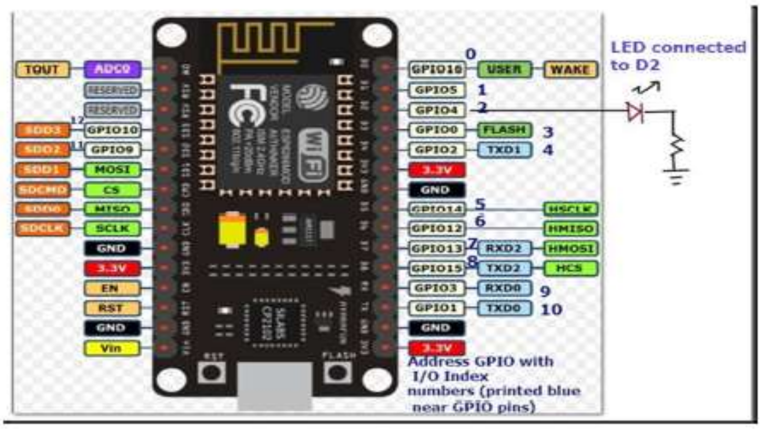


Figure 3.4 ***Node MCU***

3.1.4. Alarm

Alarm monitoring system is the fast connection between the monitoring system and the central channel that provides this security and monitoring. The alarm monitoring system is activated only if any parameter returns the specified value list. This alarm monitoring system will make a sound when any violet parameter we want to control in a baby incubator. This alarm sound will tell doctors that any parameter is changing inside the incubator.

3.1.5. Working

The Working of Smart Baby Incubator is described below.

Figure 3.5

- Adjust the baud for serial data transmission rate and com port.
- Established connection.
- Arduino receives and reads the data from sensors.
- DHT11 Temperature and humidity sensor measures the temperature and the humidity of the Incubator and sends data to the Arduino.
- Heartbeat Sensor checks the Heartbeat Rate of the baby constantly and sends the Data to Arduino.
- Arduino Also constantly checks the Alarms reading to check if any error occurs.
- After reading this data microcontroller analyze the data and checks that either values are according to the set point or not in case of any uncertainty in the values with respect to set point Arduino will ON the respective control (i.e., alarm, heater).
- Then Arduino Board Actuates the Actuators accordingly.
- After that this data is Displayed on LCD Display and sent Online so it can be checked from anywhere in the world.
- The sensors are connected with the pins of Node MCU and connected with the Arduino.
- By adding the library files in the Arduino IDE software and Node MCU files the WI-FI network is established so that the data can be stored in ThingSpeak.

CHAPTER 4

Hardware and Software Implementation

4.1. Hardware

The hardware of this project includes:

- Arduino UNO
- NodeMCU
- Temperature and humidity sensor (DHT22)
- Heartbeat sensor
- Flame sensor
- Light Intensity sensor
- LCD Display 16x4
- Incubator Body
- Humidifier Chamber
- Heating Fan
- Sprinkling Chamber
- Control Panel
- Complete Incubator

4.1.1. Arduino UNO

4.1.1.1. Description

Arduino UNO board operating microcontroller. The Arduino UNO board has an ATmega328P microcontroller on board. It has 14 digital input and output pins, 6 of these 14 pins can be used as PWM output pins. The Arduino UNO board also contains.

- Six analog inputs pins
- A 16 MHz ceramic resonator
- A USB port connection
- A power jack connection
- A reset button

The Arduino UNO board has everything on board that we need to support the microcontroller. Simply connect the Arduino UNO board to a computer with a USB cable or mount the Arduino UNO board from an AC power adapter to DC to start project boards [10].

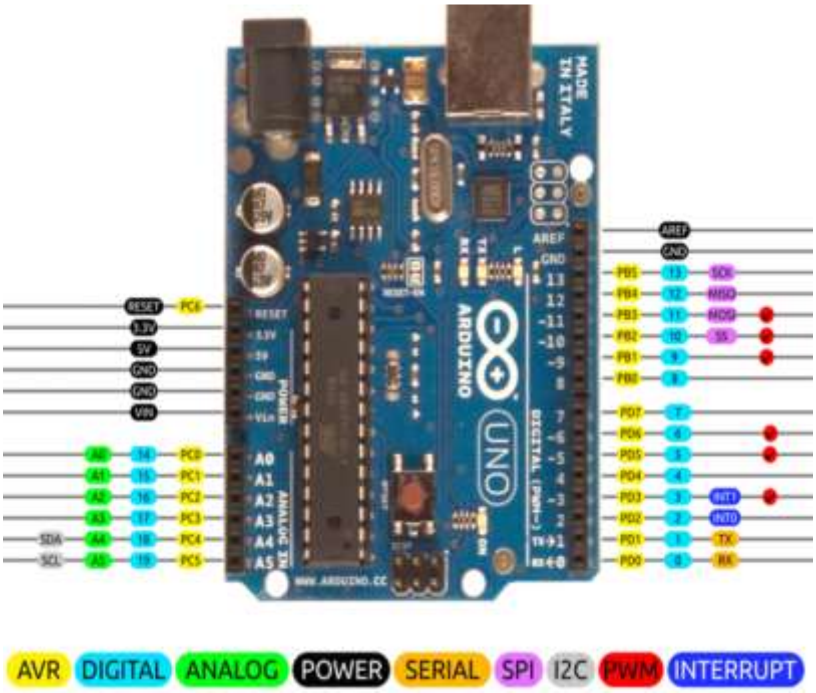


Fig 4.1

4.1.1.2. Technical specifications

Microcontroller	Atmega328P
Recommended input voltages	7 t0 12V
Operating voltage	5V
Input voltage limit	6 to 20V
DC current on inputs and output pins	40mA
DC current on 3.3V pin	50mA
Flash memory	32KB
Frequency clock speed	16MHZ
SRAM	2KB
EEPORM	1KB

Table 4.1

4.1.2. NodeMCU

4.1.2.1. Description

NodeMCU is an inexpensive open-source platform. which is LUA-based firmware and designed for ESP8266 Wi-Fi chip. As NodeMCU is an open-source platform that is why hardware design is also open to

- Edit
- Modify
- Build

The NodeMCU upgrade board contains an ESP8266 Wi-Fi enabled chip. ESP8266 is a low-cost Wi-Fi chip developed by Espressif systems on this chip that includes the TCP / IP protocol. The NodeMCU development board also has analog graphics and digital pins such as the Arduino board. The NodeMCU development board also supports successive communication agreements i.e.

- UART
- SPI
- I2C

Bye using these serial communication systems NodeMCU development board can connect with serial devices like,

- LCD display
- RTC chips
- GPS modules
- Touch screen displays
- SD cards

As the NodeMCU development board has built up Wi-Fi support that gives us an easy way to IOT applications as per our technical needs [11].

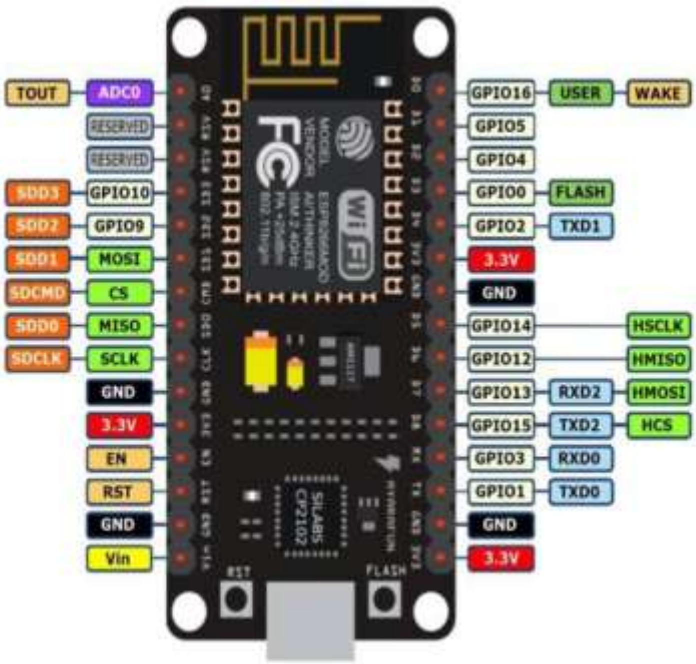


Fig 4.2

4.1.2.2. Technical specifications

Microcontroller	Tensilica 32-bit RISC CPU Xtensa LX106
Operating voltages	3.3V
Input voltages	7 to12V
Digital pins	16
Analog pin	1
UARTs	1
SPIs	1
I2Cs	1
Flash memory	4MB
SRAM	64KB
Clock speed	80MHZ
PCB Antenna	

Table 4.2

4.1.3. Temperature and humidity sensor (DHT22)

4.1.3.1. Description

Temperature and humidity sensor (DHT22) is a digital device that costs very little to measure temperature and humidity. DHT22 contains:

- Single digital cable interface.
- Strong moisture sensor and air conditioning thermistor.
- No need for analog input pins for this.
- It does not require additional components to measure humidity and temperature.

DHT22 is a simple sensor and can easily measure moisture and temperature. We can get new DHT22 sensor data every 2s [12].

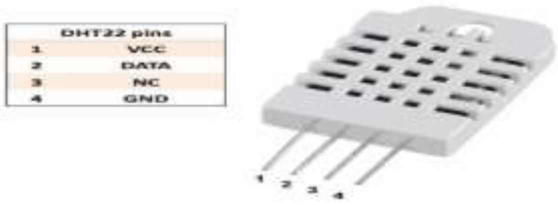


Fig 4.3

4.1.3.2. Technical specifications

Power supply	3.3 to 6v DC
Output signal	Digital signal
Sensing element	Polymer capacitor
Operating range	Humidity 0 to 100%rRH Temp -40 to 80 degree Celsius
Accuracy	Humidity +-2%rRH Temp <+-0.5 degree Celsius
Repeatability	Humidity +-1%rRH Temp +-0.2 degree Celsius
Sensing period	2s
Interchangeability	Full interchangeable
Dimensions	Small size 14185.5mm Large size22285mm

Table 4.3

4.1.4. Heartbeat sensor

4.1.4.1. Description

Heartbeat sensor is a simple plug-and-play heartbeat sensor and is easy to use with Arduino. The heartbeat sensor increases the frequency of amplification and deletion of sound in the hardware. The heartbeat is very fast in operation, easy to use and in this case, we can get reliable road readings [13].

Fig 4.4

4.1.4.2. Technical specifications

Operating voltages	3 to 5V
Operating current	4mA at 5V
Thickness	3mm
Diameter	16mm

Table 4.4

4.1.5. Flame sensor

4.1.5.1. Description

Flame sensor is a type of detector that is usually designed to detect and respond to fire and flame detection. The detection of fire and flame can depend on the location of the sensor of any kind.
Flame sensor contains:

- Electronic circuit
- A receiver like electromagnetic radiation

The flame sensor uses the infrared flame flash method. This method of infrared flame flash allows the sensor to operate with oil, dust, water vapor [14].

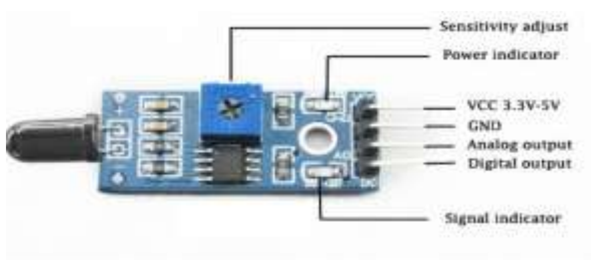


Fig 4.5

4.1.5.2. Technical specifications

Power supply(pin1)	3.3 to 5.3 V
GND (pin 2)	Power supply ground
AOUT (pin 3)	Analog output pin
DOUT	Digital output pin

Table 4.5

4.1.6. Light intensity sensor

4.1.6.1. Description

The BH1750 light sensor with 16-bit ADC built-in. The main quality of this sensor is that it provides a direct digital signal like output, the BH1750 sensor is easy to use and more accurate than a simple LDR. There is no need to do complex calculations like LDR whose output is minimal electricity and we need to advance statistics to get useful data. The BH1750 Light Sensor directly measures the power by the luxmeter. The information obtained by this sensor is directly from Lux [15].

Fig 4.6

4.1.6.2. Technical specifications

Power supply	3.3 to 5V
Light range	65535lux
Sensor built in	16 bit ADC
Size	3.2cm to 1.5cm

Digital out put	
bypass the complex calculations	

Table 4.6

4.1.7. LCD Display 16x4

4.1.7.1. Description

LCD display have 7 Characteristics: [7]

- 5x8 dots with cursor.
- Built-in controller KS0066 or equivalent.
- + 5V single power supply (option: + 3V).
- 1/16 duty cycle.
- LED B/L pins: A/K, or 1/2, 15/16.
- Backlight: LED B/L.
- Option: Negative Voltage.

Fig 4.7

4.1.8. Incubator Body

We are designing an incubator with dimensions Length = 36 inch and Width = 24 inch. Upper body is made of acrylic sheet and lower body is made of metal.

Fig 4.8

4.1.9. Humidifier Chamber

4.1.9.1. Humidifier Parameters:

working voltage: 24V
power: 16W
diameter: 45 mm
working frequency: 1700±50(KHZ)
water depth: 20mm-70mm
Working temperature: 5 ~ 45°C

Spray head

Fig 4.9

Fig 4.10

4.1.10. Heating Fan

4.1.10.1. Electric Heater Parameters:

Voltage = 12v
Power = 300w
Rated Current = 12.5A-16.7A
Outlet Temperature = 80^{o}C

Fig 4.11

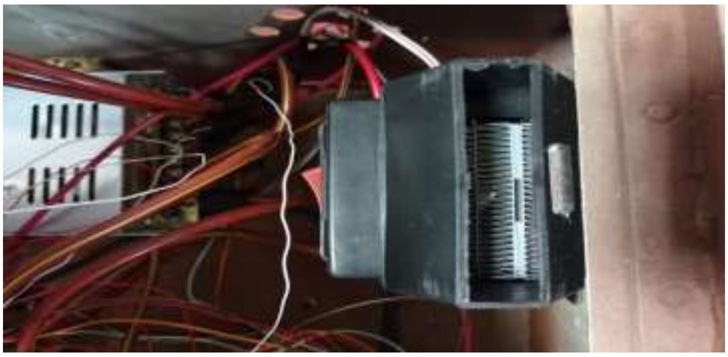


Fig 4.12

4.1.11. Sprinkling Chamber

Water Pump Parameters

Voltage = 12v DC
Power = 8 Watts
Maximum Height 5 Meters
Water Flow 10 Liter per Minute

Water Sprinkler Nozzle

Fig 4.13

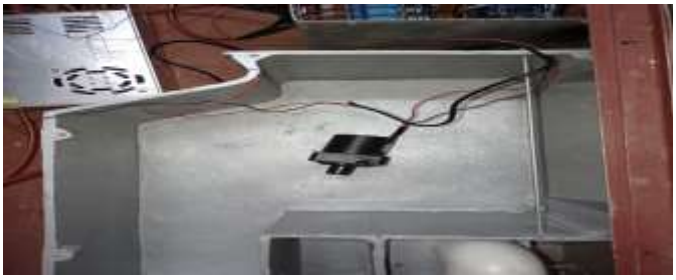


Fig 4.14

4.1.12. Control Panel

In the control panel we are using 8-channel relay module, Arduino, ESP 8266, Breaker, Indicator, and LCD.

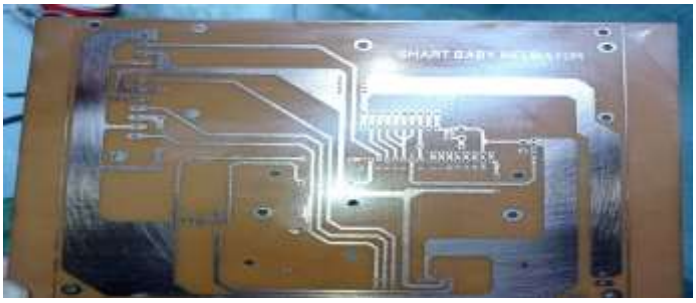


Fig 4.15

Fig 4.16

Fig 4.17

Fig 4.18

4.1.13. Complete Incubator

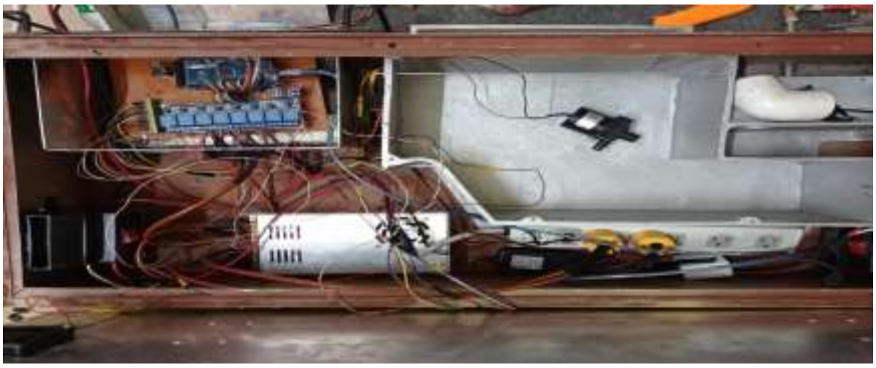


Fig 4.19

Fig 4.20

CHAPTER 5

5.1. Software

- Proteus
- Arduino IDE

5.1.1. Proteus

Proteus ISIS is software developed by Labcenter Electronics Ltd for student use and engineering to create schematics and simulation of various electrical circuits and projects prior to circuit implementation and projects. After creating the schematics and comparisons of different electrical circuits and projects we can create a PCB design for an active region. Proteus somehow affiliate software gives a tendency to circuit design. Proteus works in the right conditions; this software is available in four different languages [16].

- English
- Chinese
- Spanish
- French

Fig 5.1

5.1.2. Arduino IDE

Arduino Software (IDE) contains:

- Text editor which is used for writing code
- Message area for massages
- Text console
- Toolbar which contains common functions
- Serial monitor

The program we write with the help of Arduino Software (IDE) in the text editor is called diagrams. All of these programs or drawings we write with the help of Arduino Software (IDE) using the text editor ".ino" extension. In the editor of this Arduino Software (IDE) we can also cut, paste and change the text. In the message field Arduino Software (IDE) shows errors while compiling. The Arduino Software IDE console displays output and other related information. By using this software, we can easily design and customize any Arduino board according to our needs [17].

5.2. Project Deliverables

- Control of Temperature within limit
- Control of Humidity within limit
- Control of Light Intensity within limit
- Display of Pulse rate within limit
- Fire Protection by sprinkling system to avoid any loss
- Display on Personal Computer/Mobile in real time by using IOT platform

CHAPTER 6

6.1. Results

As we discuss and explain the functionality of our project hardware in our intended project. Where we discuss the parameters and control of the parameters needed to survive Premature Infant. For this purpose, the results we have achieved so far include.

- Working of temperature and humidity sensor and his controls with Arduino
- Working of heartbeat season and his control with Arduino
- Working of flame sensor and his control with Arduino

Now we discuss working of each sensor and his control with Arduino

6.1.1. DHT22 Sensor with Arduino

Here for the purpose of monitoring and controlling the temperature and humidity we use the DHT11 sensor. This sensor has three anchors (VDD, DATA, and GND). DHT11 also has a single wireless phone interface and data pin that is used such as temperature and humidity output. Figure 5 shows this DHT11 data pin connected to Arduino pin 2 so that the sensor-inserted values are transmitted to Arduino. After receiving these values (temperature, humidity) Arduino will analyze whether these values are within our required limits or not, if these values are below our limits Arduino will display these values on the serial monitor and LCD. if these values are not within our required limits after analyzing these values (temperature, humidity) Arduino will start proper control connected to a 3,4,5 Arduino pin as shown in Fig. 1 (Follower or heater) to maintain the standard temperature and humidity within the limits. The VDD pin is used to amplify the sensor and the virtual terminal is used to view data from the sensor via the serial port.

6.1.1.1. Technical specifications of DHT22

Power supply	3.3 to 6v DC
Output signal	Digital signal
Sensing element	Polymer capacitor
Operating range	Humidity 0 to 100%rRH Temp -40 to 80 degree Celsius
Accuracy	Humidity +-2%rRH Temp <+-0.5 degree Celsius
Repeatability	Humidity +-1%rRH Temp +-0.2 degree Celsius
Sensing period	2s

Interchangeability	Full interchangeable
Dimensions	Small size 14185.5mm Large size22285mm

Table 6.1

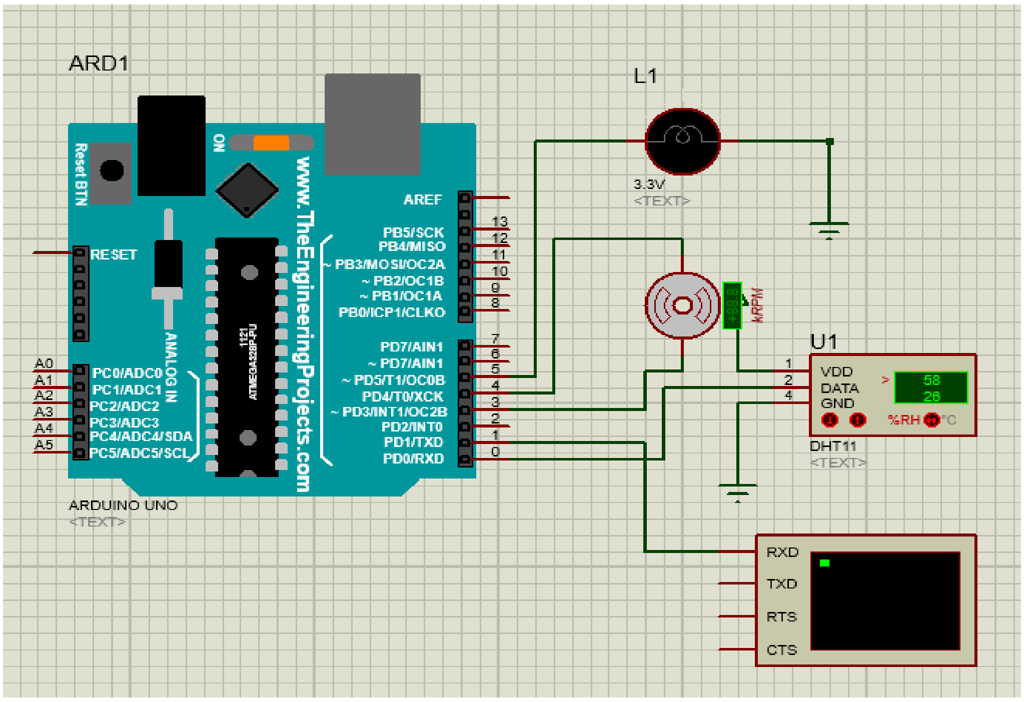


Fig 6.1

6.1.2. Heartbeat sensor with Arduino

Figure 5.1 shows the function of the heartbeat and Arduino the practical principle of the heartbeat by photoplethysmography the heartbeat consists of two main components

- light-emitting diode
- photodiode

The light of the cell falls into the tissues of the body (finger) and the tissues are illuminated by this light nerve and some blood absorbs some light and some nerve light that falls on the tissue appears and others are transmitted. Photodiode accepts this reflected and transmitted light. After receiving a bright and transmitted photodiode it creates an electrical signal that actually gives us a heartbeat.

This sensor has three VCC pins, GND, and an analog pin, an analog pin is used as output. Figure 2 shows that this pin is connected to the Arduino analog pin (A1) so that the sensor data can be sent to Arduino. After receiving the sensor data Arduino will analyze whether the heart rate is within our required range or not, if the heart rate is within our required range and then Arduino displays this number on the serial monitor and LCD. If the heart rate is not within our required range then after analyzing this number Arduino will start proper control as indicated in Figure 2 (i.e., Turn on the Lamp). The VCC pin is used to amplify the sensor.

6.1.2.1. Technical specifications of heart rate

Operating voltages	3 to 5V
Operating current	4mA at 5V
Thickness	3mm
Diameter	16mm

Table 6.2

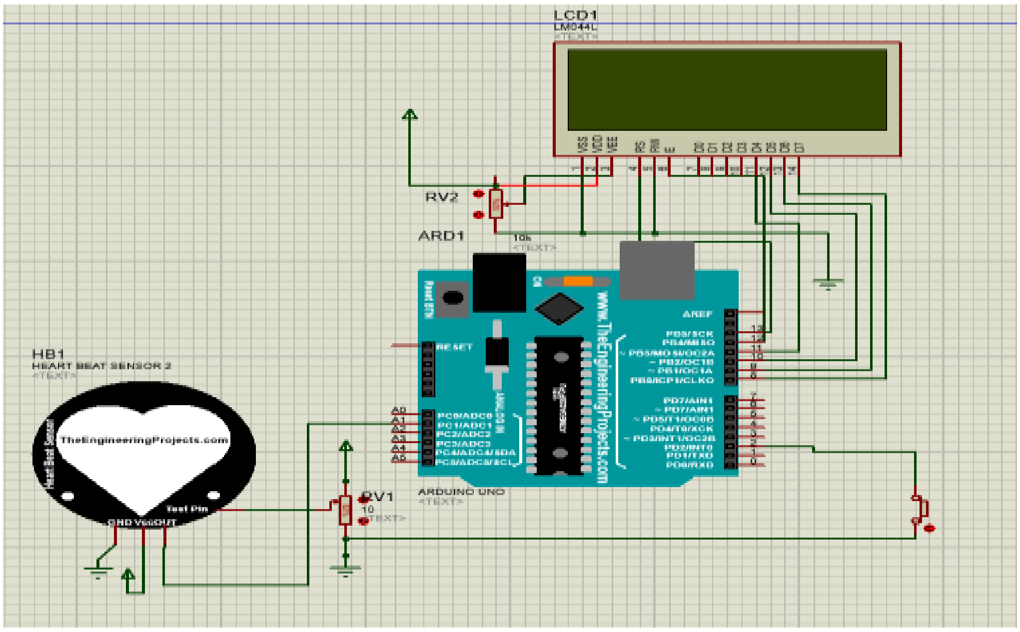


Fig 6.2

6.1.3. Flame sensor with Arduino

Flame sensor is actually a type of detector that is usually designed to detect and respond to fire and flame detection. The detection of fire and flame can depend on the location of the sensor of any kind. Flame sensor contains

- Electronic circuit
- A receiver like electromagnetic radiation

This sensor has four pin-VCC, GND, and analog pin and digital pin, analog pin and digital pin can be used as output. Figure 5.2 shows that we are using a digital pin and this pin is connected to the 7 Arduino digital PIN so that the data for this sensor is sent to Arduino. After receiving sensor data Arduino will analyze whether the sensor receives any flame or flame or not, if the sensor receives any flame the incubator sensor sends a signal to Arduino, Arduino analyzes this signal and will start proper control connected to pin 6 of Arduino as shown in Fig. 3 (e.g., OPEN spray system). The VCC pin is used to power the sensor and the GND pin is used to supply ground.

6.1.3.1. Technical specifications flame sensor

Power supply(pin1)	3.3 to 5.3 V
GND (pin 2)	Power supply ground
AOUT (pin 3)	Analog output pin
DOUT	Digital output pin

Table 6.3

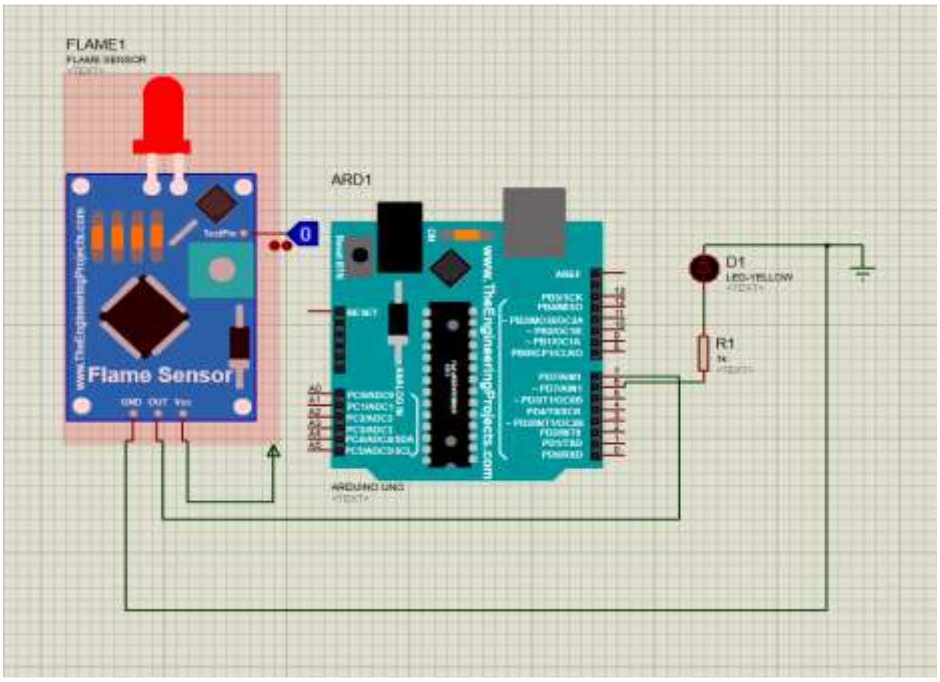


Fig 6.3

6.1.4. Working of All sensors with Arduino with output

Fig 5.3 shows the working of all sensors together with Arduino and also shows the output of temperature, humidity and heart rate.

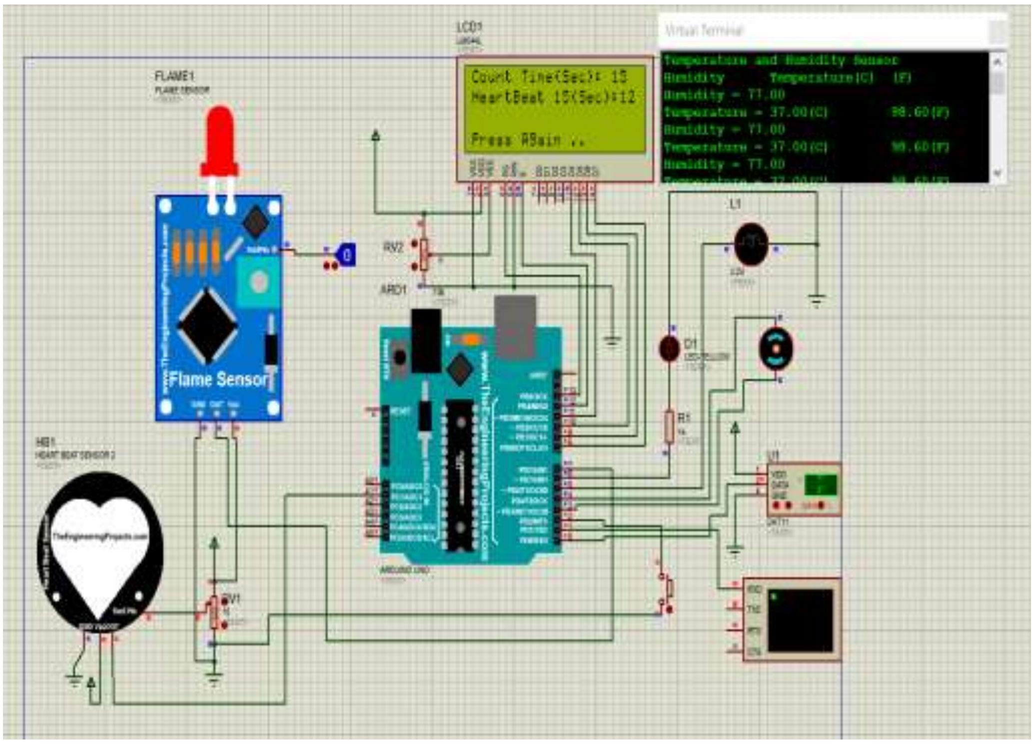


Fig 6.4

Fig 6.5

6.1.5. Control Reading of All Sensors

6.1.5.1. Temperature Control

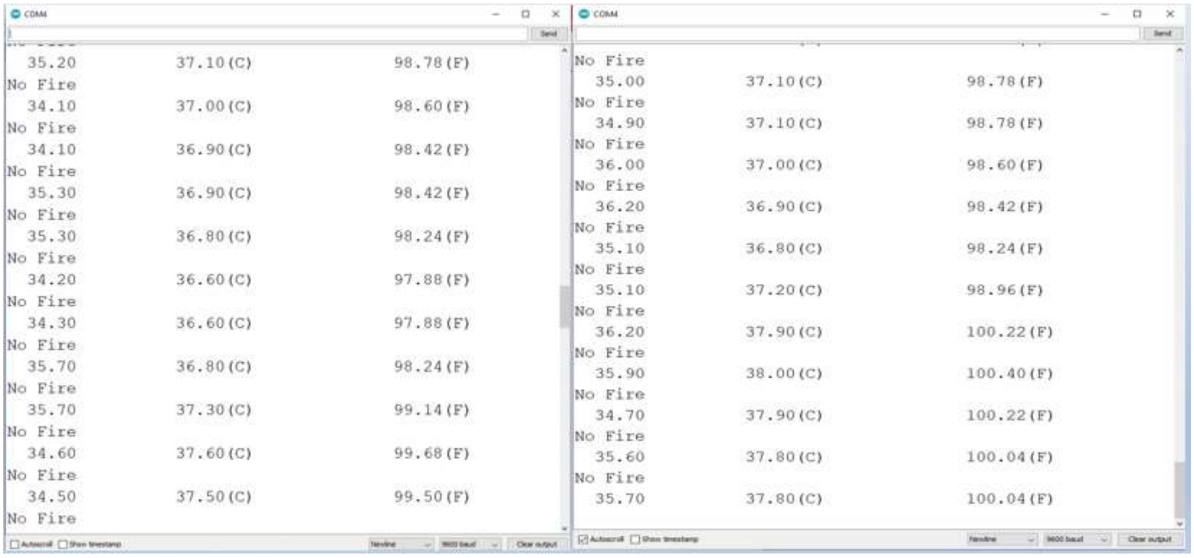


Fig 6.6

6.1.5.2. Humidity Control

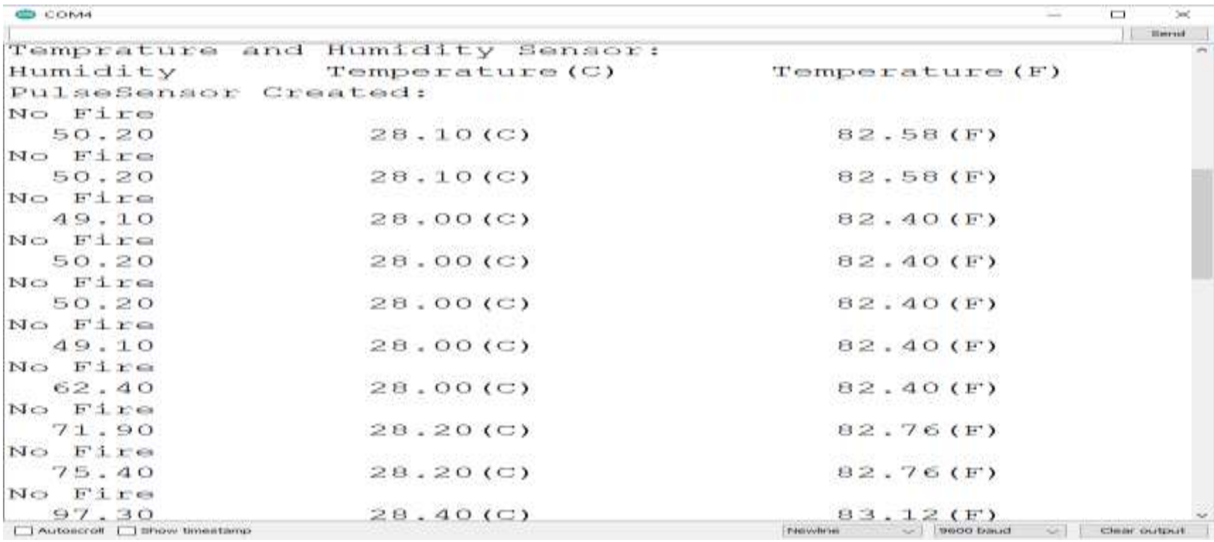


Fig 6.7

6.1.5.3. Fire Protection

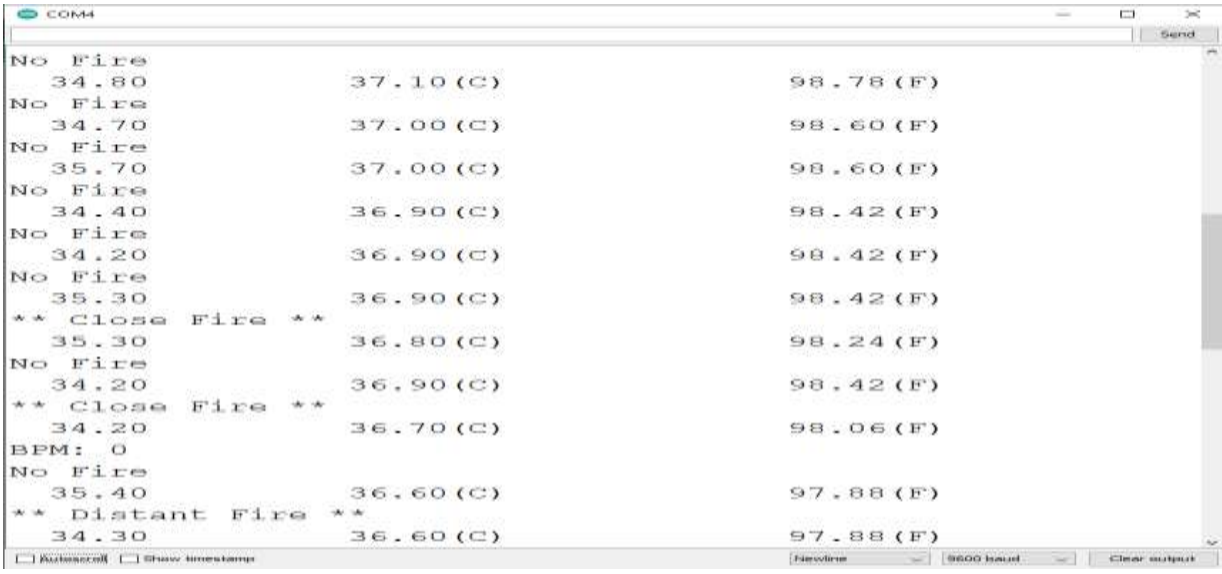


Fig 6.8

6.1.6. IoT Data

6.1.6.1. Temperature Sensor Reading

Fig 6.9

6.1.6.2. Humidity Sensor Reading

Fig 6.10

6.1.6.3. Heartbeat Sensor Reading

Fig 6.11

6.1.6.4. Light Intensity Sensor Reading

Fig 6.12

6.1.6.5. Flame Sensor Reading

Fig 6.13

6.2. Discussion

There are a variety of microcontroller boards on the market, like

- Parallax Basic Stamp
- Netmedia's BX-24
- Phidgets, MIT's Handyboard

This is something that can be used for this project. However, we use Arduino because it is very easy to use Arduino sensors and there is no need to get into the nitty gritty of microcontroller programming. Arduino IDE software provides a clear programming platform. Arduino can work with both Windows and Linux applications, and many others can only work with Windows, and are more expensive than other alternatives.

6.3. Conclusion & Future Work

Premature births and low birth weight infants require intensive care to provide appropriate care and protection. Many premature babies lost their lives as a result of the pool of care and employment. There have also been cases of Premature Infant deaths classified as technical error in incubators. This system ensures efficient and safe operation of incubators and can help provide a safe and advanced environment for Premature Infant. In this project a remote infant incubator monitoring system using Arduino microcontroller, D HT11 and DHT22 sensors, Light sensors, Heartbeat sensor, and a Fire sensor that controls the Sprinkling system used to reduce short circuit fire, all of which are connected to -ESP8266 Wi- The Fiode and NodeMCU module as a wireless module delivered the function and provided more accuracy than using the ESP8266 Wi-Fi module and all these critical readings are uploaded to the ThingSpeak IoT program so that Physicians or Parent-Related Nurses Can Monitor Learning The proposed system has proven accurate and reliable measurements of temperature and humidity and conveys through the IoT module. Remote monitoring is achieved using smart mobiles or computers that offer a cost-effective approach to remote monitoring with very little tolerance compared to the built-in incubator sensors.

In the future this concept could be applied to older patients who are disabled or severely ill and in need of a controlled environment and regular monitoring, the additional ECG function used in this project. There are some unspecified limitations in this project that include the control of oxygen filtration in the incubator, in future work this should be considered first. Another parameter is the interaction of other nerves used to measure certain values but due to contact with the skin of young men these nerves can damage or feel irritated so, with technological advances these nerves should be removed with non-sensitive nerves. There is also the possibility of switching to a solar power source, in rural areas there is a serious power supply problem and this problem will also prevail in the future.

References

[1] Katie Proctor, “Transferring the incubator: Fairs and freaks shows as agents of change”, 2004. www.people.cornell.edu/pages/ked42/Infant_Sideshow_Paper.pdf. (WHO / RHT / MSM / 1997, 2nd Ed).

[2] DA Ducker, AJ Lyon, R Ross Russel, CA Bass, and N McIntosh, Incubator temperature control: effects on the very low birth weight infant, Department of Child Health, St George's Hospital Medical School, London, 60, 902- 907,1985.

[3] S. K. Singla and V. Singh, "Design of a Microcontroller Based Temperature and Humidity Controller for Infant Incubator," Journal of Medical Imaging and Health Informatics, pp. 701-708, 2015.

[4] M. A. Muslim Ali, "Development of a Monitoring and Control System of Infant Incubator," vol. II, 12-14 Aug. 2018.

[5] Z. G. M. Sinan S. Mohammed Sheet, "Smart Infant Incubator Based On Mega Microcontroller," International Conference on Engineering Technology and their Applications, p. 14, 2019.

[6]Ali_AlAskery/publication/337186781_Remote_monitoring_of_a_premature_Premature Infant_incubator//Remote-monitord-inc-

[7] P. L. B. P. B. P. N. J. Megha Koli, “INTELLIGENT BABY INCUBATOR,” Proceedings of the 2nd International conference on Electronics, Communication and Aerospace Technology (ICECA 2018), p. 7, 2018.

[8] A. F. E. Zinat Ara Nisha, “Low Cost Neonatal Incubator with Smart Control,” Conference: 8th International Conference on Software, Knowledge, Information Management & Applications (SKIMA), At Dhaka, Bangladesh, p. 6, 2014.

[9] P. K. M. Navjot Kaur Walia, “Smart Lights controlled using WiFi,” p. 5, 2016.

[10] "Remote monitoring of a premature Premature Infant incubator," Ali Ghazi Shabib,Ali AL Askery, vol. 17, p. 5, 2020.

[11] D. D. Vyas, "System for Remote Monitoring and Control of Baby Incubator and Warmer," vol. III, p. 5, 2016.

[12] Z. A. N. Fazal Elahi, "Low Cost Neonatal Incubator with Smart Control System," 8th International Conference on Software, Knowledge, Information Management & Applications (SKIMA)At: Dhaka, Bangladesh, vol. III, p. 14, 2014.

[13] P. L. Megha Koli, "Intelligent Baby Incubator," International conference of Electronics, Communication and Aerospace Technology, vol. 10, p. 15, 2018.

[14] Katie Proctor, "Transferring the incubator: Fairs and freaks shows as agents of change", 2004. www.people.cornell.edu/pages/ked42/Infant_Sideshow_Paper.pdf. (WHO / RHT / MSM / 1997, 2nd Ed).

[15] DA Ducker, AJ Lyon, R Ross Russel, CA Bass, and N McIntosh, Incubator temperature control: effects on the very low birth weight infant, Department of Child Health, St George's Hospital Medical School, London, 60, 902- 907,1985.

[16] S. K. Singla and V. Singh, "Design of a Microcontroller Based Temperature and Humidity Controller for Infant Incubator," Journal of Medical Imaging and Health Informatics, vol. 5, p. 5, 2015.

[17] "Remote monitoring of a premature Premature Infant incubator," Ali Ghazi Shabib,Ali AL Askery, vol. 17, p. 5, 2020.

[18] B.Ashish, "Temperature monitored IoT based smart incubator," Internatonal Conference, vol. II, p. 16, 2017.

[19] A. Z. A. J. E. P. T. N. P. E. T. Abdul Latif, "Temperature Monitoring System for Baby Incubator Based on Visual Basic," vol. 2, 2010.

Appendix

```
#include <stdlib.h>

#include <LiquidCrystal.h>

#include "DHT.h"

LiquidCrystal lcd(13, 12, 11, 10, 9, 8);

#define DHTPIN 2

#define DHTTYPE DHT22

#define SSID "J main washi ho gya na"     // "WiFi Name"

#define PASS "passwordnahiha"       // "Password"

#define IP "184.106.153.149"// thingspeak.com ip


String msg = "GET /update?key=RDERAMHPF6Q23TE0"; //change it with your key...


DHT dht(DHTPIN, DHTTYPE);

const int sensorMin = 0;     // sensor minimum

const int sensorMax = 1023;  // sensor maximum

const int Alarm = 7;

int error;


void setup()

{

   Serial.begin(115200);

     Serial.println("AT");

  delay(5000);

  if(Serial.find("OK")){

    connectWiFi();

  }
```

```
  Serial.println(F("Temprature and Humidity Sensor:"));
  Serial.println("Humidity      Temperature(C)      Temperature(F)");
  pinMode(3, OUTPUT); //  Humidity Output
  pinMode(4, OUTPUT); //  Cooling Fan
  pinMode(5, OUTPUT); //  Heating Fan
  pinMode(6, OUTPUT); //  LDR Output
  pinMode(A0, INPUT); //  DHT Input
  pinMode(A1, INPUT); //  Heart Beat Input
  pinMode(A2, INPUT); //  Flame Sensor Input
  pinMode(A3, INPUT); //  LDR Input
  pinMode(Alarm, OUTPUT);//Sprinkling System
  dht.begin();
  lcd.begin(16, 4);
}
void loop()
{
 start:
 error=0;
 int HB = analogRead(A1);
 float humid = dht.readHumidity();
 float temp = dht.readTemperature();
 float f = dht.readTemperature(true);
 if(humid < 77)
 {
 digitalWrite(3, HIGH);
 }
 else
 {
```

```
digitalWrite(3, LOW);
}
if(temp < 37)
{
digitalWrite(5, HIGH);
}
else
{
digitalWrite(5, LOW);
}
if(temp > 38)
{
digitalWrite(4, HIGH);
}
else
{
digitalWrite(4, LOW);
}
int sensorReading = analogRead(A2);
int range = map(sensorReading, sensorMin, sensorMax, 0, 3);
switch (range) {
case 0:
  Serial.println("** Close Fire **");
  digitalWrite(Alarm, HIGH);
  break;
case 1:
  Serial.println("** Distant Fire **");
  digitalWrite(Alarm, HIGH);
```

```
   break;
  case 2:
   Serial.println("No Fire");
   digitalWrite(Alarm, LOW);
   break;
  }
  Serial.print("  ");
  Serial.print(humid);
  Serial.print("          ");
  Serial.print(temp);
  Serial.print("(C)");
  Serial.print("              ");
  Serial.print(f);
  Serial.println("(F)");
 lcd.clear();
 lcd.setCursor(0, 0);
 lcd.print("Humidity = ");
 lcd.print(humid);
 lcd.setCursor(0, 1);
 lcd.print("Temp(C) = ");
 lcd.print(temp);
 lcd.setCursor(0, 2);
 lcd.print("BPM = ");
 lcd.print(HB);
 switch (range) {
  case 0:
   lcd.setCursor(0, 3);
   lcd.print(" Close Fire");
```

```
    break;
  case 1:
    lcd.setCursor(0, 3);
    lcd.print(" Distant Fire ");
    break;
  case 2:
    lcd.setCursor(0, 3);
    lcd.print("No Fire");
    break;
  }
  int Data = analogRead(A3);
  Serial.println(Data);
  Serial.println(HB);
  analogWrite(6, Data);
  delay(2000);
  updateTemp(temp, humid, HB, Data, range);

  if (error==1){
    goto start;
  }
  delay(2000);
}
void updateTemp(float temp, float humid, int HB, int Data, int range){
  String cmd = "AT+CIPSTART=\"TCP\",\"";
  cmd += IP;
  cmd += "\",80";
  Serial.println(cmd);
  delay(1000);
```

```
  if(Serial.find("Error")){
    return;
  }
  cmd = msg ;
  cmd += "&field1=";
  cmd += String(temp);
  cmd += "&field2=";
  cmd += String(humid);
  cmd += "&field3=";
  cmd += String(HB);
  cmd += "&field5=";
  cmd += String(Data);
  cmd += "&field6=";
  cmd += String(range);
  cmd += "\r\n";
  Serial.print("AT+CIPSEND=");

  Serial.println(cmd.length());
  if(Serial.find(">")){
    Serial.print(cmd);
  }
 else{
    Serial.println("AT+CIPCLOSE");
    error=1;
  }
}
  boolean connectWiFi(){
  Serial.println("AT+CWMODE=1");
```

```
  delay(1000);
  String cmd="AT+CWJAP=\"";
  cmd+=SSID;
  cmd+="\",\"";
  cmd+=PASS;
  cmd+="\"";
  Serial.println(cmd);
  delay(2000);
  if(Serial.find("OK")){
    return true;
  }else{
    return false;
  }
}
```