

Baby Incubator

Shanmathi Gayathiri.S

Department of Electronics and Communication Engineering
PSG Institute of Technology and Applied Research
Coimbatore, India

R.M.Swaathi

Department of Electronics and Communication Engineering
PSG Institute of Technology and Applied Research
Coimbatore, India

Vishnupriya.R

Department of Electronics and Communication Engineering
PSG Institute of Technology and Applied Research
Coimbatore, India

Swathmika.V

Department of Electronics and Communication Engineering
PSG Institute of Technology and Applied Research
Coimbatore, India

Abstract:- About 20 million premature and low birth weight infants are born every year in developing countries. The death of these infants occurs due to the unavailability of cost-effective incubators. In earlier days the babies were monitored by nurse. This system was prone to human errors. After that NICUs were an established part of hospitals in the developed world. The preterm infant care is one of the most important, delegate and sensitive area in bio-medical field. The incubator is used to maintain an artificial environment for a neonate to survive. An infant incubator provides stable level of temperature to an extent in which the preterm have the same condition as in the womb. The aim of our project is to develop a portable incubator. Regulating the temperature is one of the most important factors affecting the survival. In this project, we design an incubator system that helps us to monitor and control the temperature. The output of the temperature sensor is provided to the Arduino which takes decision based on the comparison between the desired set point value and the value obtained from the sensor. The decision taken is either to turn on the bulb (when the temperature is low) or turn the fan on (when temperature is high). The heartbeat, humidity and moisture content is continuously monitored and displayed in LCD. The baby's body movement is detected using flex sensor. An oxygen hood is provided to monitor and control the breathing rate. The system also consists of IOT parts, which helps in displaying the data in web server. There are many systems proposed for this purpose, but this system is more integrated in nature and thus more efficient in performance. We tend to provide an affordable, feasible, patient friendly and reliable premature baby incubator.

Keywords—*Internet of Things(IoT), Neonatal Intensive Care Unit (NICU), Liquid Crystal Display(LCD).*

I. INTRODUCTION

The preterm infant care is very important for the baby to survive. Womb like environment is maintained in the incubator which is required for the preterm baby to cope with the external environment. A stable temperature has to be maintained for the baby to survive. The preterm baby need some time to cope up with the external environment. The incubator serves this purpose. Temperature in the womb

is approximately 36-37 degree Celsius but in outside world is approximately 27-28 degree Celsius. The temperature in the incubator has to be adjusted according to the baby's weight.

II. DIFFERENT STAGES OF GESTATION

Most of the premature babies born between twenty third and twenty fourth weeks of physiological state can survive delivery and live to ascertain life outside of the intensive care unit. They weigh simply over a pound and live regarding eight inches long. The body of the baby can principally be underdeveloped at twenty third - twenty fourth weeks of gestation. Premature babies weigh regarding 1½ - a pair of pounds and are regarding nine inches long throughout the twenty fifth to twenty sixth week. they need to be unbroken in intensive care unit for a protracted amount and have several health problems associated with immaturity. By the twenty sixth week of gestation, the premature baby's lungs begin to develop alveoli. By the twenty seventh week, these babies have larger than ninety five p.c rate of survival past birth and intensive care unit discharge. By the twenty eighth week, premature babies weigh regarding 2½ pounds and are regarding sixteen inches long. speedy eye development happens, and premature babies born when twenty seven weeks will blink and now not have consolidated eyelids. The baby born within the twenty seventh or twenty eighth week would like a lot of medical aid. A growing baby has matured loads by twenty ninth to thirtieth week. Premature babies born between twenty ninth and thirtieth weeks can still need a protracted intensive care unit stays. However, their very important organs are far more developed than those of babies born earlier, and that they weigh regarding three pounds and are regarding seventeen inches long. Their eyes will currently blink, however bright lights and loud noises are typically uncomfortable for them. By thirty first to thirty second weeks, premature babies weigh around 3½ to four pounds and are between eighteen and nineteen inches long. that is nearly as long as a baby born at term. They use all five senses to find out regarding the setting however still might recover from stirred up by bright lights and loud noises. Premature babies are nearly absolutely developed by thirty third and thirty fourth weeks advisement around four to five pounds at birth and measure nearly twenty inches long. At thirty third and thirty fourth weeks, most premature babies can have fairly short intensive care unit stays with solely

many complications. The babies learn to eat solely when a protracted time and that they would like facilitate to breathe for a brief time. Premature babies born around thirty fifth to thirty sixth weeks ar regarding twenty inches long and frequently weigh between 5½ and half-dozen pounds. though they give the impression of being like mature babies, babies born between thirty five and thirty six weeks ar premature babies. Their lungs won't be fully developed for an additional few weeks, and that they might not have enough fat to remain heat or enough strength to breast or bottle feed effectively.

III. REASONS FOR SENDING THE BABY TO THE NICU

A. Prematurity

[1] Babies born before the period of gestation are called premature babies or preemies. These babies are not fully developed and they cannot be exposed to the external environment. These babies must be kept in an incubator which provides heat to maintain a controlled environment as these babies often have various problems like weight loss.

B. RDS

RDS is a respiratory problem and occurs in infants due to immature lungs. Oxygen mask can be used to treat this problem wherein a machine is used to supply oxygen through a mask to the baby. The solution to this can be provided by placing the baby in an incubator or with the help of a breathing tube.

B. Sepsis

Sepsis or infection results in neonatal death and poor outcomes. Premature babies are more affected by infections than full term infants. The immune system of the premature baby is very weak and hence it can't fight off the infection. The use of antibiotics for a specific period may help cure this infection.

D. Hypoglycemia

Hypoglycemia occurs in babies born to a mother having an infection or gestational diabetes. Hypoglycemia is also known as low blood sugar.

E. Perinatal Depression

Blood flow and oxygen to the baby will be decreased during Traumatic delivery, or due to problems during delivery. The babies born with perinatal depression can be treated by doctors with whole body cooling.

F. Maternal Chorioamnionitis

[2] Mother's health plays an important role in sending the baby to the NICU. It is an infection caused in the mother before or during labor in which the mother suffers high fever with increased heart rate. Hence the baby will be at high risk. Baby is straight away admitted to the NICU when birth and began on antibiotics for a minimum of forty eight hours before being discharged to home.

IV. OBJECTIVE

The main purpose of an incubator is fulfilled which is to maintain an artificial environment for a neonate to survive. This system can provide automatic control of temperature to minimize the number of premature death. Also this system senses and displays the humidity level, heart rate and sweating rate.

V. LITERATURE SURVEY

The first report of the use of an incubator was published in American journal in 1887. It was reported to the Chicago Medical Society, by John Bartlett, a Physician and Professor of diseases of Women and Children at the Chicago Polyclinic. He designed an incubator in which there were no provisions for ventilation. The incubator top was open and it was created using metal tubs. A blanket was used by Bartlett to cover the baby except for its face. In 1891, a new incubator design was reported in France which was designed by Alexander Lion of Nice. It was made of iron. The incubator had spiral pipes at the bottom through which hot air circulated. At the front, glass doors were present. The filtered air was delivered to the base of the incubator. A fan at the top was used to ensure air circulation. The infant was placed on a mattress in a basket which was suspended from the sides of the apparatus by springs. Alexander Lion stipulated that the boiler, placed to the side of the device, could be heated with gas, oil, electricity, ethylated spirits, or any other fuel. Temperature was automatically regulated via a thermostat. The device was large, complex, heavy, and expensive. Mrudula Borkar, Neha Kenkre, Harshada Patke stated that warmth is the important parameter for the infant in an incubator. Their system mainly focused on monitoring the desired temperature of infant incubator. Arduino UNO and RF transmitter-receiver module was implemented to send the data from micro-controller to the computer for better monitoring purpose. Mohit Kumar, Mrs. Suryakala discussed a conventional approach to monitor the infant which includes constant monitoring of infant using a web camera or appointing a nurse for the baby or using audio monitoring. This system provided peace of mind to parents when they were away from their infant as they can obtain the updates of health of baby. The fundamental part of their incubator was that the communication was done by using GSM interface through which SMS can be sent. Suruthi and S. Suma implemented the idea of monitoring the temperature and pulse rate using the appropriate sensors. Accelerometer was used to sense the motion. The GSM Modem interfaced with the microcontroller sends an SMS alert to the parent's mobile number. Shijo Joseph Mathew, S. Mathankumar, S. Vaishnodevi implemented the single chip microcontroller which read the surrounding temperature, humidity, respiration along with the sensor. The values were displayed on LCD Single chip microcontroller was used to analyze all the three sensed data and any if variation occurred, an alert was sent to parents automatically. N.A.A Hadi, M.H.C. Hasan, N.M.Z. Hashim, N.R. Mohamad, A.S. Rahimi, K.A.M. Annuar recommended the method of providing infant temperature regulation in resource settings

by KMC, the practice of placing newborns, directly onto the mother's chest. KMC has demonstrated benefits in terms of improved weight gain for preterm infants. Faruk AKTAS, Emre KAVUS, Yunus KAVUS discussed about the pulse rate and temperature and also describes the design of a very low-cost remote baby monitoring system which measures heart rate and body temperature of an infant and sends the data to a remote end where the data will be displayed to the parents or the caretakers to examine them continuously.

VI. PROPOSED SYSTEM

The main aim of the proposed baby incubator is to maintain the baby with same environmental conditions that is available in its mother's womb. The temperature is maintained to few degrees of Fahrenheit depending on the age of the baby. [3] When the temperature inside the incubator decreases than the required temperature then the temperature of the incubator is raised using a heater which is indicated using an LED. When the baby's body temperature increases then the temperature inside the incubator also rises which is continuously being sensed and after a particular set value, the fan gets turned on to decrease the temperature inside the incubator. The humidity level inside the incubator is also sensed. To maintain proper hygiene inside the incubator sweating of the baby during inappropriate conditions is also noted. [4] Respiration is one of the important aspects, where some of the babies breathe on their own while some of them require external help for breathing. There are three methods to provide breathing externally with nasal cannulas, CPAP, ventilators. [5] We have made use of an oxygen hood to measure the breathing rate of the baby. The heart beat rate of the baby is also continuously monitored. The baby movement is also detected by using a sensor.

A LCD is used to display all these temperature value, heart beat value, breathing rate, sweating indication, movement indication, and humidity level. All these values are displayed on a web server which helps the doctors to have a constant eye on the baby.

VII. HARDWARE DESCRIPTION

A. Arduino UNO

Arduino UNO is a microcontroller board based on the ATmega328P. The Arduino has 6 analog pins and 14 digital pins that can be used to connect with external circuitry. The Arduino has a USB interface in the new version. The analogy pins are input pins and the digital ports are I/O ports. 6 I/O pins are used for PWM output. A 16 mega hertz clock is provided which helps in producing more frequency and increases the number of instructions per cycle. A USB connection, a power jack, an ICSP header and a reset button are all provided by Arduino. A microcontroller can be connected to a computer via USB cable as the Arduino supports all the features needed for this process. A battery or AC-to-DC adaptor can be used to power the USB cable or an external power supply can be used to power the Arduino board. External power can be derived from either AC-to-DC adaptor or from the battery.



Fig. 1:- shows the Arduino board which acts as the microcontroller

The pins in the Arduino board are as follows:

- **Vin:** Vin represents the input voltage that is provided to the board. Vin can also be used to provide supply voltage. When the supply voltage is given through power jack, Vin pin can be used to access it.
- **5V:** Voltage regulation can be provided by Arduino. Output regulated voltage is provided by 5V pin. The USB, Vin or DC power jack can be used to power up the board.

It is best to operate the board on 5V

- **3.3V:** A 3.3V supply is generated by the on-board regulator.
- **GND:** GND represents Ground pins. Many ground pins are provided for various usage.
- **I/Oref:** This pin is used to provide the voltage reference by using which the microcontroller operates.
- **Reset:** This pin resets the program running on the board.
- **LED:** Arduino Uno comes with a built-in LED which is connected to pin 13. When a high value is given to the pin, it will turn on and when a low value is given, it will be turned off.
- **Input and Output:** With the help of the functions, pinMode(), digitalWrite() and digitalRead(), each of the digital pin can be used as input or output. These pins provide flexibility and ease of use to external devices that can be connected to these pins. They operate at 5V.
- **AREF:** It is called Analog Reference. This pin is used for providing reference voltage to the analog inputs.

B. Liquid Crystal Display

Liquid crystal displays (LCDs) have materials that mix the properties of each liquids and crystals. It consists of 2 glass panels whose inner surface is coated with clear electrodes on that the characters are displayed. It's a sandwiched structure wherever a liquid material is placed intermediate the 2 glass panels. An outlined orientation angle is maintained with the assistance of compound layers that are given in between the glass panel and also the liquid material. Two polarizers and also the liquid are used to rotate the sunshine rays in such a way that the rays initiate the alphanumeric display with no orientation throughout the off state and therefore the alphanumeric display seems clear. Once sufficient voltage is applied to the electrodes, the liquid molecules would be aligned during a specific direction. The sunshine rays passing through the alphanumeric display are revolved by the polarizers, that lead to activating or lightness the required characters.

Address or management lines are allotted to drive the RS and R/W inputs. Directions that prolong the browse and Write or alternative applicable knowledge strobes are used, thus on notice the interface temporal order needs. If a parallel interface is employed to drive the RS, R/W and 'E' management lines, setting the 'E' bit at the same time with RS and R/W would violate the module's discovered time. A separate instruction ought to be wont to reach correct interfacing temporal order needs.

- The process or maybe a small deformation of the claws of the metal frame can have result on the association of the output associated cause an abnormal show.
- When collection the module into another instrumentality, the house between the module and therefore the fitting plate ought to have enough height, to avoid stress to the module surface.
- There should be enough space behind the module, to dissipate the heat generated by the ICs while functioning for longer durations.
- When using a vacuum cleaner to clean it, the sucking mouth should not be brought near the module. Static electricity of the electrically powered driver or the vacuum cleaner may destroy the module.

The LCD module should be operated under the relative condition of 40 degree Celsius and 50% relative humidity. The blinking speed of the LCD is retarded by the low temperature and the overall display is discoloured at high temperature. The display is normal when the temperature is maintained within normal limits. Polarization degradation, bubble generation or polarizer peel-off could occur with heat and humidness.[6] The module, interfaced to the system, is treated as RAM input/output, enlarged or parallel I/O. Since there's no typical chip choose signal, developing a stroboscope signal for the alter signal (E) and applying acceptable signals to the (RS) and read/write (R/W) signals are vital. The module is chosen by obtaining a decoded module – address with the host – processor's read/write stroboscope. The resultant signal, applied to the LCDs alter (E) input, clocks within the information. Associate address bit that sets up earlier within the host's machine cycle is used as R/W. Once the host processor is therefore quick that the strobes are too slender to function the 'E' pulse, These pulses should be prolonged mistreatment the hosts 'Ready' input. The host should be prolonged by adding wait states. The Host's Crystal frequency ought to be small Despite doing the on top of mentioned, if the matter continues, each the info) and management information are to be locked then the 'E' signal is to be activated. For 4-bit information interface, the bus lines DB4 to DB7 are used for information transfer, whereas DB0 to DB3 lines are disabled. {the information|the info|the information} transfer is complete once the 4-bit data has been transferred doubly.



Fig. 2:-LCD display

- They are sometimes a lot of compact, light-weight, portable, less costly and a lot of reliable
- They're out there in an exceedingly wider vary of screen sizes than CRT and plasma displays and since they are doing not use phosphors, they can't suffer image burn-in.
- LCDs are a lot of energy economical and provide safer disposal than CRTs. Its low power consumption allows it to be utilized in powered equipment.
- It's created from any variety of pixels crammed with liquid crystals and clothed before of a lightweight supply (backlight) or reflector.
- They are utilized in a large vary of applications including: laptop monitors, television, instrument panels, craft cockpit displays, etc.
- LCDs have displaced CRT displays in most applications.
- They're common in client devices like video players, gambling devices, clocks, watches, calculators, and telephones.

C. Relay

The relay is associate degree magnet switch. A flux is formed once current flows through the relay's coil. It's employed in applications to show on and off by a coffee power signal or wherever many signals ought to be management led by one control signal. So, relays have 2 switch positions and that they are double throw (changeover) switches. Shift from one circuit to a different is feasible in relay. There's no electrical association within the relay between the 2 circuits; the link is magnetic and mechanical. Transistors are typically accustomed amplify the IC current.[7] Relays are typically SPDT or DPDT, however they'll have more sets of switch contacts, as an example relays with four sets of transformation contacts are pronto offered. Most relays are designed for PCB mounting however the wires will be soldered on to the pins. The lever gift on the relay will be attracted by magnetism because the coil gets switched on. This lever moves the switch contacts. There's one set of contacts (SPDT) within the front and another set behind them, creating the relay DPDT.

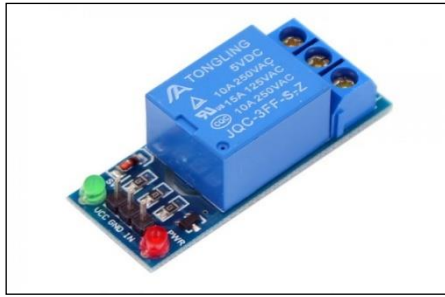


Fig. 3:- Relay

The relay's switch connections are usually labeled COM, NC and NO:

- COM = Common
- This is the place where connection is made.
- NC = Normally Closed, When the relay coil is off, COM is connected to this portion.
- NO = Normally Open, When the relay coil is on, COM is connected to this portion.

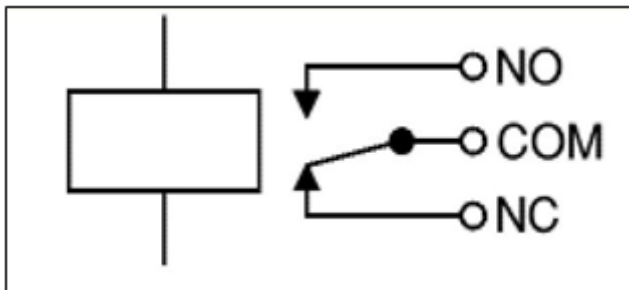
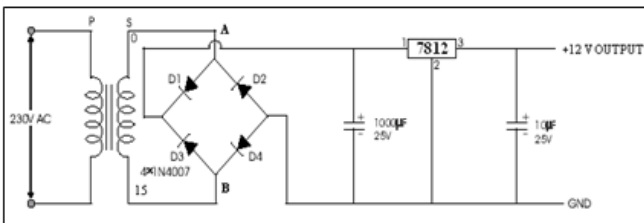


Fig. 4:- Relay's switch connections



This circuit is intended to regulate the load (which could be a DC motor during this case). The load is turned ON and OFF through the relay. A try of shift transistors(BC547) square measure wont to management the ON and OFF of the relay. The relay is connected within the Q2 semiconductor collector terminal. A Relay is Associate in Nursing magnetic force shift device that consists of 3 pins. they're Common, ordinarily shut (NC) and ordinarily open (NO). The relay common pin is connected to the availability voltage. The ordinarily open (NO) pin is connected to the load. once high (5 Volt) pulse signal is given to base of the Q1 transistorsis conducting and shorts the collector and electrode terminal and nil (0 Volt) signal is given to base of the Q2 transistor. that the relay is in turned OFF state. once low pulse is given to base of semiconductor Q1, the semiconductor is turned OFF. currently 12V is given to base of Q2 semiconductor, it starts conducting and also the relay is turned ON. thence the common terminal and NO terminal of relay square measure shorted. currently the load gets the availability voltage through relay.

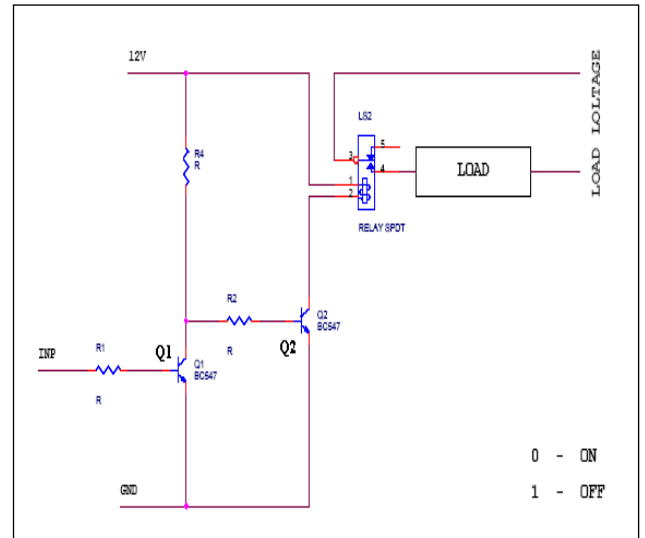


Fig. 5:- Relay – schematic diagram

D. Power Supply

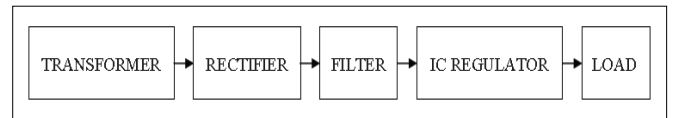


Fig. 6:- Block diagram of power supply

The ac voltage, usually 220V RMS, is connected to a electrical device, that steps that ac voltage all the way down to the amount of the required dc output. A full wave corrected voltage is filtered by a condenser to supply a dc voltage. This full wave corrected voltage is provided by a diode rectifier. This ensuing dc voltage sometimes has some ripples or ac voltage variation. These ripples may be removed and therefore the same dc price may be maintained by employing a regulator circuit even though the input dc voltage varies. This voltage regulation is typically obtained victimization one in all the favored transformer IC units.

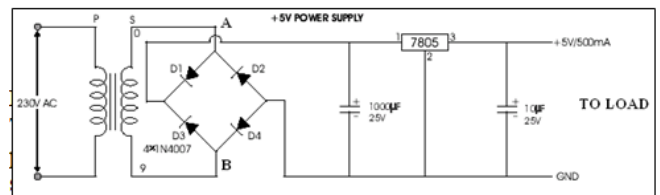


Fig. 7:- Schematic diagram of power supply

The potential electrical device can step down the ability provide voltage (0-230V) to (0-15V and 0-9V) tier. If the secondary has less turns within the coil than the first, the secondary coil's voltage can decrease and also the current or AMPS can increase or decrease relying upon the gauge. this can be referred to as a transformer.

Once four diodes ar connected as shown in on top of figure, the circuit is named as bridge rectifier. The input to the circuit is applied to the diagonally opposite corners of the network, and also the output is taken from the remaining 2 corners.

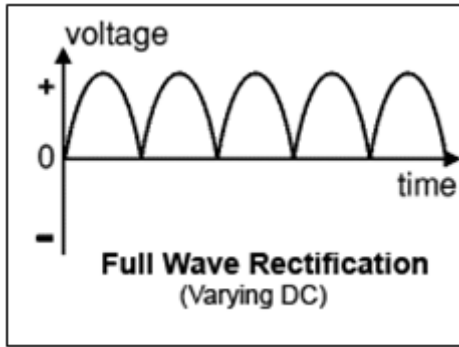


Fig. 8:- Full wave rectification of bridge rectifier

Fig.8 shows the Full wave rectification of Bridge Rectifier. A voltage that is double than that of standard 0.5 wave circuit is provided by the bridge rectifier. This can be one amongst the most important advantage of bridge rectifier. This bridge rectifier invariably drops one.4 Volt of the input voltage thanks to the diode. 1N4007 PN junction diode is employed that, the discontinue region is zero.7 Volt. therefore any 2 diodes area unit invariably conducting, and therefore the overall drop voltage is one.4 volt.

We will get an additional stable DC voltage by adding a condenser in parallel with the load electrical device that forms an easy filter circuit. At first, the condenser is charged to the height worth of the corrected undulation.

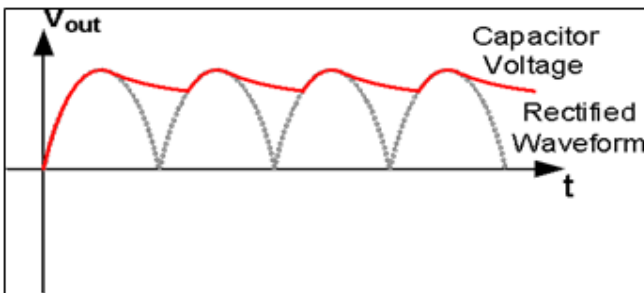


Fig. 9:- Filter waveform

Beyond the peak, when the rectified voltage becomes higher than the capacitor voltage, the capacitor is discharged through the load. Then the capacitor is charged again, and the process repeats itself.

E. IC Voltage Regulators

[8] Voltage regulators comprise a category of wide used ICs. The electronic equipment for reference supply, comparator electronic equipment, management device, and overload protection square measure gift in regulator ICs bushed one IC. Regulation of either a hard and fast positive voltage, a hard and fast negative voltage, or AN adjustably set voltage may be provided by exploitation IC units. The series seventy eight regulators offer mounted positive regulated voltages from five to twenty four volts. Similarly, the series seventy nine regulators offer mounted negative regulated voltages from five to twenty four volts. this can be a regulated power provide circuit exploitation the 78xx IC series. These regulators will deliver current around 1A to 1.5A at a fix voltage levels. The common regulated voltages square measure 5V, 6V, 8V, 9V, 10V, 12V, 15V, 18V, and

24V. it's vital to feature capacitors across the input and output of the regulator IC to boost the regulation. within the circuit, 7805 and 7812 regulators square measure used therefore it converts variable dc into constant positive 5V and 12V power provide severally.

F. Humidity Sensor

Humidity is that the quantity of vapour in Associate in Nursing air sample witness are often measured as absolute wetness, ratio, and specific wetness. A wetness detector additionally known as a measuring device. It measures and often reports the ratio within the air. they will be employed in homes for individuals with diseases laid low with humidity; as a neighborhood of home heating, ventilating, and air-con (HVAC) systems; and in humidors or wine cellars. they'll even be employed in cars, workplace and industrial HVAC systems, and in meteorology stations to report and predict weather. A wetness detector senses ratio which implies that each air temperature and wet ar measured. ratio, expressed as a %, is that the quantitative relation of actual wet within the air to the best quantity of wet air will hold at that temperature. electrical phenomenon measure is employed in these sensors. The principle of those sensors depends on the flexibility of the electrical conductors to form Associate in Nursing electrical field between them. this method depends on electrical capacitance. The detector consists of 2 metal plates with a non-conductive chemical compound film sandwiched between them. The wet causes minute changes within the voltage between the 2 plates and this can be collected by the film from air. The changes in voltage ar reborn into digital readings showing the quantity of wet within the air.

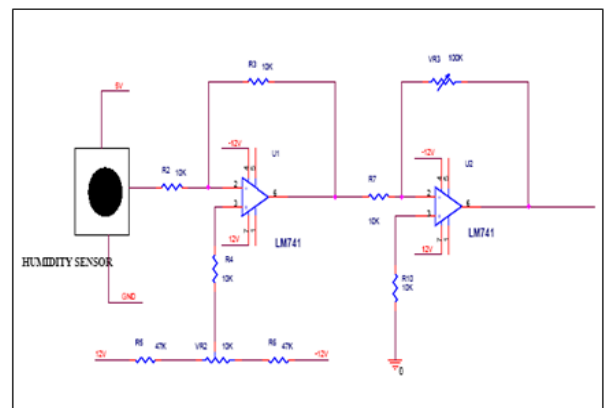


Fig. 10:- Schematic diagram

This circuit is supposed to measure the humidity level among the air. The humidity device consists of a stable multi-vibrator throughout that the capacitance is varied betting on the humidity level. that the multi-vibrator produces the numerous pulse signal that's regenerate into corresponding voltage signal. The voltage signal is given to inverting input terminal of the comparator. The reference voltage is given to non-inverting input terminal. The comparator is supposed by the LM741 operational equipment. The comparator compares it with the reference humidity level and delivered to the corresponding error voltage at its output. This output is given to next stage of the gain equipment throughout that the resistance is connected

among the feedback path. By adjusting the resistance the desired gain is usually obtained. Then the ultimate voltage is given to Arduino controller so as to search out the humidity level within the atmosphere. Once the info has been obtained they're displayed on the digital display connected to the circuit.

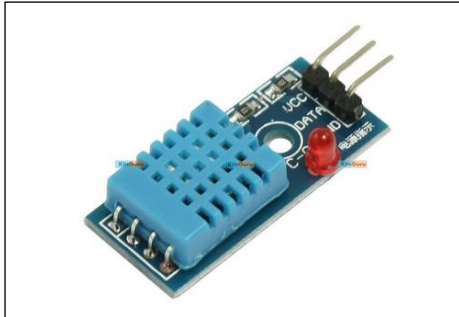


Fig.11 Humidity sensor

G. Moisture Measurement

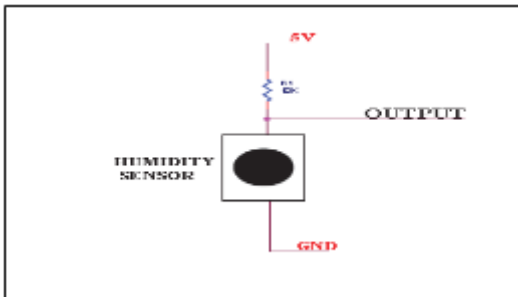


Fig. 12:- Schematic Diagram

In this circuit the two conductors are used to measure the moisture. Moisture represents the water particles in the sand. When the values of R1 and R2 are equal, the output is half of the Vcc supply. Here the output is variable. It depends upon the R2 resistance value.

Resistance value will be varied depending upon the Temperature level. Due to variation in temperature the resistance value also varies. The moisture value and output are inversely proportional which means that if moisture value increases then output decreases. For conversion of analog to digital, the output is given to ADC and the corresponding digital signal is processed by the microcontroller. The ADC value will increase if the temperature increases. We can measure the moisture only with the help of any controller or processor.

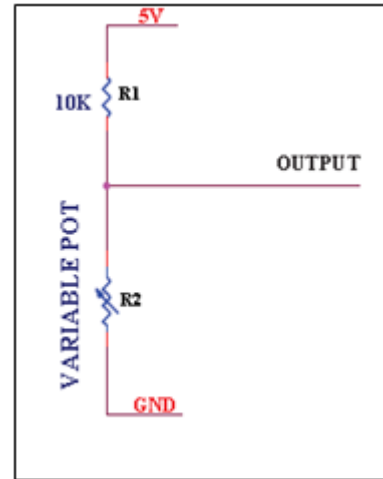


Fig. 13:- Potential Divider

$$V_{out} = V_{in} \frac{R_2}{(R_1 + R_2)}$$

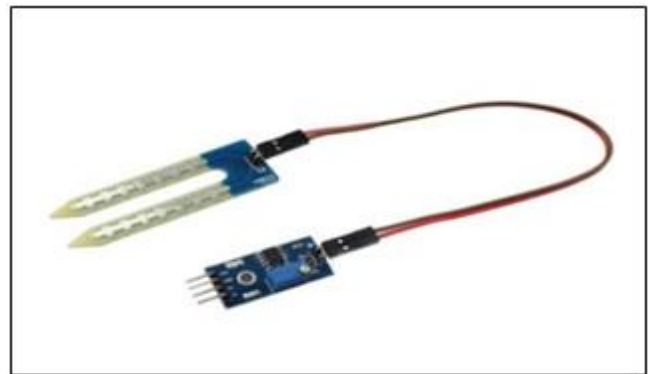


Fig.14:- Moisture Sensor

H. Heart Beat Sensor

The principle of heartbeat device is exposure plethysmography. it's the method of passing the sunshine from a supply during a specific a part of the body. once the sunshine is passed, the degree of blood flowing in this half varies. This variation is measured. The temporal arrangement of the pulses is a lot of necessary particularly for applications wherever heart rate is to be monitored. The flow of blood volume is set by the speed of heart pulses and therefore the signal pulses square measure comparable to the center beat pulses since lightweight is absorbed by blood.

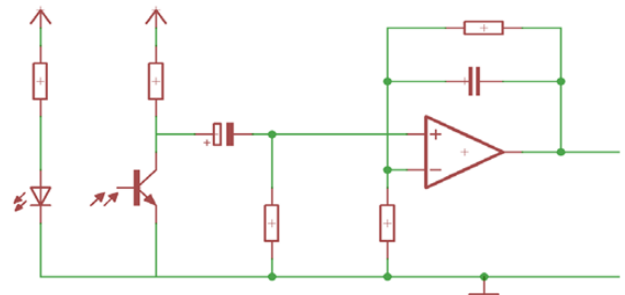


Fig. 15:- Schematic diagram of heartbeat sensor

The basic heartbeat detector consists of a lightweight emitting diode and a detector like a lightweight detection electrical device or a photodiode. The guts beat pulses causes the variation of blood flow in numerous components of the body. [9] light-weight{the sunshine} from the supply is lighted and also the light gets transmitted through the tissue. Some a part of the sunshine are mirrored. This light-weight is detected employing a light-weight detector. once light-weight passes through a tissue, the sunshine emitted by the semiconductor diode gets transmitted or mirrored back. This light-weight is detected by employing a light-weight detector and a few of the sunshine gets absorbed by the blood. the number of sunshine absorbed by the blood depends on the blood volume therein tissue. The detector output is proportional to the guts beat rate and it's in variety of electrical signal. This signal may be a tissue relating DC signal. The blood volume and also the AC part is synchronous with the guts beat and it's caused by pulsate changes in blood volume that's superimposed on the DC signal. so the most demand is to isolate the AC part. so as to realize the task of obtaining the AC signal, the output from the detector is initial filtered by employing a a pair of stage HP-LP circuit and it's reborn to digital pulses employing a comparator circuit or an easy ADC. The heartbeat is calculated by giving the digital pulses to a microcontroller. The formula for scheming the heartbeat is given as follows.

$$\text{BPM(Beats per minute)} = 60 * f$$

Here f is the pulse frequency.

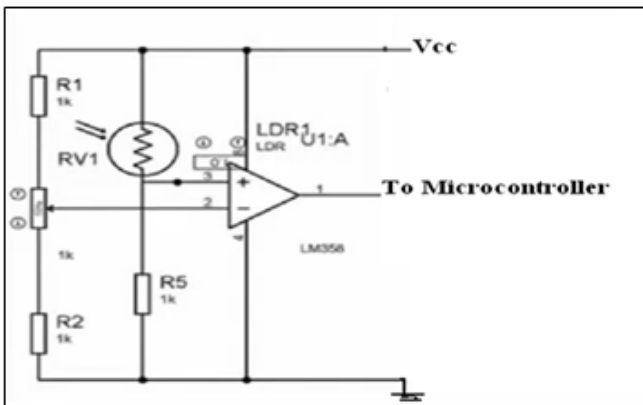


Fig. 16:- working of heartbeat sensor

Example for practical heartbeat sensor is Heart Rate Sensor. An Infrared LED and an LDR embedded onto a clip like structure is attached to the organ such as earlobe or finger with the detector part placed on the flesh.



Fig. 17:- shows the practical heart beat sensor

A Heartbeat detector system will be engineered by victimisation some basic elements like LDR, comparator IC LM358 and Microcontroller. The principle is same as that of the guts beat detector that states that once a lightweight is capable a tissue by employing a light, a number of light-weight{ the sunshine} gets absorbed and also the different are going to be transmitted or mirrored which may be measured by employing a light detector. Here a LDR is employed as a lightweight detector. The principle of LDR is that the resistance changes once light-weight fallson it. the sunshine intensity and resistance square measure reciprocally proportional. As the strength will increase, the resistance decreases and thus the drop across the resistance decreases. The output voltage from the LDR is compared with the edge price by employing a comparator. the edge voltage is that the drop across the LDR once the sunshine with mounted intensity, from the sunshine supply falls directly on that. The inverting terminal of the comparator LM358 is connected to the resistor arrangement and also the non-inverting terminal is connected to the LDR. The resistor arrangement is ready to the edge voltage. The intensity of the sunshine reduces once somebody's tissue is lit victimisation the sunshine supply. As this reduced strength falls on the LDR, the resistance will increase and as a result the drop will increase. When the drop across the LDR or the non-inverting input exceeds that of the inverting input, a logic high signal is developed at the output of the comparator and drop is lesser a logic low output is developed. so the output may be a series of pulses. These pulses will be fed to the Microcontroller that processes the knowledge to urge the guts beat rate that is showed on the display connected to the microcontroller.

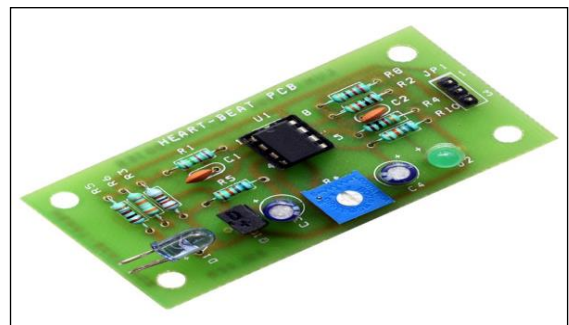


Fig.18:- shows the heart beat PCB

I. Wi-Fi Module

The ESP8266 Wi-Fi Module is a self-contained SOC with integrated TCP/IP protocol stack that can give microcontroller access to the Wi-Fi network. The ESP8266 module is used for communication. It is used to send or receive data, sometimes even upload data. It can provide access to Wi-Fi networks to other devices and helps to connect them to a wired network. AT commands are used to program this module. These commands provide interaction between the device and not module. The Arduino can be connected to the internet with the help of this module. It serves as wireless internet access interface by simple connectivity. Connectivity is established by serial communication or UART interface. The ESP8266 module is an extremely cost effective board with a huge, and ever

growing, community. Storage capability and on-board processing are important characteristics of the module. Due to this, integration with the sensors and other application specific devices through its GPIOs with minimal development up-front and minimal loading during runtime is possible. It occupies only less PCB area due to high degree of on-chip integration. The ESP8266 Module require an external Logic Level Converter. The new version of the ESP8266 Wi-Fi Module provides increased flash disk size from 512k to 1MB.

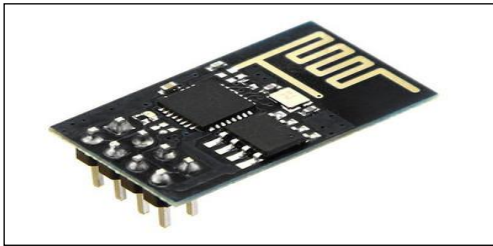


Fig.19:- Wi-Fi module

J. Flex Sensor

Flex sensors are passive resistive devices, which is used for the baby’s body movement detection in this proposed model. These sensors are used to detect flexing or bending. It is nothing but a variable resistor. As the body of the component bends, there will be an increase in resistance. The resistance of an inflexed sensor is around 10K ohms, when it is bent at 90 degrees, the resistance will range from 30-40k ohms.

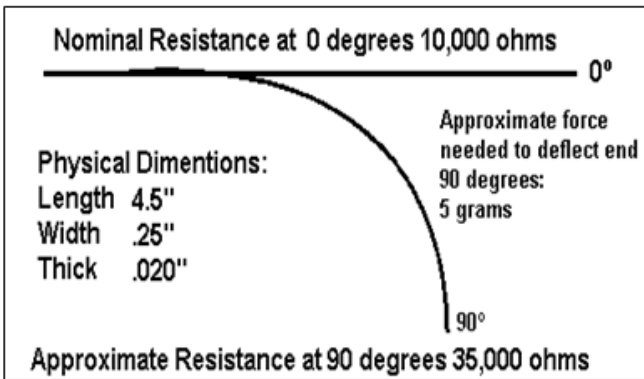


Fig. 20:- Resistance variation in flex sensor

The flex sensor perceives changes in bend angle as a linear proportional change in current or voltage. The characteristic is so obtained, because of the differing area of the resistor, which is indeed caused by the different flex angles.

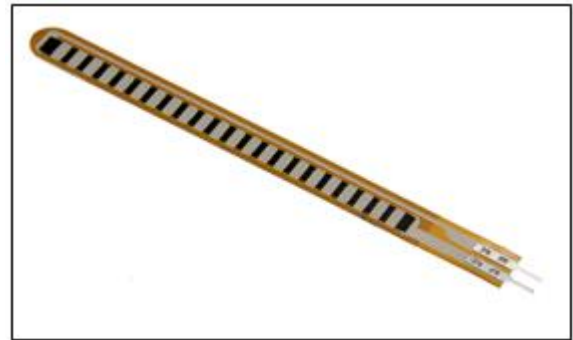


Fig. 21:- Flex sensor

VIII. SOFTWARE DESCRIPTION

A. Arduino

Arduino is an open-source platform used for building electronics projects. A microcontroller board is present which can be connected to the computer with the help of USB and a program can be loaded for specified application. A software is used to write and dump the code into the board. This software is called IDE (Integrated Development Environment). The Arduino platform has become quite popular with electronics. A USB can be used to load a new code on the board unlike other programmable circuit boards. It is easier to learn the program in Arduino as it uses a simplified version of C++. The code can be easily dumped into the board and compiled. It provides a more accessible package. The Arduino hardware and software is very helpful to interact with various devices. It takes in analog input and provides digital output. Arduino can interact with buttons, LEDs, motors, speakers, GPS units, cameras, the internet, and even with smart-phone or TV. Arduino has various advantages such as flexibility, free software, cheap hardware boards, easy learning of both hardware and software. Due to this, it has been widely used by a large community for doing Arduino-based projects.

B. IoT

AT commands square measure went to establish communication. AT commands were derived from Hayes commands which might be went to management the modems and it stands for Attention. AT commands square measure used for creating interaction. It is used with GSM module and GPRS to access the message. These commands facilitate to speak with the pc. The ESP8266 Wi-Fi module and also the microcontroller is interface through UART and with the assistance of a large vary of AT Commands, the Microcontroller will management the parapsychology Module.

The AT Commands of the ESP8266 Wi-Fi Module square measure liable for dominant all the operations of the module like restart, connect with Wi-Fi, amendment mode of operation so forth.

The AT commands is delineate in terms of 4 basic commands like check, read, set and execution.

These commands square measure used for numerous functions like checking the compatibility of a command, extracting the settings, dynamical the settings and conjointly to perform the operation. These basic commands square measure vital for numerous varieties of applications.

The below seven square measure the foremost normally used AT commands:

1. AT: AT checks for correct interaction between the pc and module. OK is mostly used for reply or acknowledgement.
2. +CMGF: it's used for choosing PDU mode. a close access to SMS service is provided by this mode.
3. +CMGS: Used to send SMS to a selected sign
4. ATD: Used to create decision to a selected variety
5. ATA: Used to answer the incoming calls. The calls square measure denoted by a message 'RING' that duplicated for each ring of the decision. when the decision ends a message voice communication 'NO CARRIER' is displayed.
6. +CMGW: Used to store a message within the SIM. when the execution of the command, the '>' sign seems within the next line wherever the message is entered.
7. ATH: This command is used to disconnect an overseas user with the GSM module.

IX. RESULT ANALYSIS

The main purpose of the incubator is to provide the conditions inside the incubator same as in the mother's womb. We make use of an Arduino UNO board and a Wi-Fi module. The Temperature and humidity sensor is connected to the 8th pin of Arduino board. It senses the air temperature and moisture in it. A general baby's temperature is maintained between 35 degrees Celsius to 38 degrees Celsius. Generally the new born babies find it difficult to maintain their body temperature. When the temperature goes down babies makes use of oxygen and energy to maintain warmth. When it goes lower that 36.5 degree Celsius then the LED starts glowing to produce warmth. When the temperature inside the incubator rises above 38 degree Celsius then the light gets turned off automatically and to cool down the temperature a fan is used which gets turned on automatically. The fan gets turned off when the appropriate temperature is maintained. A relay is used to either turn on turn off the fan and it is connected to the 13th pin of the Arduino. A relay acts as a switch. The humidity sensor is used to detect the water content inside the incubator that notifies the urine status. The Heart beat is measured using a heartbeat sensor which is based on the principle of photo phlethysmography. It is connected to the 10th pin. It means that a change in the volume of blood causes a change in the intensity of the light through that organ. IR radiation is passed through the particular part of the body where it is placed, and some amount of the radiation gets reflected or transmitted which is detected by the detectors and some amount of the radiation gets absorbed. The detector output is an electric pulse that is passed through a low pass or high pass filter. It is then converted to a digital pulse and the heart beat is calculated and the value is displayed on the LCD. The sweating rate of

the baby is identified by making use of the moisture sensor. It is connected to A5 pin of Arduino. It is generally placed in such a way that it is in contact with the backbone of the baby. Depending on the temperature value the resistance value varies and as the temperature increases the output moisture value keeps decreasing. The respiratory rate is detected normal or abnormal by using a sensor connected to A0 pin of the Arduino. The child movement is detected by using a flex sensor. It is placed in such a way inside the incubator that with the bend of the flex sensor the child movement gets identified and is displayed in LCD. The Wi-Fi module is connected to A1 and A2 pin of the Arduino. It makes use of UART protocol for one to one communication. The Arduino and Wi-Fi model communicates and the data is stored in the Wi-Fi module. This data like temperature, heart beat rate, urine status, and child movement detection is displayed on a web page

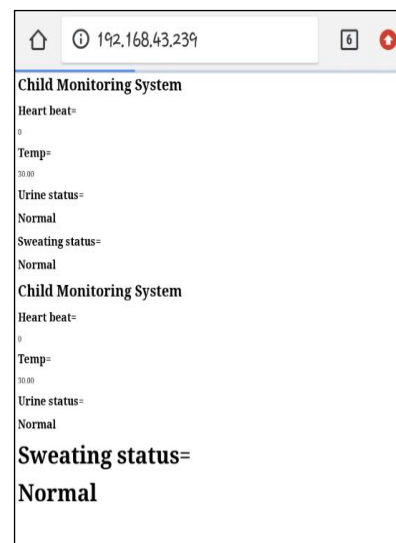


Fig. 22:- Webpage display

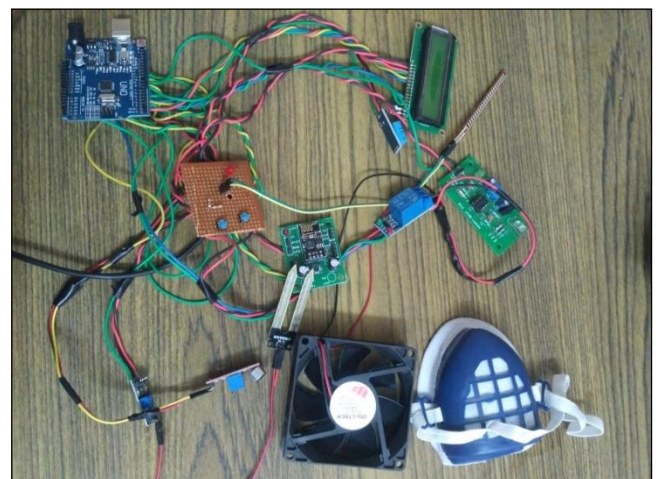


Fig. 23:- Picture of the module

X. CONCLUSION

Thus we have successfully developed a model for baby incubator which helps to prevent the death of premature

babies in developing countries. The incubator model is made cost efficient so that it is reachable and can be accessed by all range of people in a society.

ACKNOWLEDGEMENT

We would like to thank the **Management** of PSG Institute of Technology and Applied Research for providing us with excellent facilities for the completion of this project.

We are grateful to our Principal **Dr. P. V. Mohanram**, Principal of PSG Institute of Technology and Applied Research for giving us support throughout the project.

We would like to thank the Vice Principal **Dr. G. Chandramohan**, Vice Principal of PSG Institute of Technology and Applied Research for encouraging us throughout the project.

We are thankful to **Dr. T.Hamsapriya**, Professor and Head, Department of Electronics and Communication Engineering, for her constant support throughout the project.

It is our pleasure to thank our Project Guide **Ms. M. Deepa**, Assistant Professor (Senior Grade), Department of Electronics and Communication Engineering, our guide for helping us to complete the project successfully.

We also would like to thank all the faculty members and staffs of Electronics and Communication Engineering Department for their kind co-operation and encouragement during the course of this work.

At last, we would like to thank our parents and friends for helping us wherever necessary and having faith in us.

REFERENCES

- [1]. Prof. Kranti(2013) 'Real Time Infants monitoring by developing an Embedded Device for incubator'- International Journal of Research in Computer and Communication Technology, Vol2, Issue 10.
- [2]. Abdul Saleem, Mohammed Junaid.M, SyedaHusnaMohammadi, Mohamed Jebran.P, Sarah Iram.L. Indikar(2013)'Embedded Based Premies Monitoring System with Jaundice Detection and Therapy' - International Journal of Scientific & Technology Research Volume 2, Issue 6.
- [3]. Desai. M(2011), 'Design of an on stage incubator'- Bioengineering Conference (NEBEC) IEEE 37th Annual Northeast.
- [4]. M.Shahib, M.Rashid, L.Hamawy, M.Arnout, I.ElMajzoub, A.J. Zaylaa (2017) 'Advanced Portable Preterm Baby Incubator'- Fourth International Conference on Advances in Biomedical Engineering (ICABME).
- [5]. Richard F, Guillermo G, William J, Danny M, Gabriel R (2013) 'Low-Cost Neonatal Incubator'- Senior Design Project Report ,Santa Clara University,California.
- [6]. O. Bonner, K. Beardsall, N. Crilly, and J. Lasenby, "There were morewires than him: the potential for wireless patient monitoring in neonatalintensive care," BMJ Innovations, pp. bmjinnov–2016, Jan 2017
- [7]. O.Bonner, K. Beardsall, N.Crilly, and J.Lasenby(2017)'There were more wires than him: the potential for wireless patient monitoring in neonatal intensive care'- BMJ Innovations.
- [8]. Harshad Joshi, DattuShinde (2015)'Pic Microcontroller Based Efficient Baby Incubator'- International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering Volume 4, Issue 2.
- [9]. Joshi N S, Kamat R K, Gaikwad P K(2013) 'Development of Wireless Monitoring System for Neonatal Intensive Care Unit'- International Journal of Advanced Computer Research Volume 3, Issue 11.
- [10]. Lawn JE, Mwansa-Kambafwile J, Horta BL, Barros FC, Cousens S(2010) 'Kangaroo mother care to prevent neonatal deaths due to preterm birth complications' - Internal Journal of Epidemiology.
- [11]. IlariaBaldoli, SeleneTognarelli, Rosa T Scaramuzzo, MassimilianoCiantelli, FrancescaCecchi, Marzia Gentile Emilio Sigali, Paolo Ghirri, Antonio Boldrini, ArianaMenciassi, CeciliaLaschi and Armando Cuttano(2015) 'Comparitive Performance Analysis of Neonatal Ventilators, - Italian Journal of Pediatrics.