*Impact Factor (SJIF): 5.301*

**International Journal of Advance Research in Engineering, Science & Technology**

*e-ISSN: 2393-9877, p-ISSN: 2394-2444*

***Volume 5, Issue 3, March-2018***

# A SMART INCUBATOR FOR INFANTS BASED ON IOT USING ARDUINO

Mrs.M.Abirami[*1], Makani Lakshmi priya[*2], Kavuturu Tapaswini[*3],Ravuri Yamini[*4]

[1]*Assistant Professor, Department of Computer Science and Engineering, Panimalar Institute of Technology.*

[2]*Final Year, Department of Computer Science and Engineering, Panimalar Institute of Technology.*

[3]*Final year, Department of Computer Science and Engineering, Panimalar Institute of Technology.*

[4]*Final Year, Department of Computer Science and Engineering, Panimalar Institute of Technology.*

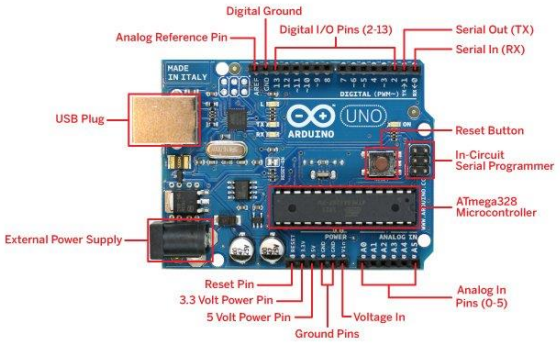
*Abstract*---***Suitable temperature is a vital element of the human being and even for machines in the industry. This study was aimed to explore the implementation of radio frequency in the certain field. For this project, the radio frequency was implemented in the NICU for the incubator system. The concept of incubator has been identified and the function of the main component has been analyzed. The use of Arduino UNO and Arduino Pro Mini was in order to provide the portable RF monitoring device along with the enhancement of the use of wireless sensor network technology. As to control and stabilize the temperature inside operation theatre, LM 35 is been placed inside the operation theatre that will perform as temperature sensor. It gives a signal to PIC16F876A to trigger the blower or heater. The temperature needs to be maintained degree to be maintained around 18'degree to 22' degree. A prototype of radio frequency monitoring device was designed and operated successfully. The readings of temperature and humidity were able to be displayed. This result obtained and achieved.***

*Keywords— Neonatal incubator, Neonatal Intensive Care Unit (NICU), Low cost incubator , Smart temperature control, Premature Baby, Kangaroo Mother Care.*

## 1. INTRODUCTION

One of the most sensitive concern of biomedical field is the premature infant care. Bangladesh is a developing country and most of the people here lives around the immediate vicinity of the poverty line. So highly expensive newborn care is not affordable for them. But the babies who born 2 or more weeks before the 38 week gestation badly requires intensive care. Those infants generally have a net body area greater than normal babies from same age. That means their body heat loss is higher than normal babies. Also these neonates possess a net weight less than the normal babies which make them unable to keep their body temperature to the required level. In case of premature babies, it is not possible to control their body temperature without an external aid. In these circumstances Kangaroo Mother Care (KMC) is certainly effective which means to hold a preterm baby skin-to-skin with an adult especially mother. But sometimes KMC could not be possible for unavoidable reasons. Firstly, if the mother is too ill after delivery, she won't be able to provide Kangaroo Mother Care (KMC). Some of the mothers are helpless because they may have reasons such as other children or a job or any ineluctable cause. If providing KMC is not feasible and the baby is sent home therefore suffer the complications of hypothermia, breathing problems, hypoglycemia and even death . To get to a normal growth premature newborns need a warm, clean and salient environment. The newborns with complications must be put into a Neonatal Intensive Care Unit (NICU). NICUs were developed in the 1950s by pediatricians to provide better temperature support, isolation from infection risk and also specialized feeding to newborns. The incubators are designed as an isolated area having an infant friendly environment without any dust or parasite and has the ability to control environmental factors like temperature and humidity to remain them in acceptable levels such as (36°C-37°C) for temperature, (70%-75%) for relative humidity Incubator can also be used for full term babies to give special medical treatment. Albeit developing countries need

the incubator most, many people living there are not capable of affording one. So this development provides a shimmering solution for them. The current recommended method of providing toddler temperature bylaw in resource constrained settings; the practice of placing newborns directly onto the mother's chest very low cost




## II. PHSIOLOGY

Babies can be categorized according to their gestation period; Pre term (less than35 week gestation), Full term (35 to 42 weeks gestation) and Post term (born after 42 weeks gestation) . Premature babies are those who are born before the pre-term. If an infant born before 31 weeks gestation evaporative water loss is the main reason to heat loss. It's because loss of moisture from skin which causes higher permeability. Having difficulties with heat regulation within the body a newborn child can experience an organ failure. Heat may loss from the body by four ways; Conduction, Evaporation, Convection and Radiation.

## III. THERMOREGULATION IN PREMATURE BABIES

The warmth inside the mother's womb is 38oC (100.4oF). After birth, the wet baby finds itself in a much colder environment. So it immediately starts losing heat thus the thermal protection of the newborn is very much important. The metabolic rate with body temperature of a preterm baby and normal range of infant body temperature at which thermo neutrality is achieved. This temperature range is very narrow and lies between 36.5oC-37.5°C. Thus, the environmental temperature at which the infant regulates its body temperature can be considered as the neutral (operative) temperature. Heat losses from premature baby Thus there is no accurate ambient temperature that is suitable for new born babies without considering all factors such as gestation period, body mass, size etc. The new born baby cannot regulate its temperature like an adult. It therefore cools down or heats up much faster and is able to tolerate only a limited range of temperature. The smaller the new born the greater the risk. Thermal stability improves gradually as baby increases in weight. As the difference between warm womb temperature and the ambient is very high, most of the heat loss occurs just after the birth of newborn. Incubator can offer shorter hospitals stay to millions of premature children and can enable infants who power have faced a lifetime of severe disability.

## IV. METHODOLOGY

This project emphasizes on developing an infant incubator especially for premature babies. Entire chamber of the incubator is constructed using Acrylic sheet as it is more advantageous over glass and plastic. This material is less dense – its density can range from 1100-1200 kg/m3 . It is very much less than the density of glass which ranges 2420 to 2790 kg/m3. Transportation and assembling of acrylic materials are consequently easier and cheaper. Main chamber consists of two compartments. Larger compartment keeps the baby in and smaller compartment comprises of control units. The control unit section has three portions. The lower portion is the heating unit. Heating unit consists of an incandescent bulb and a 12V dc fan. There are slits on the joining wall of the unit. The fan exert air flow which becomes heated by the bulb heat and passes through the slit to the baby room. The dc fan and bulb starts running when the baby room temperature reduces from 37oC and stops when the sensor gives the signal that the baby room temperature is above 37oC. The upper portion has two subsection. One is cooling unit and the other is humidity control unit. Some ice are kept in the cooling unit to reduce the temperature when it goes beyond 37oC. A 12V dc fan is attached outside the cooling chamber to flow the air stream to the baby room in order

to confine the temperature within 37oC. The humidity control unit has the capacity to collect the molten water from the ice of cooling chamber. It contains a heater and a 12V dc fan. When humidity sensor sense the humidity level below 70% this unit automatically starts. It runs no later than the humidity level reaches at 75%. There is an exhaust fan on the outside of the baby chamber which ensures the continuous flow of air. The whole system is controlled by an Arduino microcontroller program. The supply current is provided by using transformers, rectifiers, bridge and relays with 220V AC current.

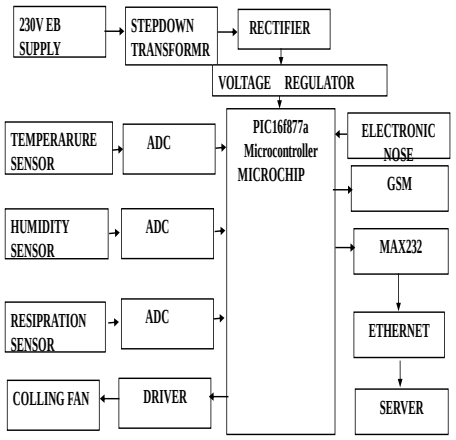
## V. DESIGN AND CONSTRUCTION

The Design Requirements of infant incubator are to provide the infant with provisions, these are: (i) An ambient temperature of $36^0$C-$37^0$C (ii) Humidity greater than 70%RH and (iii) sterile air supply. The proposed system of a neonatal incubator contains following portions:- (a) Structure development of incubator (b) Temperature control system (c) Humidity control system (e) Cost Analysis

***(a)Structure development of incubator***

It is better that the incubator is light in weight so that it can be portable at the same time provides strong support for the components used and can bear the weight of the infant. Isolation of the compartment where the baby is kept from the controlling unit is a necessary requirement. The incubator design can be divided into four subsystems: structural support, enclosure, shell, and bed. The structural support is the device that accommodates the other subsystems and the preterm infant. Design Parameters: Length 80 cm, Height 30 cm, Width 30 cm thickness of material 5 mm. Control units inside the box has a dimension of 10 cm x 30 cm x 30 cm. The control unit is responsible for holding the heat exchanger and the electrical components needed for the incubator to work. The shell is responsible for retaining the heated air, preventing airborne infections from reaching the preterm infant, and venting the stagnant air. The bed is intended to keep the preterm infant in place.

BLOCK DIAGRAM




8

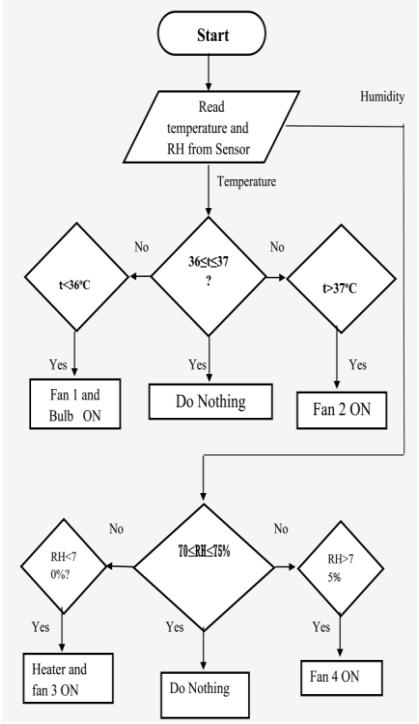
***(b)Temperature Control System***

The temperature is sensed by DHT11 sensor. It is connected to the Arduino Uno. In the circuit arrangement of the control system. Signal pin of the sensor is connected to the analog input pin A0 of the microcontroller. These are connected through relays with the digital output pin 10 and 9 of Arduino board. Each Relays are of 5 volts and are interfaced with the Arduino Uno through relay drivers. Here NPN transistors are used as relay drivers. Arduino Uno is the controller used here. The program is written to control the bulb and fans. When the temperature in the

chamber falls down below 36oC the bulb glows and fan associated with the bulb is turned ON so that that the hot air is blown to the compartment B through the slider. The cooling unit consists of an Aluminum vessel containing ice and a 12 v dc fan. This fan is connected with the digital output pin 7 of the Arduino board through a relay. Whenever the temperature in the chamber goes beyond 37oC the bulb automatically switches off and the fan in the cooling unit turns ON. Cool air is blown to the compartment B until the desired temperature is achieved.

**C. Humidity Control System**

At one side of the cooling unit a small compartment is built to serve the purpose of controlling humidity. In this compartment there is a 100 watt heater and a 12 V dc fan connected with the digital output pin 6 and 13 respectively. When the relative humidity falls below 70% the bulb glows. As a result water is turned into vapor. The fan placed behind the heater helps to blow the vapors to the small compartment. If relative humidity exceeds over 75% an exhaust fan placed outside of the compartment exhausts the air outside of the incubator. Here the humidity is sensed by the same sensor DHT11. Fig. 6 depicts the real constructed image of the incubator humidity control unit. This sensor is so beneficial because it can render signals for both temperature and humidity.



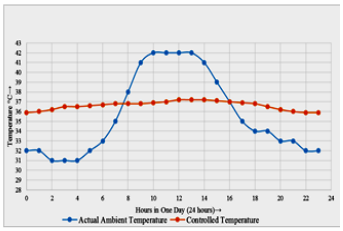

***(d) Cost Analysis***

The project aims to a cost effective neonatal incubator with consistent presentation. Total cost of the prototype construction is enumerated below. The amounts are in Bangladeshi taka and given according to the particulars used. Cost of the sample construction is so less than the commercially available incubator. Thus the calculated incubator would be available for all at a low cost.

## V. RESULT AND DISCUSSION

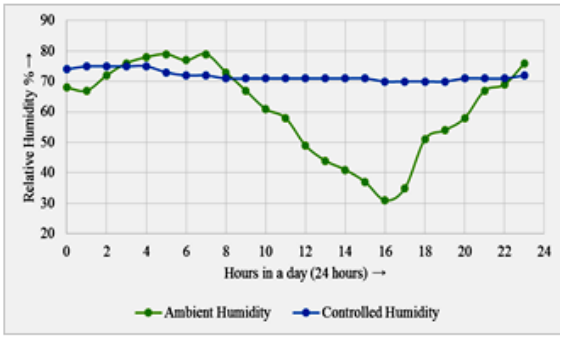
***(a) Temperature Control Unit***

The major concern of this incubator is to control the temperature of the baby room and maintain it within the desired range 36oC to 37oC. Exemplifies the process control by Arduino UNO microcontroller. Here a whole day (24 hour) data of controlled temperature is inset with the ambient temperature of the same day. At 00:00 am the temperature of atmosphere was low and almost constant up to morning 6:00 am. Then it rises with the day time and again lowered at and after 5:00 pm. But the scheme for protection preterm baby safe and sound the high temperature is needed to be constant within the range. The incubator construct has been efficient at doing this and the graph shows that it kept the temperature of the baby compartment at 36oC to 37oC irrespective of ambient temperature.



***B. Humidity Control Unit***

Humidity is another critical factor for preterm infants. Fig. 12 depicts the humidity control by Arduino microcontroller system and its variation with the ambient humidityThe baby room is maintained within the RH level of 70% to 75% though the humidity in the immediate vicinity of the incubator varies from 30% to 80% at different time of the day.




## VI. CONCLUSION

Every year, about 1 million infants in the developing world die due to prematurity complications. Premature infants are born before the developing organs are mature enough to allow normal postnatal survival. To provide a sound environment for the baby temperature in an infant incubator must be maintained at a proper level, generally set at 37oC. The developed system is one of the most practical solutions for addressing the lack of proper care for infants, affected preterm and other complications in impoverished regions. The system is capable of providing the most crucial aspects of patient care at a cost low enough. The prototype is capable of maintaining a proper environmental temperature (36oC-37oC) and humidity (70%-75%) for a patient, which are the primary functions of an incubator. Once set, the temperature and humidity are maintained automatically by the microcontroller based system which makes the system easy to operate. The proposed model can be further improved by using a voice detection system using DSP to detect if the baby's crying. Emergency oxygen supply mechanism should be incorporated. Solar power can be used as an alternative power source.

## REFERENCES

**[1]** F. Hunt, "The importance of kangaroo care on infant oxygen saturation levels and bonding," Journal of Neonatal Nursing, vol. 14, pp. 47-51, 2008.

**[2]** Zermani, M A, Feki, Elyes, Abdelkader M., "Temperature Acquisition and Control System based on the Arduino", International Journal of Emerging Science and Engineering (IJESE) ISSN: 2319–6378, Volume2 Issue-12, October 2014

**[3]** Kranti Dive, R. W. Jasutkar, "Infants monitoring by developing an Embedded Device for incubator", International Journal of Advanced Engineering Sciences and Technologies (IJAEST), Vol No. 2, Issue No. 1, pp. 068 – 072, 2011

**[4]** Tereza Y K, et al. "Noise at the Neonatal Intensive Care Unit and Inside The Incubator." Revista Latino-Americana De Enfermagem (RLAE), 19.5 (2011): 1214-1221, 2013

**[5]** A. Rullo, P. Marti, E. Grönvall, and A. Pollini, "End user composition and re-use of technologies in the Neonatal Intensive Care Unit, "International Pervasive Health Conference and Workshops, pp.1-10, 2006

**[6]** Rddy, N.P., G. Mathur and S.I. Hariharan, "Toward a fuzzy logic control of the infant incubator" Annals Biomed. Eng., 37: 21462152, 2009.

**[7]** Shin, D.I. ,Shin, K.H., Kim, I.K., Park, K.S., Lee, T.S., Kim, S.I., Lim, K.S., Huh, "Low-power hybrid wireless network for monitoring infant incubators" ,S.J. Medical

**[8]** Amer, G.M, "Novel Technique To Control The Premature Infant Incubator System Using ANN", Third International Conference on Systems, Signals & Devices, March 21-24, Sousse, Tunisia, 2005
**[9]** Abbas, K, Leonhardt, Steffen, "Intelligent neonatal monitoring based on a virtual thermal sensor", Abbas and Leonhardt BMC Medical Imaging 2014, 14:9, doi:10.1186/1471-2342-14