IOT BASED PORTABLE INSOLATION INCUBATOR

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Abstract:A life saving device designed for infants which is incorporated with temperature control. With the increasing infant mortality rates in rural areas and the scarcity of power supply, there is a need for a portable and reliable device to aid the infant. The design implements a suitcase, which consists of two compartments. One of the compartments consists of the integral part of the design which is the components. The other compartment embraces the mattress and the infant. It also constitutes a "tent" like structure which is made up of fiber. A solar powered panel is integrated as the backup supply. Along with this the physician can do live monitoring of the parameters through an application using a smart phone.

Keywords-infant, incubator, solar panel.

I. INTRODUCTION

A child under 28days of age is known as a newly born infant. During the initial 28 days of life, the infant has a potentially high probability of facing death. Hence, it is very important that pertinent care and feeding is presumed throughout this period, in order to ameliorate the infant's chances of survival and to lay the foundations for a healthy life.

In rural areas, access to optimal level healthcare is a bare minimum and this is a major concern, since availability of basic level healthcare facilities can go a long way in avoiding many diseases of neonates and aid to a better way of life.

Thermoregulation is a vital physiological parameter that is closely connected with the infant's survival [1]. Due to comparatively massive surface area of the infant, it results in penurious thermal insulation, and only a little quantity of mass operates as a heat sink [1].

An infant has only a limited propensity to preserve heat by varying posture and thus cannot modify their clothing as a feedback to thermal stress [1]. Therefore, there is a need to emerge with a low cost, portable incubator inclusive of solar panels as a backup [2]. An effective method of maintaining infant temperature is by using a solar-powered room heater which is also cost effective in comparison to the current warming devices [2].

This paper presents a device that incorporates few hardware circuits, a software program of the incubator and a system structure for preterm infants. In this particular project the temperature sensor used is LM35 and mlx90xxx infrared sensor is used for the contactless temperature sensing [3].

The objectives of the current design are to construct an incubator that will harmlessly incubate the preterm infant by conserving and maintaining an optimum temperature between 34 ℃ - 37 ℃ [2].

II. PRETERM INFANTS

Preterm birth is also known as premature birth, which is the birth of the infant before the 37th week of the gestation period.

These infants are at an inclined risk for developing problems in hearing, vision and delays in overall development. Around 15 million preterm infants are born each year. It increased between 1990 and 2015.Due to certain complications in preterm babies, it resulted in 1.57 million deaths in 1990 and gradually reduced over the years to 1 million in 2016.

A. Neonatal Intensive Care Units

The neonatal intensive care unit (NICU) is also known as an intensive care nursery. Preterm infants which require special medical attention are admitted into this special area of the hospital. The NICU integrates advanced technology and upskill health care staff for the provision of sophisticated and expertized care for infants.

III. METHODOLOGY

Thermoregulation is a critical factor; thus the body temperature of an infant must be modulated [3]. The mother's womb is maintained at a temperature of 38℃. Once the infant is exposed from the warmth of the womb to a colder environment, it immediately starts losing heat to the surrounding environment [4]. If the heat loss is not prevented, then it may lead to hypothermia and the infant might have an escalated risk of serious health complications and can be fatal [3]. An incubator is a device used to maintain environmental conditions suitable for the infant [2]. It is used in preterm or for some ill full-term infants. The mattress in which the infant is placed is entirely circumscribed by a clear fibre [2]. One of the compartments consists of the integral part of the design which is the components. The inside part is covered by a material called sun board. The other compartment embraces the mattress and the infant [2]. The incubator temperature is increased using a heater element which is placed underneath the mattress [4]. The main parameter controlled and regulated are temperature. A motor driven fan is positioned close to the heater and is used to draw fresh air from a filter and blows through the heater, raising the temperature of air [4]. This air is then administered upwards via the slots into the region over the mattress and is circulated [4]. Potentiometer is used to manually set the threshold value of

temperature. Temperature sensors are used to monitor the air temperature and this is possible by modifying the current which is being sent to the heater. If the incubator temperature rises above the threshold value, then the alarm will ding and this will turn ON the fan and it remains ON until the temperatures decreases to the threshold value. If the temperature of the incubator falls less than the threshold value, then the alarm dings and the bulb will now remain ON and this continues until the temperature is increased to the threshold value. Suppose if the temperature is less than the set or required value, significant quantity of heat vitality must be supplied to the incubator to conserve the temperature level. This can be concluded by simply turning ON and OFF control systems which will also turn ON the heater when the temperature is beneath the set or required level else turn OFF [4].

IV.DESIGN AND CONSTRUCTION

A. Design outline

Five vital integrants of the incubator design are

1. The substructure of the incubator
2. The covering of the incubator
3. The warm-up or heating system
4. Solar-powered set-up
5. Contactless temperature sensing [2].

For the incubator housing design, on-the-market travel products are contemplated. It not only intensifies the design permanence but also the cost of the device. A suitable suitcase with appropriate dimensions is chosen for the housing of the infant.The suitable suitcase is made superior as it is feathery, solid material and a vacant rectangular form, which allows effortless inclusion of warmer substances [2].

The uppermost structure of the warmer is a tent structure. The main advantage of this particular design is that volume is decreased and thus there is decreased usage of energy. Farther, the facility of design is intensified by fiber (used in the canopy) and it can be easily assembled. The aim is to build the design in such a way that it can be effortlessly grabbed to remote areas with deficiency of dependable power grid [2].

Three heating options are considered as shown in Figure 2. Here 2, 50 W DC heaters are cased middle the interior of the incubator [2]. The supremacy of utilizing the AC adapters is that the heaters make use of both the battery and main-line power. The DC heater has the capability to calefaction the incubator to the required temperature. Here, the requisite power is reduced throughout both main-line and cell usage [2]. Consequently, the cell or battery can warm-up the incubator for prolonged schedule than possibility or choice 1. Farther, there is no tube required and the design complications are decreased when equated to both possibilities 1 and 2[2].

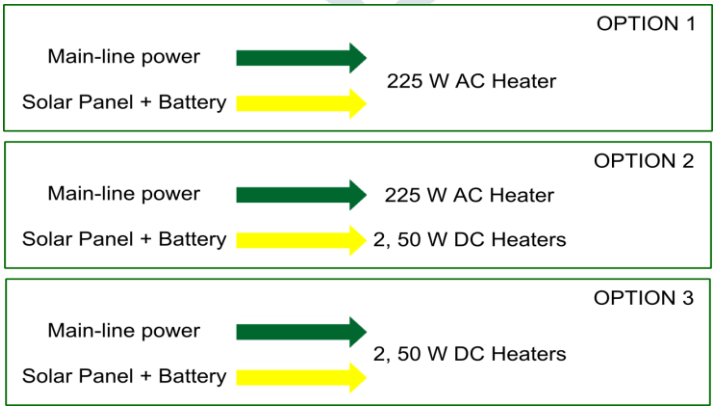

Fig 1: Three heating possibilities are contemplated. The first arrow that is green specifies to the primary supply and the second arrow that is yellow specifies to the secondary supply (used when power grid is not accessible). Here the suitable possibility for the project is possibility or choice 3[2].

B. Block diagram

The system main components consist of solar panel, battery, temperature monitoring sensors, humidity sensors, contactless body temperature sensor, PWM based solar charge controller. Microcontroller Arm cortex is integrated with the incubator monitoring system [6]. Here, both the temperature monitoring sensors and humidity sensors senses the data from the incubator. The contactless body temperature sensor senses the particulars from the infant. The STM32f microcontroller reads and analyzes the parameters like temperature, humidity and the temperature of the infant. Each of the above mentioned parameters are displayed on OLED display. When there is a lack of power supply then the solar panel with a battery backup is provided. If any variations of the parameters or malfunctioning of the system occurs, then the failure will be alerted to physician or the user by the indication of buzzer.

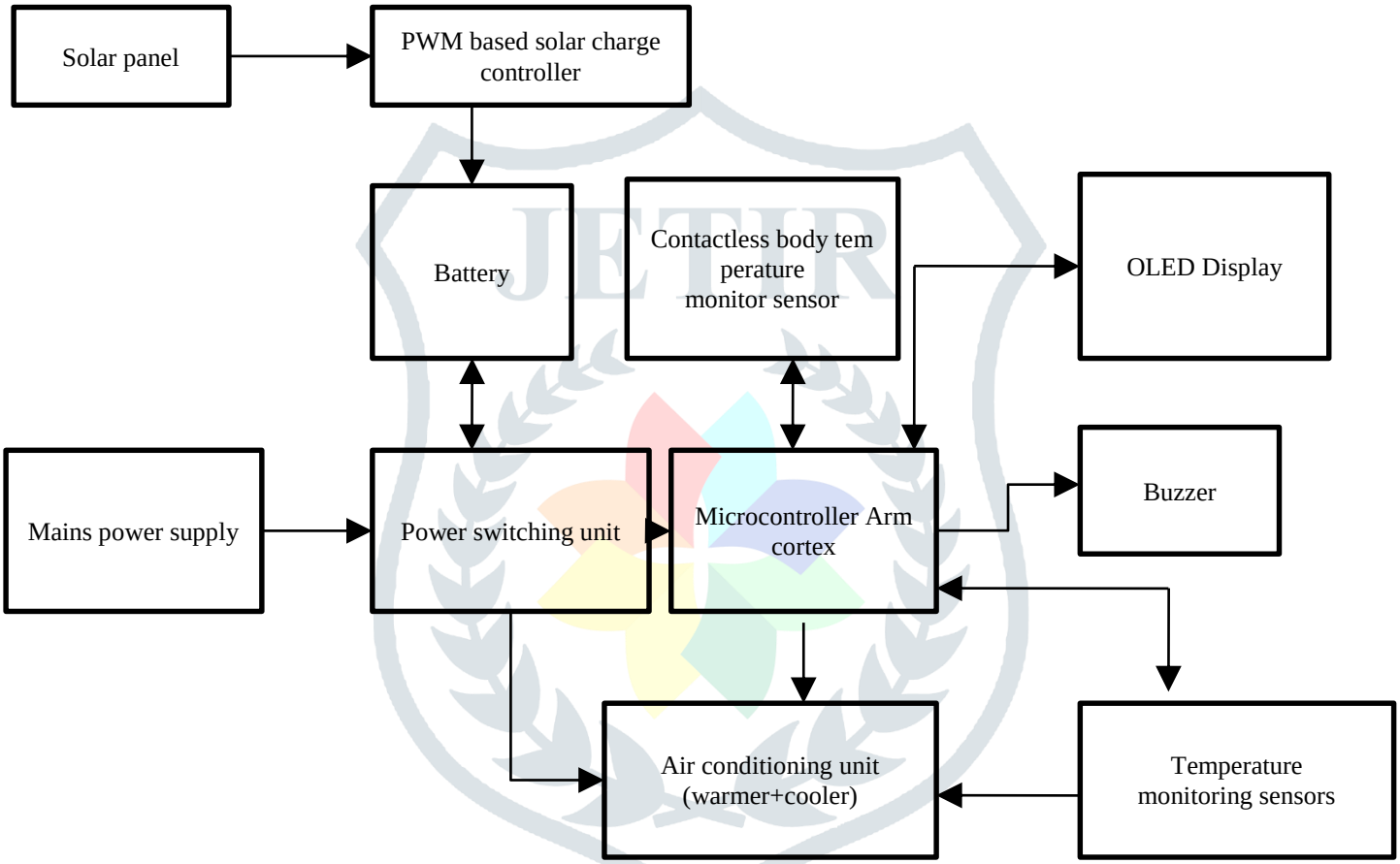

Fig 2: Functional pattern of portable insolation infant warmer.

C. Construction of incubator

Here, the incubator is made light weight since the aim is to make it portable and also it provides well built substructure for all the components that is used [13]. The important requisite is that the compartment where the baby is kept must be isolated from the controlling unit. The incubator structure can be cleaved into four subsystems that are systemic support, enclosure, shell and bed [13]. The systemic support is the device that fits in the other subsystems and the infant. The function of the control unit is to grasp the heat exchanger and also the electrical components that is required for the incubator [13]. The function of the shell is to maintain the heated air, avert the airborne infections from outstretching the infant and to aperture the immobile air. The bed is premeditated to upkeep the infant in place [13].

D. Temperature control system and analysis

The temperature is sensed by LM35DZ temperature sensor [13]. The required temperature range was reached and retained by both AC and DC warm up unit possibilities [2]. The DC heaters took 12min more to reach the required temperature range compared to AC heaters [2]. However, smaller power is needed by the DC heaters and thus makes it as a solar power empowering solution [2]. The temperature sensor is connected to the STM32G071 microcontroller. When the temperature in the chamber descends below 36ºC the LED glows and fan which is connected to bulb is turned ON so that the hot air is gusted into the compartment. When the temperature in the chamber increases beyond 37ºC then the bulb will automatically go OFF and the fan that is there in the cooling unit switches ON. Until the desired temperature is attained the cool air is gusted to the compartment.

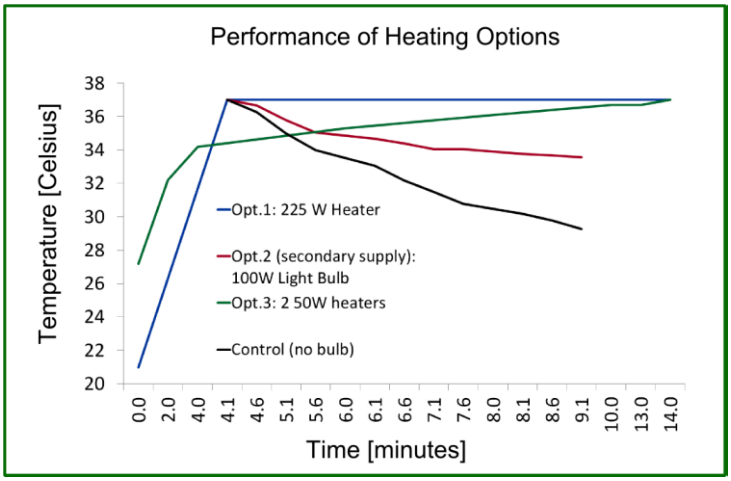

Fig 3: Performance of heating options.

E. Non-contact temperature sensor

Fig 4: MLX90614 infrared temperature sensor.

The MLX90614 is an Infra-Red thermometer for non-contact temperature measurements. Both the IR sensitive thermopile detector chip and the signal conditions ASSP are integrated in the same TO-39 can. It is calibrated in wide temperature ranges: -40ºC…+125ºC for the ambient temperature and -70ºC…+380ºC for the object temperature. Apart from that is of small size and low cost. In addition to that is has high medical accuracy making it suitable for healthcare applications. In real time applications it is effective up to 1 meter, which is best suitable for these chosen dimensions.

F. Solar Panels

Loom solar panels are one of India's popular brands and it is incorporated as the backup supply in the incubator. It has good durability and can survive in extreme weather conditions. The specifications are as follows: 40 W maximum powers (Pmax) and a maximum power voltage (Vmp) of 19.25V and a maximum power current (Imp) equal to 2. 08A.The dimensions of the loom solar panel used is as shown in Fig 3.

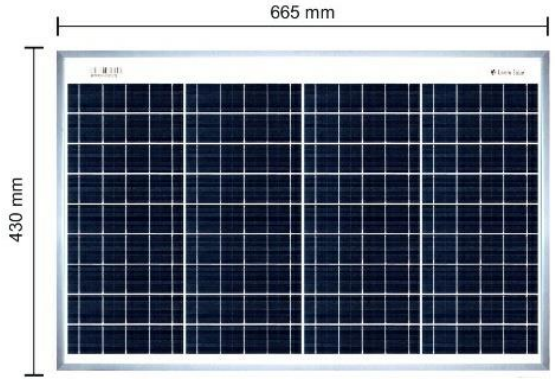

Fig 5: Dimensions of loom solar panels.

V.RESULT AND DISCUSSION

With the current scenario of rural healthcare in India, the need of the hour is to come up with novel innovations which are elementary in their principality, but will perform the intended task with efficiency is capable of surviving in the rural environment.
The current rate of infant mortality in rural India is on the high side and new improved method for care and monitoring are required. These measures would go a long way in bringing down the infant mortality rate (IMR) and aid in the better upbringing of the child from the time of birth.

The infant warmer for neonates introduced in this paper is a device motivated from the current rural scenario for neonates can be utilized for continuous monitoring of core body temperature and provide warmth to the neonate. This parameter provides knowledge about real-time temperature of the body after birth and are useful for detecting most of the common ailments present in neonates such as pneumonia, anemia, jaundice and hyperthermia.

When the temperature of a Peltier element reaches a certain temperature and does not have heat sinks the temperature from one side is transferred to the other and reaches a state of homeostasis. Thus, the Peltier element acts a constant heating device after a particular time.

The major issue with the sensing devices is the instability due to body movements and that is a concern with the device as well. Power supply can also be a concern for long period of monitoring due to the presence of three Peltier elements, mosfet, resisters and Arduino board draining the battery too quickly.

These issues can be overcome by working on the device in the near future and the parameters mentioned below are the ones that need to be addressed.

VI.CONCLUSION AND FUTURE SCOPE

To improve the performance of the system a better supply unit can be created for longer duration of monitoring.

Adding more monitoring sensors such as ECG and spo2 so that we get better understanding of the neonate. Less bulky heat sinks and efficient cooling fans can be incorporated so that the cooling of the neonate can also be implemented if necessary.

Along with miniaturization more monitoring parameters can be implemented for a complete monitoring system that would be cheap, efficient easy to use and more comfortable for the neonates

VII. REFERENCES

[1] D A Ducker, A J Lyon, R Ross Russel, C A Bass, and N McIntosh,Warmer temperature.

[2] Virginia Hall, Eric Geise, Nasser H KashouOctober 2014, Global Humanitarian Technology Conference Paper

[3] Rutuja G. Shelke, Dipali S. Sarode, Shital K. MathpatiMay 2017, International Journal for Research in Applied Science and Engineering- Intelligent Baby Incubator Using Solar (IJRASET).

[4] Hitu Bansal1, Dr. Lini Mathew2, Ashish Gupta Vol. 4, Issue 2015 Controlling of Temperature and Humidity for an Infant Incubator Using Microcontroller(IJAREEIE).

[5] 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, Volume-2 Issue-12, October 2014.

[6] Meghakoli, purviladge, bhavpriya Prasad, ronakboria, intelligent incubator, 2018 conference paper.

[7] A.ahmed, J.cabello, D patel, D Russo, low cost transportable infant incubator,2013,conference publication paper.

[8] Shehlainam, mohammudfarrukhqureshi, faisalamin, android based internet accessible infant incubator, conference publication paper,2019.

[9] SandraSendra, Pablo Romero-Diaz, Jorge Navarro-Ortiz, Jaime Lloret, Smart infant incubator Based on LoRa networks, International conference paper,2018.

[10] M.Shaib, M.Rashid, L.hamawy, M.Arnout, Advanced portable preterm baby incubator, 2017 Fourth International conference on Advances in biomedical Engineering.

[11] SinanS.Mohammed Sheet, Zaid Ghanim Mohammed, KhaleelNawafalKhaleel, Ahmed Abdulrudah Abbas, Smart infant incubator based on Mega microcontroller,2019 2nd International conference on Engineering Technology and its application.

[12] J.ElHadjali, E.Feki, Incubator system identification of humidity and temperature: Comparison between two identification environments,2018 9th International Renewable Energy Congress(IREC).

[13] ZinatAraNisha and A.H.M fazle elahi,2014 conference paper,low cost neonatal incubator with smart control system.