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MEASUREMENT OF DYNAMIC MULTI-PARAMETER IN NEONATAL INCUBATOR

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ABSTRACT

The present article portrays a design and implementation of an infant incubator with better multi-parameter measurements. The proposed model focuses on the design of low cost and effective incubator which can be utilized in developing countries and rural areas for the treatment of premature babies and infants. Infants typically lose heat to their environment in four different ways: through conduction, convection, radiation, and evaporation. The temperature, moisture, heart beat rate of the infant are monitored through sensors. The central controlling unit of the incubator is the ChipKit UNO32 which takes care of data acquisition. The data is transmitted serially through USB and they are given as input to LabVIEW. LabVIEW consists of graphical user interface which makes data acquisition and monitoring easy. Thus with the help of LabVIEW the monitoring of data can be made automatic and emergency conditions can be indicated. The proposed model will make the operation like the normal neonatal ICU with the efficiency of 60 to 80% to advanced neonatal incubators.

Keywords

LabVIEW, MP IDE, HVAC, .LVM

1. INTRODUCTION

The Incubator is an apparatus for maintaining an infant, especially a premature infant, in an environment of controlled temperature, humidity, and oxygen concentration. Infants born prior to thirty seven weeks of gestation are referred to as premature. Prematurity is a significant problem in developing countries, where preterm infants make up approximately 25% of all live births. The World Health Organization (WHO) and Engineering World Health (EWH) have both expressed the necessity for a low cost, transportable infant incubation unit that can be used specifically for transit [1]. With the development of computer technology, modern measurement technology, and electronic instrument technology, virtual instrument becomes mainstream direction of current instrument development because of its characteristics of efficiency high, man-machine interactive interface good, convenience of reconstructed system, self-defining function, and so on. Design in this system can improve detecting speed, and make temperature sensor, humidity sensor intelligence and automation [2]. Premature babies are not fully equipped to deal with life in our world. Their little bodies still have underdeveloped parts that include the lungs, digestive system, immune system and skin. The Incubator is used for preemies to survive the first few days, weeks or months of life until they are strong enough to make it on their own. The system is equipped with monitoring and alarm systems, respiratory and resuscitation equipment, access to physicians in every pediatric specialty. The device needs to be economical, robust, and use easily replaceable parts. The heating mechanism will use computer fans, a humidifier, and car headlights to provide heat. The temperature will be automatically maintained by a proportional integrative derivative (PID) controller [4]. The temperature of the incubator should be maintained in certain limit as the infant or premature babies cannot tolerate even one degree deviation from the limit of 36.5°C to 37.5°C [1]. Alternatives to incubators such as locally sourced radiant warmers and Kangaroo Mother Care KMC)are effective in certain situations. When no

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alternative sources exist, providers have used radiant warmers, such as high voltage lights and space heaters. Unfortunately, these alternatives have dubious safety records and have been known to cause harm to neonates [3].

2. EXISTING MODEL

The existing incubators in developing countries allows the doctor to treat the infant with low-birth-weight and premature babies. The temperature can be automatically varied. The incubators are semi-automatic where the infant's heart beat rate and temperature should be measured manually and time to time human monitoring is needed. If the human monitoring is irregular it will cause serious consequences and even lead to death of infants. In case of emergency the incubators will not provide any emergency alert. The existing models will not provide any automated documentation of the infant or premature babies' health condition which is important for the future investigation time to time.

3. PROPOSED MODEL

The proposed model is a low cost infant incubator designed using ChipKit UNO32 which consists of Microchip® PIC32MX320F128 processor. The incubator also monitored through the LabVIEW which is a graphical programming software which makes the monitoring automated and documentation of the medical data which helps in analysis and investigation.

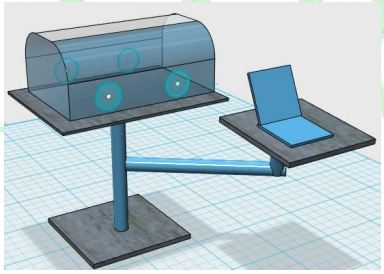

Figure 1 3D Model of the proposed system

The model consists of the polycarbonate cabin which will be the best choice for maintaining the temperature [4]. The 3D model of the neonatal incubator is shown in the Figure1.

4. NEONATAL INCUBATOR

The heart of the neonatal incubator PIC32MX320. The processor takes care of the data acquisition, Transferring and processing. The block diagram is shown in the Figure2. The processor is embedded as a development board by "Microchip" and it is called as "ChipKIT UNO32". ChipKIT is programmed using the modified Arduino programming software called "MP IDE". The MP IDE provides the way to program the kit using the serial USB programming as the boot loader is inbuilt. This allows debugging the program and reprogramming of ChipKIT easier.

The important parameters which are needed to be documented and monitored are Infant's heart rate, Movement count, and Infant/Incubator temperature. These parameters are measured using the different sensors which are connected to ChipKIT. The data are also transferred to LabVIEW for monitoring through serial communication and the LabVIEW has the inbuilt function called VISA to communicate to external devices using the serial communication. Both read/write operations can be performed in external devices using the VISA.

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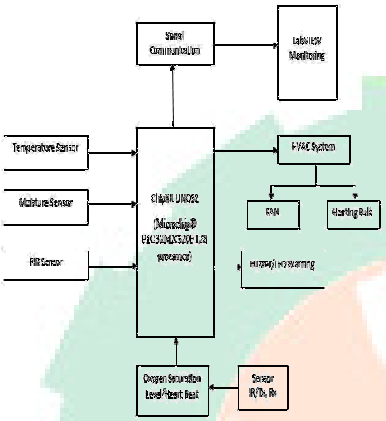

Figure 2 Neonatal Incubator

4.1.1 Temperature/Moisture sensor

The DHT11 is a robust little one-wire device that can measure both temperature and humidity. It is a simple low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the air condition of surrounding and it provides a digital output.

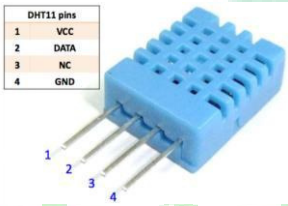

Figure 3 DHT11 Temperature Sensor

The sensor is interfaced to the ChipKIT by the digital GPIO pins. The GPIO pins are initialized as the input pins and then the data from the DHT11 are monitored. When more than one temperature sensor is used then it can be connected using the I2C protocol which is best way for communicating with the multiple devices.

The temperature of the infant is measured using the simple LM35 analog temperature sensor. The analog sensor value will be given as analog input pin of ChipKIT and then the inbuilt ADC will convert the temperature and displays it in the LCD as data is transmitted to the LabVIEW.

4.1.2 PIR sensor

The objects that are having the temperature above absolute zero will emit heat energy in the form of radiation. This radiation is invisible to the human eye because the emitted radiation is at infrared wavelengths. It can be detected using electronic devices.

PIR sensor is connected to digital pin as input and then when the pin gets the high input the movement count is incremented.

4.1.3

The system consists of two components to maintain the temperature. The heating is made through the heating bulb which can be automobile light or the traditional halogen bulbs [4, 3]. The ventilation is made through the exhaust fan. In our project we have used the computer fan which is smaller in size and low cost for the ventilation system [1, 3]. The heating bulb and the temperature programming sensors have interconnection. Whenever the temperature falls below the certain limit then the heating bulb is turned ON using the relay circuit. The ventilation is also made by using the fan when the temperature is higher than the limit. The physical relay operation and the warning is made by the LabVIEW once the upper and lower limits are crossed.

5. LabVIEW MONITORING AND DOCUMENTATION

The LabVIEW monitoring is an automated

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and efficient monitoring compared to the human monitoring. The ChipKIT UNO is connected to PC through the USB port and the inputs are given through it. The data are collected through the VISA function in LabVIEW and then processed. The various indicators in the front panel will display the obtained values. The front panel is designed in such a way that everyone can understand and easy to use. The health data of the infant will be saved in the location shown in front panel.

The data will be saved in the format of .LVM which is default documentation for LabVIEW. When we use DAQ for data acquisition [2] the

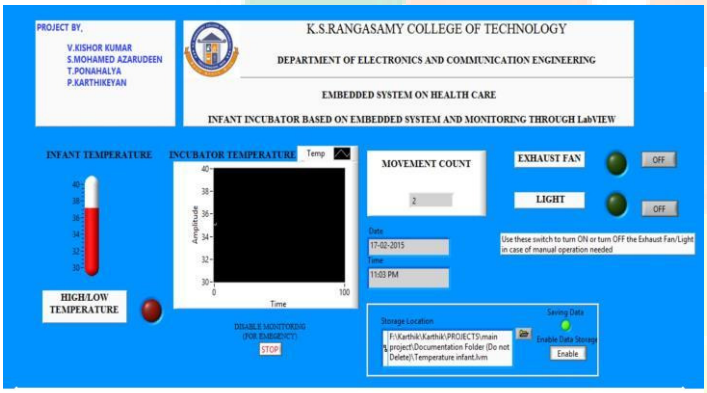

Figure 4 Front panel of LabVIEW Monitoring

cost will be high and the total incubator cost will be around lakhs. The front panel is shown in the Figure4.

The simulation of the incubator monitoring is made through LabVIEW and tested using the random values. The real time monitoring uses the serially received data to show the indications and documentation of the values. The random value simulation of incubator model is shown in the figure5.

The "Write Measurement file" function is used to document the medical data. The whole system is placed inside a While Loop which will execute continuously until the loop is force stopped manually. The loop is made to run one iteration per second using the "Wait until" function. Without this function the loop will iterate at 1024/second which leads to increase in storage of the medical data as the samples are taken from the sensor at rate of 1024/second.

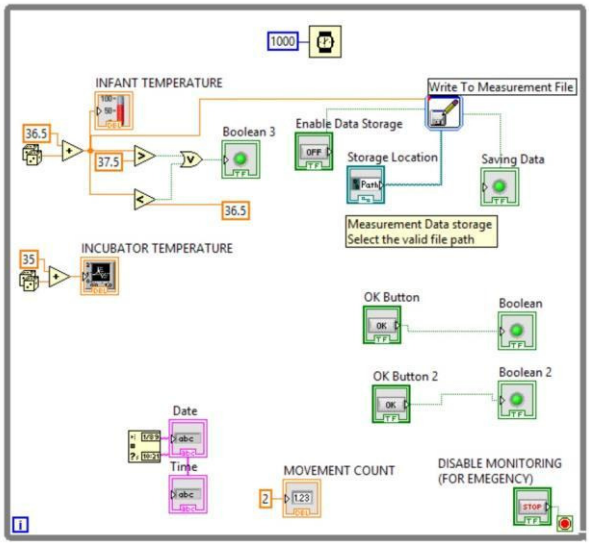

Figure 5 Back panel of the neonatal monitoring simulation

5.1 DATABASE

The LabVIEW stores the data in different formats such as .LVM, .XLSX, TDMS, TDM. Here we have programmed the VI to store the data in LVM format which is default LabVIEW format and it can be read by any PC using the LabVIEW. The data can also be read by using the Microsoft Excel which is easier for viewing. The data stored are Number of input channels, Time and date, Sensor output. The location of the stored data can be viewed in the front panel. The example data stored is shown in the Firgure6.

	A	B	C
3	Reader_Version	2	
4	Separator	Tab	
5	Decimal_Separator	.	
6	Multi_Headings	Yes	
7	X_Columns	Multi	
8	Time_Pref	Absolute	
9	Operator	karth_000	
10	Description	The file will save the temperature of the int	
11	Date	18-02-2015	
12	Time	14:55:39.1473836898803710937	
13	***End_of_Header***		
14			
15	Channels	1	
16	Samples	1	
17	Date	18-02-2015	
18	Time	14:55:39.1473836898803710937	
19	X_Dimension	Time	
20	X0	0.00E+00	
21	Delta_X	1	
22	***End_of_Header***		
23	X_Value	Untitled	Comment
24	0	37.234212	
25			

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Figure 6 Temperature of Infant stored in PC

6. CONCLUSION

The incubator is designed with the proposed and recommended materials. The output of the sensors are displayed in the LabVIEW in PC and then the secondary display as in LCD also. The incubator will maintain the temperature range of 36.5°C to 37.5°C. The movement count is calculated for every day. The proposed model will be a replacement for the normal warmers with just temperature maintenance and the human monitoring. This project can be used in several government hospitals, rural area hospitals to treat the premature babies.

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