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Temperature Monitoring System for Infant Incubator Using Arduino

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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 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 objectives of this project.*

Keywords: *Infant, LM35, Monitoring System, PIC1Ff876A, Temperature.*

1. INTRODUCTION

A balanced and suitable temperature is an important element of the human being and even for machines in the industry [1]. The temperature monitoring system applied in many fields such as biomedical field for health monitoring purpose [2]. This system was important in neonatal intensive care unit, NICU for monitoring the temperature of infant incubator [3]. As known that, warmth is important for the infant in an incubator. Preterm infant refers to the baby that born before 37 completed weeks of gestation [4]-[5]. They may have a problem in keeping a constant body temperature. The preterm infant needs an environmental condition as in its mother's belly [6]-[8]. According to (*AtomV-2100G Infant Incubator-Service manual*, 2004)[3] , the incubator air temperature was setting at the range (23°-37°C) and the humidity setting range was (40%-95%RH). So, this project is about to design a portable temperature monitoring system that can be used to monitor the desired temperature of infant incubator [9]-[10]. This project used Arduino UNO as a micro-controller and the RF transmitter and receiver module were implemented and sends the data from micro-controller to the computer for better monitoring purpose [11],[12-16].

2. METHODOLOGY

1.1 Electronic Hardware

Arduino UNO is a micro-controller board based on the ATmega328 and it has 14 digital input/output pins. There are 6 pins as a PWM output pins such as 3, 5, 6, 9, 10 and pin 11. There are another 6 analog inputs and a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. This microcontroller can simply connect to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. In this project, the RF receiver connected to the computer and receives data measured from the RF transmitter that attached to Arduino microcontrollers. Then, the users can monitor the data virtually from the computer. On the Arduino

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board, there is a sensors used to measure the 3 parameters such as air temperature, relative humidity percentages in an incubator prototype and the presence of water [17]-[18]. From this data measurement, the actuators which is fan, heat element and water pump acted on the data. The PWM pins used to control the fan speed and relay module used to control the pump and heat element [19]-[25].

1.2 Connection of nRF24L01

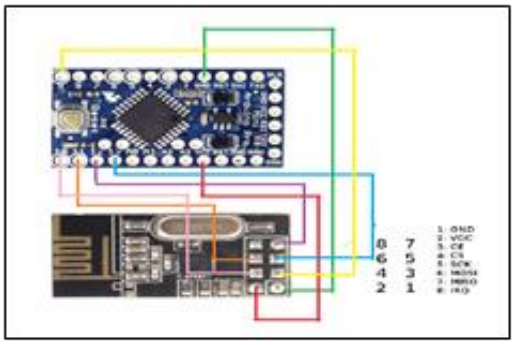

Figure 1: Arduino Pro Mini to nRF24

The SCK pin from nRF24 was connected to pin 13 at Pro Mini. The Master In Slave Out (MISO) pin from nRF24 was connected to pin 12 Pro Mini. Then the Master Out Slave In (MOSI) pin from nRf24 was connected to pin 11 Pro Mini. The pin 10 from Pro Mini was connected to pin CS at nRF24. All pins 10, 11, 12 and 13 are a SPI pins. This connection used for the receiver circuit that were attached to USB port at the user's computer and received data from the transmitter.

3. RESULT AND ANALYSIS

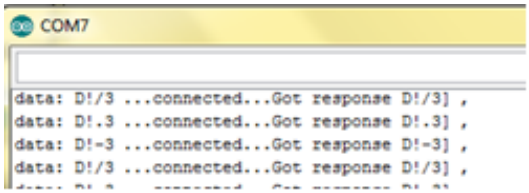

Figure 2: Data packet sends to RX

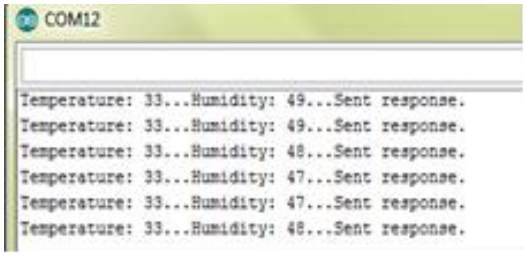

Figure 3: Data packet received from TX

Result at Figure 2 and Figure 3 shows the display readings of temperature and humidity continuously from serial monitor RX and Visual Basic interface. The "connected" status at the TX serial monitor means that the connection between TX and RX circuit was connected. When the Rx received the data packet from the TX, the "Sent Response" status comes out as above Figure 3. Then the TX successfully received the feedback from the RX. This explains the "Get Response" status at serial monitor TX. The data packet transmitted and was received very well.

Table 1: The distance Rx able to receive the signal [26]

Distance(m)	Status
14.7 meter	Connected
More than 14.7 meter	Disconnected

Table 2: The Output Power for Transmitter

Power (mW)	Power (dBm)
0+ mW	-∞ dBm
0.01 mW	-20.0 dBm
0.1 mW	-10.0 dBm
1 mW	0.0 dBm
2 mW	3.0 dBm
3 mW	4.8 dBm
4 mW	6.0 dBm
5 mW	7.0 dBm
6 mW	7.8 dBm
7 mW	8.5 dBm
8 mW	9.0 dBm
9 mW	9.5 dBm
10 mW	10.0 dBm
100 mW	20.0 dBm
1 W (1000 mW)	30.0 dBm
10 W	40.0 dBm
10 MW (10000 KW)	100.0 dBm

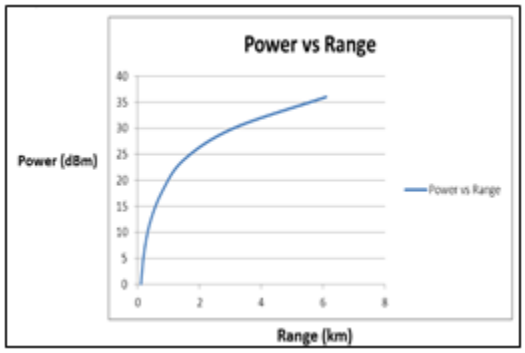

Figure 4: Output power vs Range distance

According to (Nordic Semiconductor, n.d.), the transmitter output power stated as 11.3 mA at 0dBm output power. As above Table 2 according

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to (Laird Technologies, 2012), the output power for transmitter is only 0+mW.

Based on above Figure 4, the distance for nRf24 (RX) to receive the signal is not more than 1 km. The range of the distance will increased when the output power is increased.

4. CONCLUSION

In conclusion, a prototype of radio frequency monitoring device is done successfully. The readings of temperature and humidity were able to display. This result obtained and achieved the first objectives of this project. The development of circuit for transmitter and receiver using Arduino microcontroller was intend to achieve the second objectives of this project. The uses of interface as Visual Basic with the pop up window functionalities add more alertness to users and increase the security level. The monitoring and controlling purpose can be done easily with the ability of data that can be saved directly to computer. Thus, the devices are affordable.

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