Neonatal Incubator Embedded Temperature Observation and Monitoring Using GSM

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Abstract

In order to reduce the risks of death rates, neglecting by the observers, and sometimes the little number of the medical staff in hospital, A monitoring system based microcontroller in neonatal incubatorwas developed in this article.An interfacing process is made between the infant, infant incubator, and the computer, by taking the temperature readings and send the results to doctor's or the person who in-charge's phone through Short Messages Service, and to a personal computer PC, with sound alarm on the incubator, every given period of time; A temperature sensor is interfaced with a configured single inline module SIM of phone, the temperature reading that obtained from interfacing method is combined with the readings of the incubator sensor, then the final result will be taken from the microcontroller because it will be more accurate than the incubator's thermometer.

This system was designed only to check and give an alarm if there was any unaccepted change in temperature due to the normal temperature ranges.

Keywords:SIM, SMS, Thermistor, temperature-sensor, Arduino.

I. Introduction:

The changing in body temperature has a great effect on human health itself. Some instruments in the markets may provide many medical measurement data to patients and doctors, but some of the patients may not translate these measurements into diagnosis because they have very little medical background [1]. If the raw of medical data given to the doctor takes more time, it can cause difficulty or even high death rates especially on countries that has no powerful medical or healthcare systems. The data obtained from the microcontroller can cover a huge area of interests (temperature change, humidity, oxygen level, and UV levels), and these data can be shared with all desired destinations (medical staff, emergency units, and biomedical engineering staff)

These data obtained can reduce the risk of many sudden cases like (hypothermia, hyperthermia, Heat syndromes, cramps, stroke etc.).In neonates hyperthermia rarely does occur but for an external source like

• Overzealous re-warming

• Poorly serviced equipment
• Misuse of warming lamps
• Incubator too close to a sunny window
• Temperature probe not in good contact with)

In developing countries, the use of remote health monitoring system application enables doctors from monitoring patient's temperature practically based on web and GMS, where death rates were increased most painfully due to inadequate prompt attention [2]. The task was developed by making the function of collection of patient's temperature and give it to doctors or the responsible staff by the use of web or GSM, which they remotely monitor their patients, and removing the barrier of distance [3].

The application of remote temperature monitoring (RTM) has wide field in the life. GMS network provide a tool to take and view temperature readings anytime and anywhere by receiving these readings by cell phones or other mobile devices making distance a non- issue [3].

II. Background of Neonatal Incubator:

The incubator process is used to produce healthful micro-environment in order to reduce new born heat loss by controlling temperature inside incubator. Temperature is one of the most important factors that need to be maintained with a minimum variation. But only temperature control is not sufficient to provide comfortable environment. Also, the relative humidity control is very important to reduce the new born heat loss. In the current neonatal incubator systems, temperature is the only variable detected, which has been monitored at the incubator's site only without any further observation [4].A neonatal incubator, which is represented in Figure (1), consists of a rigid box built in fiber and steel, where an infant may be kept in a controlled environment for medical care. The device includes an AC-powered heater, an electrical motor fan to circulate the warmed air, a water container to add humidity, a mechanical filter through which the oxygen flows and an access port for nursing care. The electric motor allows the air to circulate into the neonatal incubator through an air inlet at the bottom of the equipment. It influences the temperature and humidity levels inside the incubator dome, as well as the oxygen level. The air is renewed by a set composed of an electrical exhaust fan and an air inlet [5].

Fig. (1) Incubator system

III.Design and Implementation Approach:

The layout and also the execution approach defines the procedure's ingredients of the mooted system along with the interactions between these ingredients. The circuit diagram representation of the developed model is shown in Figure 2.

The scope of normal values is set before the system starts taking any readings. All the ingredients required to take the readings of the temperature are initialized. The monitoring system now starts its work in an unending loop until it is manually halted. The mooted system will read the temperature in analogue data, then the analogue to digital converter (ADC) will convert these data to digital format. The converted format will be compared to the present values. If the read value is within the present scope the value will be transmitted to the local server where it will be displayed in tabular format and display results. If the read value is outside the scope,a warning is sent to the doctor and the nurses, with sound alarm in the incubator.

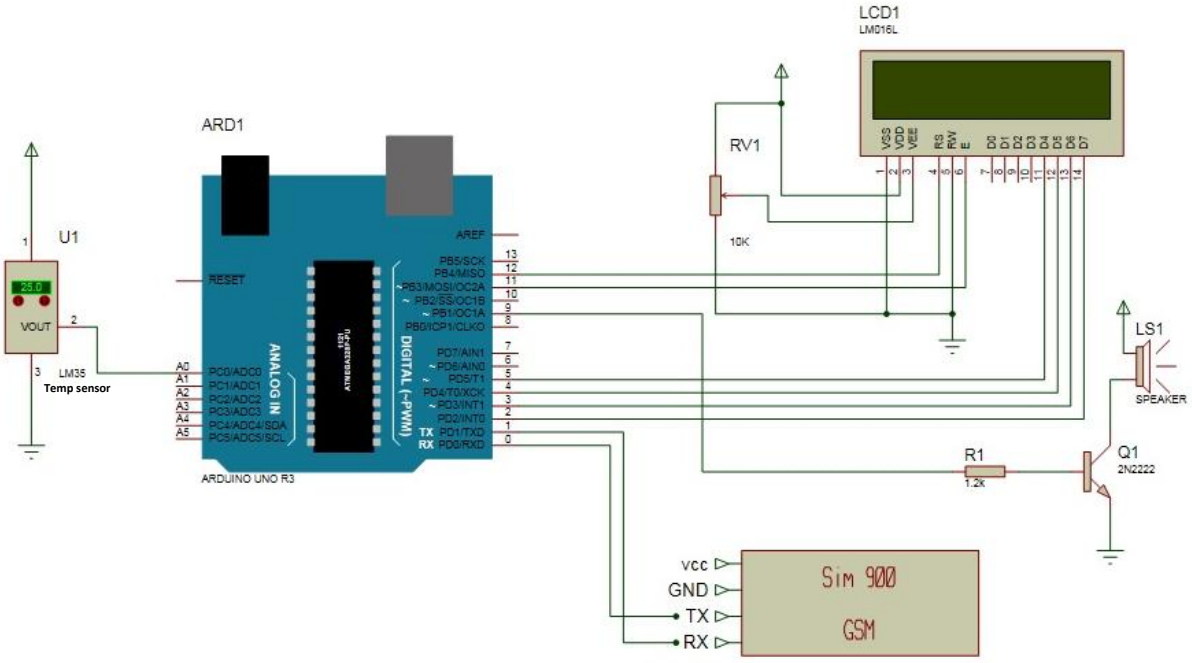

Fig. (2) Circuit diagram of developed system.

The temperature reading taken from the sensor attached to the wristwatch placed on the hand of the infant was fed to an ADC port of the microcontroller, in order to convert analog readings from the sensor to

digital. Also, upon a given command, the microcontrollerwill read the temperature sample. It was then being converted and stored in the microcontroller memory as two 8-bit unsigned integers (0-255).

After completion of signals acquisition and comparison with preset values, the microcontroller then constructs the SMS messages as well as emails and packs the data samples in these messages to the desired length, it then communicates with the mobile phone using at-commands on its serial port to send the message(s).The device records temperature data continuously. When a temperature reading exceeds the present values, an alarm is triggered, and an email and a SMS message was sent to the in-charge doctor, then, the measured values are sent to the local web server and displayed on the website of the hospital in a tabular format; this assists the doctor(s) in taking correct decisions based on the accurate data; as shown in the flowchart bellow (fig. 4).

The SMS message can be programed as the doctor's request, in this system the message would be sent is {emergency in incubator no. ( )}.

As a future scope, the designed system could have some precaution solution to reduce the unusual or unaccepted change in temperature by adding extra cooling fans to the incubator.

Fig.3 parts of the system

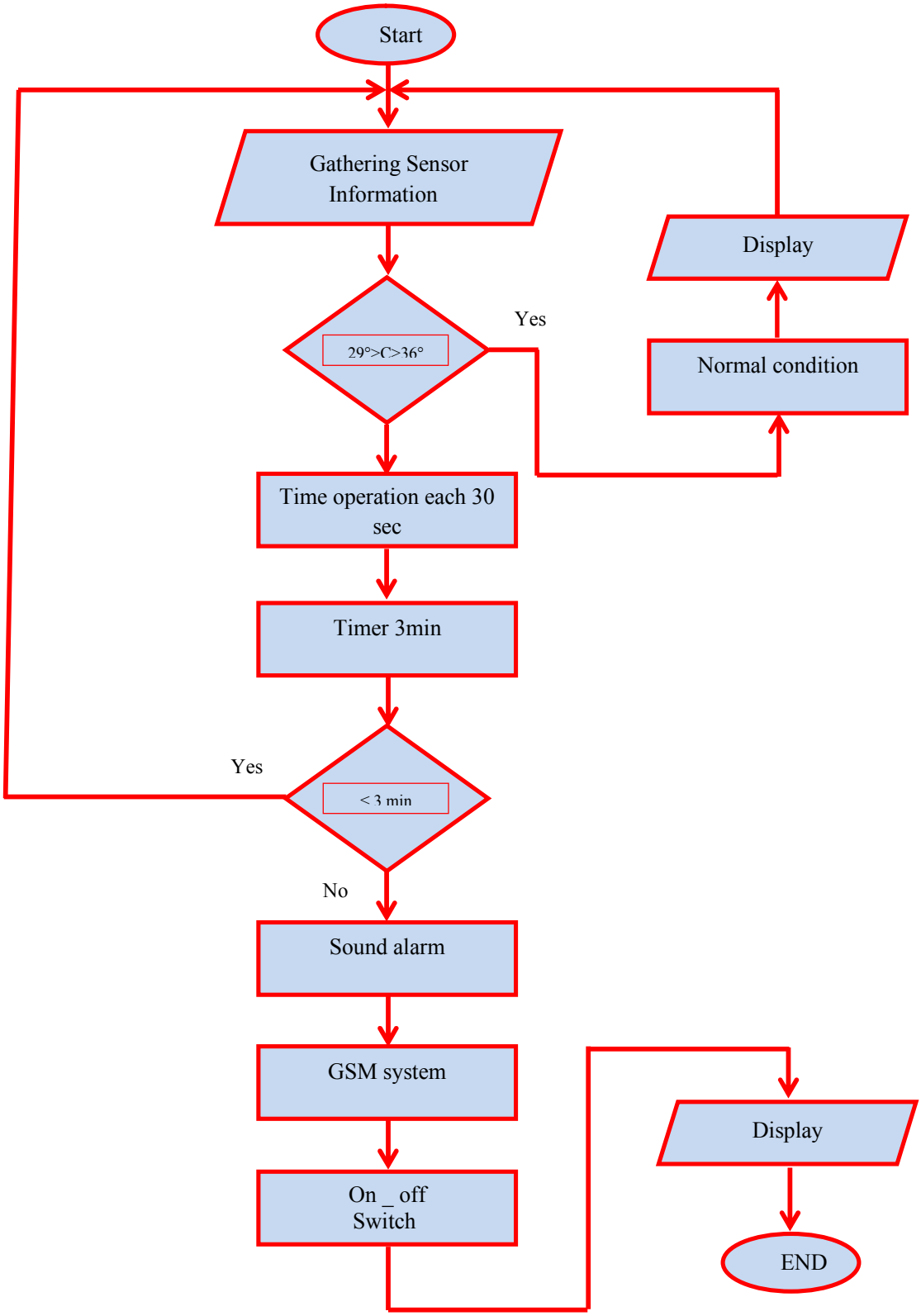

Fig. (4) Flowchart representation of the developed model

IV.Arduino board:

Arduino is an open source computer hardware and software company, project, and user community that designs and manufactures single-board microcontrollers and microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical and digital world. Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with sets ofdigital and analog input/output (I/O) pins that may be interfaced to various expansion boards or Breadboards (shields) and other circuits. The boards feature serial communications interfaces, including Universal Serial Bus (USB) on some models, which are also used for loading programs from personal computers [6]. Figure (5) shows the Arduino board.

Fig. (5) Arduino board

V.GSM:

A GSM (Global System for Mobile Communication, originally from Group SpecialMobile) modem is a wireless modem that works with a GSM wireless network. A wirelessmodem behaves like a dial-up modem, except the main difference between them is that a dialupmodem sends and receives data through a fixed telephone line, while a wireless modemsends and receives data through radio waves[7]. The GSM Association estimate that 80% of the global mobile market uses the standard A GSM modem is a wireless modem that works with a GSM wireless network.Global Positioning System is one of the widely used mobile standards. As the name specifies, it enables the mobile users to interact all over the world at any time. It is a hardware component that allows the capability to send and receive SMS to and from the system. Communication with the system is carried out via RS232 serial port. Cell phone can be attached at the place of GSM hardware but it limits the hardware functionality such as sending or receiving of SMS [8]. The dominant mobile phone network in the world today is GSM. It is a digital mobile communication network, whichdeveloped, rapidly in recent years. This network has coverage in most urban areas and offer support for the SMS [9]

VI. System Testing and Results:

The results obtained were tested and confirmed under normal temperature and dustless environment and agreed with the expected results which were displayed on the Liquid Crystal Display (LCD). The results obtained were compared and tabulated

as shown in Table 1. From the result, it was seen that there was little or no variation in the patient's readings from the clinical thermometer and the monitoring unit.

Subject	Readings from Clinical Thermometer (C°)	Readings from infant body using microcontroller sensor (C°)
Patient A	**30**	**30.5**
Patient B	**33.6**	**34.1**
Patient C	**36.5**	**37.5**
Patient D	**30.2**	**31.7**
Patient E	**37.1**	**37.9**

Table 1 Readings results comparison between the incubator thermos sensor and the Microcontroller sensor.

VII.Conclusions:

From the results which was obtained practically from the patient's, the accuracy of the designed system was acceptable and the efficiency of the system was very high.

The designed system is very easy to use and manufacture, and the coast of manufacturing is rather reasonable, in the other hand the size of the designed system is small and can be reduced to minimum size depending on the size of microcontroller used.

We have presented remote temperature monitoring system using microcontroller to ease the work of doctors in hospitals suffering from less number of staff, and in remote areas. The designed system was capable of helping the doctors to make the right decision at the right time. The system is also appropriate for the monitoring of day-to-day activities in places like server rooms, hospital rooms, warehouses etc...

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