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Infant's Health Monitoring Device and Alert System with GSM Technique

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Abstract: ***The continuous monitoring of thevital signs and the purity of the environment for infants who are in a critical development period or they are represented as critical patients is an important issue for their safety whether at home or in the hospital. It is not easy to achieve these things by the mother or anyone else except by using sophisticated devices so that the continuous monitoring device is an absolute solution for this case. By using Embedded systems and wireless communications, the device can monitor infant's heart rate, temperature, as well as smoke concentrations in the infant's room and activating an alarm by sending a text message (SMS) to the parent's or caregiver's mobile under risk situation to increase the potential for them to initiate early intervention. The device consists of an Arduino Uno microcontroller, GSM interface, sensors to measure vital signs, a sound buzzer, and a rechargeable battery. Finally, the outputs of this device provide a real-time data monitoring, effective services, and excluding manual data collecting.***

Keywords: Vital signs, Embedded system, continuous monitoring, wireless communication

1. Introduction

To provide a safe environment for the infant and follow up his health, it is necessary to monitor his vital signs in real time as well as the external factors like smoke concentrations in the surrounding which play a crucial role in his life [1], the traditional way of monitoring infant's health is often done under the observation of the physician [2]. It couldn't be achieved by parents or unspecialized persons, besidesthat, it was done by using complicated and expensive devices. In this device, these parameters will be monitored easily and continuously and anyone can identify the physiological condition of the infant. Many of the vital events are related to the temperature of the infant as well as the number of heartbeat so that any biological problem may lead to a change in temperature or number of heartbeat, which in turn will provide peace of mind to the parents or health care provider because they will be aware of these vital signs [3]. By using this device, the parents or caregiver can monitor the infant's condition easily whether they were close to him or away from him [4].

2. Literature Survey

Sudhindra F et.al used digital device OMRON NIBP unit for monitoring heart rate in real time. The developed system uses GSM for measured signal information transformation through SMS and GPS for location knowledge [5]. Vikram Singh R. Parihar et.al proposed a system that relies on using the Arduino Uno microcontroller. The designed system measures heart rate and temperature of the patient and displays the values on the LCD monitor. By using wireless technology, the measured data can be transmitted to a remote location [6]. Faruk AKTAS et. Al. developed a real-time infant monitoring system that uses Android-based mobile devices. An Arduino Leonardo board was used in the system as well as a sound detection sensor, body temperature sensor, pulse rate sensor, and humidity sensor. So as to activate an alarm if any parameter exceeds the normal values [7].

3. Method and Materials

Embedded systems, GSM module, and different sensors have been used. It focuses on including the most factors that lead to enhancing life quality, also it provides a simple monitoring method that doesn't require smartphone or internet availability. Using GSM module makes it easy to get information regardless of distances which in turn gives comfort for parents or caregiver. The system monitors biological parameters such as heart rate and temperature as well as external factors like infant's position, smoke concentration and CO_2 concentration in the surrounding. Figure (1) shows the system architecture. The device will measure three inputs from the sensors connected to the Arduino Uno microcontroller which are: temperature, smoke concentration in the periphery, and heart rate. These parameters will be displayed on the LCD monitor in real time and compared with normal values stored in Arduino master if any parameter exceeds the normal ranges, the device will send an SMS alarm to the parent's phone and activate audible alarm. The device will resend the alarm message every 20 seconds until intervention occurs or an infant's condition becomes normal again.

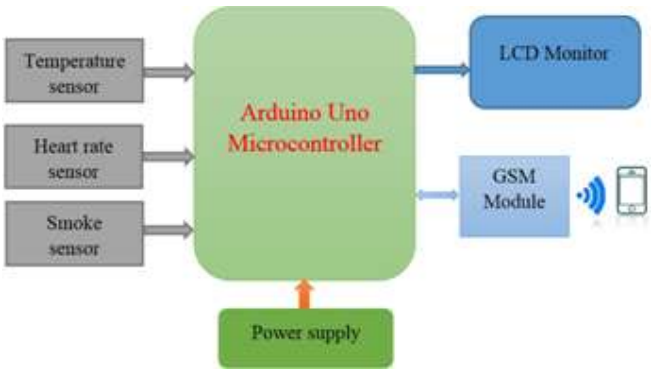

Figure 1: Device Architecture

The components used will be described briefly in the following sections.

3.1 ARDUINO UNO Microcontroller

Arduino is an open-source physical computing platform depends on a simple input/output (I/O) board and an Integrated Development Environment (IDE) that performs the Processing language. It uses Atmega 328 microcontroller with a clock speed of 16MHz. it has14 digital I/O pins and 6 input analog pins.

3.2 GSM Module

GSM/GPRS Modem-RS232 is built with Dual-Band GSM/GPRS engine- SIM900A, which operates on frequencies 900/ 1800 MHz, The Modem has an RS232 interface, which enables connection to PC and a microcontroller. The baud rate can be configured from 9600-115200 through AT commands. By using this modem, audio calls, read and send SMS, attend the incoming calls and internet etc. by using simple commands.

3.3 Smoke Sensor

The MQ-2 gas sensor is used in this device. The sensitive material of this sensor is SnO_2. The sensor conductivity is proportional to the smoke concentration in the periphery. As the target chemical concentration increases, the magnitude of resistance change increases too. The relationship between the sensitive layer and a particular oxidizable gas's concentration is shown by the empirical equation:

$$R_s = A[C]^{-\alpha} \quad (1)$$

Where R_s represents the electrical resistance of the sensor
A is a constant specific for a given sensitive layer composition,
C is the concentration of the gas, and
α is the R_s characteristic slope for that material [8].

3.4 Heart Rate Sensor

The heart rate of an individual is the speed of heartbeat which is measured by the number of hearing contractions per minute (bpm). The normal heart rate of an infant is probably a range between 80 and 150 bpm. Tachycardia is above 150 bpm at rest, Bradycardia is below 80 bpm at rest [9].

In this device, the Pulse Sensor Amped with 3.3V ~ 5V power supply and the wavelength of an LED is 906nm, is used. It can be put on an infant's finger or earlobe.

3.5 Temperature Sensor

The DS18B20 Digital temperature sensor is used to measure the infant's temperature, which is placed under the armpit. It has an accuracy of ±0.5°C over the range from -10°C to +85°C. it directly converts measured temperature to digital format. It provides adjustable 9, 10, 11, or 12 bits temperature resolution. The connection between Arduino Uno board and this sensor based on 1-Wire protocol, which is a serial signaling protocol that operates and powers devices with a single connection and ground, providing a significant reduction interface complexity.

3.6 Rechargeable Battery

Due to the rapid electronic development and increased need for devices that work for a long time without the need to source electricity, a great motivation has been generated to make safe, lightweight, compact, and high energy density batteries with better cycle life. The lithium-ion batteries are very suitable to achieve the above-mentioned characteristics. Three batteries of 3.7V were used and connected in a serial configuration to provide about 12V to ensure that the device will operate independently for several hours.

3.7 Voltage Converter

LM2596 voltage buck up-converter is used in this device. To minimize voltage ripple, capacitors are added. It provides much higher power efficiency as DC-to-DC converters than linear regulators, which lowers voltages by dissipating power as heat.

3.8 I2C/ 16x4 LCD Display

The I2C bus standard is used to minimize connecting wires and avoid lack of the Arduino pins so that only two bus lines are needed, (SDA) as a serial data line and (SCL) as a serial clock line. Where (SDA) of I2C Module is connected to (A4) pin in Arduino board and (SCL) of I2C Module is connected to (A5) pin in Arduino board.

3.9 Device Block Diagram

As shown in fig. (15), the Arduino Uno board is connected to the heart rate sensor and a smoke sensor through analog pins (A0) and (A1) respectively, and to the temperature sensor through the digital pin (2). By using activating alarm switch with specific programming, the alarm function can be controlled easily. (TX) and (RX) pins in GSM are connected to the pin (7) and pin (8) in Arduino respectively. And by using Software Serial Library of Arduino, the communication between Arduino and GSM is established.

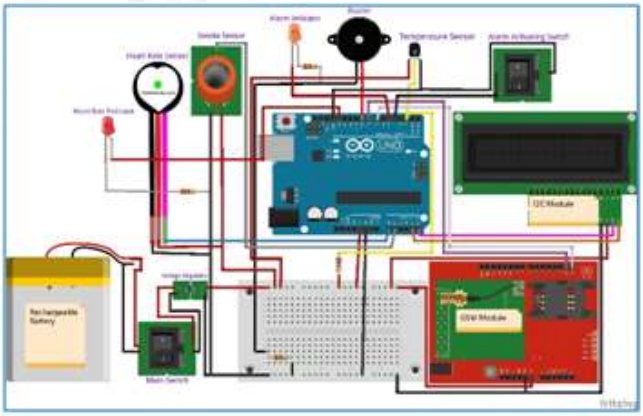

Figure 2: Block diagram

4. Results

The parameters are measured for 6-months infant and displayed on the device's LCD monitor continuously fig.

Heart rate signal is represented with serial plotter fig. (3). the signal is processed with Arduino ADC and represented in the **green** pattern, the bpm according to a threshold value which is equal 550 mv, it is represented in the **blue** pattern, and The **red** pattern represents the time interval between two successive points baud rate set in this plot is 115200 bps, that speed provides about 11 bytes per millisecond to plot the signal properly. The measured temperature is increased gradually and within about 1-2 minutes the reading reaches to the final value which represents the infant's temperature.

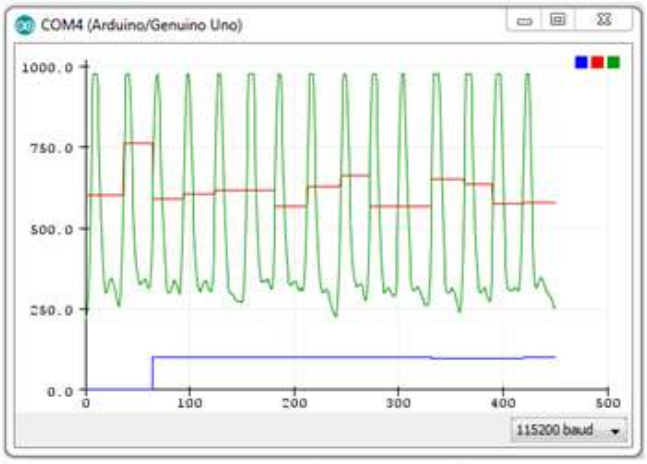

Figure 3: heart rate signal on Arduino serial plotter.

The process of sending the message gets when any value of the sensors exceeds the normal values and as an example of that fig. (4). The temperature is below the normal levels.

Figure 4: sending a message, the device sends "Problem" and to know the measured values a message with "X" letter is sent

5. Conclusion

The existing systems need smartphones and the internet. These systems may be also affected by the barriers or long distances and may lose its effectivity at risk moment. Hence, this designed device can send an alarm to the parent's phone anytime and anywhere. The device monitors the most important factors in real time and displays the date on LCD monitor continuously. It doesn't require a specific type of mobile phone to communicate with it. Anyone can be aware of all factors that the device measures simply by sending an SMS to the phone number stored in the program with (X) letter and the device will respond by sending an SMS containing all information about measured factors. Accurate measurement is obtained by this device that matches the standard devices.

6. Future Scope

- GSM/GPRS Modem-RS232 is used so that the location detection can be added.
- Other sensors can be used such as breathing rate and CO2 concentration etc.
- The output values can be sent to multiple phones.
- A ventilation system can be added to improve room temperature.

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