HEALTH MONITORING DEVICE FOR PREMATURE INFANT

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Abstract-This paper presents a design of a premature infant Monitoring System based on the wireless technology. A prototype is developed which gives a reliable and efficient baby monitoring system that can play a vital role in providing better infant care. This system monitor vital parameters such as body temperature, pulse rate, cry, movement of an infant and using GSM network this information is transferred to their parents. Measurements of this vital parameters can be done and under risk situation conveyed to the parents with sms alert to initiate the proper control actions.

Keywords: SIDS, Neonatalintensive care un,it,GSM network.

I.INTRODUCTION

In today's working world, Sudden Infant Death Syndrome (SIDS) causes unexpected death of infants; a variety of risk factors have been detected through the years. A device is developed which gives a reliable and efficient baby monitoring system that can play a vital role in providing better infant care. This device monitor vital parameters such as body temperature, heartbeat, cry, movement of an infant and sends SMS alert using wireless technology. Our proposed system aims at monitoring the vital signs of the premature infant such as heartbeat, movement of body, body temperature and cry using wireless technology and sensors which are comfortable for the baby to wear. It is also accurate and precise than other sensors. We also focus on increase the scope of transmitting the information without over the internet in order to provide remote access. This system overcomes the drawback of the existing systems which are clumsy, less user friendly and expensive may cause discomfort to the infant. Wireless and wearable sensors provide more convenient and long term monitoring. Sudden Infant Death Syndrome (SIDS) is the unexplained death of an infant below the age of one year. It usually happens without any warning signs during sleep, which is why it is difficult to identify and predict. Therefore our proposed monitoring system would be an effective way to predict the onset of SIDS[1].

Neonatology is a subspecialty of pediatrics that started to develop in the 1940s. After the World War –II the specific needs of sick newborn infants were recognized and new premature nurseries were built. The term "Neonatology" was first used by Alexander Schaffer in 1960 in the introduction of the first edition of his book[13,15]. The miniaturization of samples for blood tests, needed for clinical management including electrolytes, bilirubin and blood gases was one of the major advances in the development of Neonatology. In the following decades important progress was achieved in thermoregulation, nutrition, growth, respiratory support, cardiopulmonary support and infection control.[16]

This proposed system give a peace of mind to loved ones when they are away from their infant as they can get an update status of their wellbeing. The other advantage is the programmability of alarm conditions can alleviate any inaccuracy through a normal sensor. Communication is done by GSM interface in which Short Messaging Service (SMS) is fundamental part of the original GSM system and its progress.[2]

In this way just by an infant's few biomedical parameters parents can get information about their health.

II.LITERATURE REVIEW

There are many designs of incubator for infants in the literatures. In recent work, Dive and Kulkarni designed an incubator that can monitor and detect the light inside the incubator, and also audio or voice of the infant [1]. The proposed incubator system can notify doctor and nurse about the infant's condition, as when the infant cries, the alarm will be triggered and the alarm will stop or deactivated only if someone turned it off. The advantage of the work is it helps doctors and nurses to monitor the infant's condition continuously. For future improvement, they recommended adding parameters such as monitoring of Temperature and moisture, developed a newborn incubator that can check the conditions of the incubator environment by utilizing a humidity control system[1,6.] They concluded that the control of humidity could contribute to the thermos-neutral of the environment, thus improving the premature newborns' quality of life. Therefore, it is necessary to consider the temperature effects of care giving when developing incubators. There are several others unresolved issues in developing infant incubators such as exposure to high noise levels in NICU, incubator's surrounding light environment and electromagnetic fields (EMFs) impact on infant health to name a few. Based on the literature above, monitoring of moisture level and measurement of infant's temperature are important parameters to be considered in designing an infant incubator. Furthermore, an alarm system that can detect both parameters are nearing safety level threshold, and then, alert caregivers about this situation is also essential to prevent harmful situation. Therefore, the proposed infant monitoring system will consist of an alarm system and sensors that can measure incubator's monitor temperature.

III. SYSTEM ARCITECHTURE

The architecture of the system consists of both hardware and software. Block diagram is as shown in Fig.1, hardware components were assembled according to the block diagram. The code is written in embedded C and is burnt into the ARDUNIO UNO R3

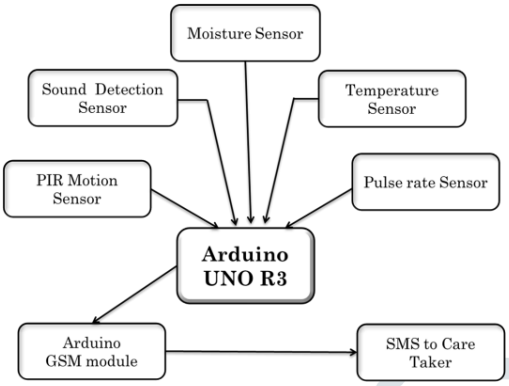

Fig.1. Block Diagram of Proposed System

The following subsections provide more details of the components used in our prototype:

A. TEMPERATURE SENSOR

Human body needs special type of sensors for reliable readings which led to the choice of using the LM35 temperature sensors in our prototype[1,6]. It operates at 3 to 5 V and can measure temperature in the range of - 40 C to +125 C which is sufficient for the targeted body temperature range[4] .It is having linear response and easy conditioning. The sensor's output is an analog DC voltage signal which is read by the microcontroller using an analog pin linked to an ADC[10]. The ADC used has a resolution of l0-bits, 1024 levels, with a sample rate of 9600 Hz and input voltage range depending on the ground and Vee. The output voltage of the LM35 is analog and in the linear range of -1 V to 6 V with accuracy of ±0.5 °C can be converted from volts to degrees of Celsius and Fahrenheit .[2,3]

The temp sensor and actual readings are listed in table below:

TABLE.I

Serial No	Actual pulse Rate	Practical pulse Rate
1	72	78
2	66	72
3	70	76
4	54	60

B. P

IR MOTION SENSOR

A PIR(Passive InfraRed) sensor is a motion detector which detects the heat (infrared) emitted naturally by humans(as shown in Fig.2)[9].When a person in the field of vision of the sensor moves, the sensor detects a sudden change in infrared energy and the sensor is triggered (activated).They are commonly used in security lighting and alarm systems in an indoor environment.The PIR sensors have a range of approximately 6 meters, depending on conditions.The sensor adjusts to slowly changing conditions that occur normally within the environment, but shows a high-output response when a sudden change takes place.

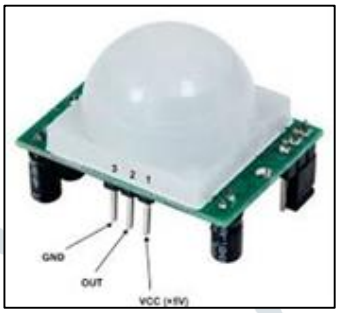

Fig.2.PIR sensor

C. PULSE RATE SENSOR

A Pulse rate sensor is a monitoring device that allows one to measure the infant's heart rate in real time . It provides a simple way to study the heart function[5]. This sensor monitors the flow of blood through the finger and is designed to give digital output of the heartbeat when a finger is placed on it. When the sensor is working, the beat LED flashes in unison with each heartbeat. This digital output can be connected to the microcontroller directly to measure the Beats per Minute (BPM) rate(Fig.3). It works on the principle of light modulation by blood flow through finger at each pulse[15]. The Pulse Sensor is a well-designed plugand-play heart-rate sensor for Arduino. It also includes an open-source monitoring app that graphs your pulse in real time.

The pulse-rate sensor and actual readings are listed in table below:

TABLE.II

Serial No	Actual Temp (0C)	Practical Temp(0C)
1	**32**	**36.1**
2	**31**	**35.5**
3	**33**	**37**
4	**35.6**	**36.7**

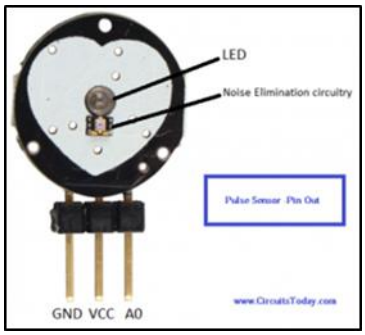

Fig.3.Pulse rate sensor

D. SOUND DETECTION SENSOR

The sound sensor module provides an easy way to detect sound and is generally used for detecting sound intensity. This module shown as in (Fig.4) can be used for security, switch, and monitoring applications[14]. Its accuracy can be easily adjusted for the convenience of usage.It uses a microphone which supplies the input to an amplifier, peak detector and buffer. When the sensor detects a sound, it processes an output signal voltage which is sent to a microcontroller then performs necessary processing.

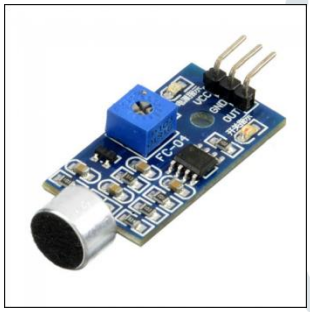

Fig.4.Sound detection sensor

E. MOISTURE SENSOR

The Moisture sensor is used to measure the water content (moisture). To determine the moisture condition i.e. urine detection, two pairs of copper electrodes are placed under the cloth on which baby is sleeping. Humidity readings in the incubator were taken continuously by placing the moisture sensor inside the incubator[9]. The experiment was carried out in air-conditioned rooms, which has riskier moisture condition. This is because the moisture in the air-conditioning is lower compared to normal rooms. Moreover, the moisture sensor is also tested with extremely hot condition (by placing the sensor near a fire source) and extremely cold condition (by placing the sensor in a container full of ice cubes) for the reliability test.

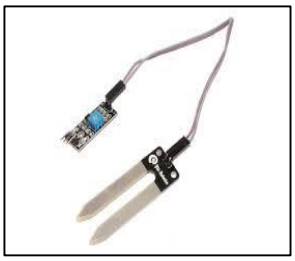

Fig.5.Moisture Sensor

F. GSM MODULE

GSM (Global System for Mobile communication) is a digital mobile telephony system. With the help of GSM module interfaced, we can send short text messages to the required authorities as per the application. GSM module[5] is provided by SIM uses the mobile service provider and send SMS to the respective authorities as per programmed[3]. This technology enable the system a wireless system with no specified range limits. In this way, whenever the safe range of the vital parameter of an infant is violated, the programmed microcontroller produces an alarm and GSM Modem interfaced with the microcontroller sends an alert SMS to the parent's mobile number deploying wireless technology.[8]

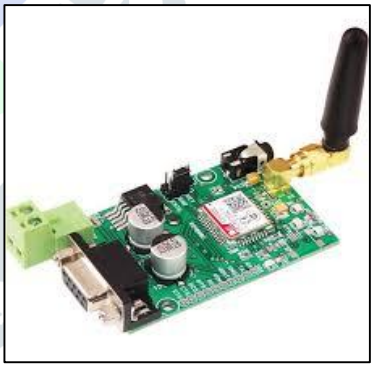

Fig.6.GSM module

IV. ADRUINO UNO R3 BOARD

The Arduino UNO is a widely used open-source microcontroller board based on the ATmega328P microcontroller and developed by Arduino.cc.[The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits[7]. The board features 14 Digital pins and 6 Analog pins. It is programmable with the Arduino IDE (Integrated Development Environment) via a type B USB cable. It can be powered by a USB cable or by an external 9 volt battery, though it accepts voltages between 7 and 20 volts. It is also similar to the Arduino Nano and Leonardo. The hardware reference design is distributed

under a Creative Commons Attribution Share-Alike 2.5 license and is available on the Arduinowebsite[11]. Layout and production files for some versions of the hardware are also available. "Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform. The ATmega328 on the Arduino Uno comes preprogrammed with a bootloader that allows to upload new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol[12]. The Uno also differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.[7] The Arduino UNO is generally considered the most user-friendly and popular board,with boards being sold worldwide for less than 5$.

Fig.6.Arduino UNO R3

V.RESULTS

The system was tested carefully, the results found to be same as the one's measured by standard instrument[2]. While testing this system on an infant parent's concern was considered. During the execution of the system snapshots of the display were taken. The system being a complete hardware design and the data available on cell phone.Test results of the system are given below, shows successful implementation of the system. Fig.7 shows hardware module.Fig.8 shows message received on parent's cell phone when some abnormal condition exists. Message shows infant is crying, motion is detected and moisture condition exists.

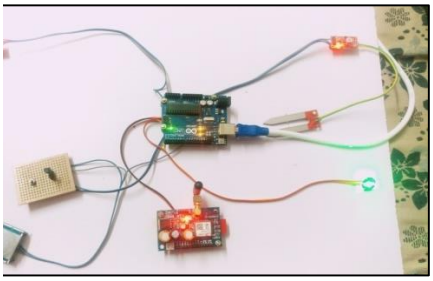

Fig.7.Hardware Module

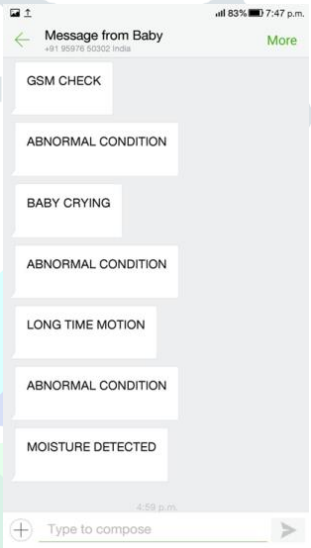

Fig.8.Snapshot of output

VI.CONCLUSION

In conclusion, There are an increase number of premature babies that, once they achieve some degree of maturity, can be moved at home when their parents can take care of them in a loving environment which most of the times fasten the babies' recovery. This system expressively provides the parents with the feeling of assurance. The constant capturing of multiple biological parameters of the baby and analysis of the overall health helps mother to understand the internal status of the baby. As GSM technology is used which makes the users to communicate for longer distances. This is a convenient system to monitor the baby's health condition from any distance.Our future work involves further experimentation including the testing in a real environment and the comparison of results obtained by other techniques. In addition, the influence of context awareness on obtained recommendations should be studied.

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