IJCSC International Journal of Computer Science and Communication Vol. 2, No. 2, July-December 2011, pp. 501-503

INFANT MONITORING SYSTEM

P. Sushma Chowdary[1] and S. Aruna[2]

[1]Department of Electronics and Communication Engineering, Andhra University College of Engineering (A), Andhra University, Visakhapatnam, AP 530 003, India.
E-mail: psushmachowdary@gmail.com
[2]Department of Electronics and Communication Engineering, Andhra University College of Engineering (A), Andhra University, Visakhapatnam, AP 530 003, India.
E-mail: aruna_ece@rediffmail.com

ABSTRACT

In this paper, we presented an infant monitoring system using CO_2 sensors to non-invasively monitor the exhaled air from an infant in order to reduce the potential risks for Sudden Infant Death Syndrome (SIDS). Due to the variation in the exhaled CO_2 concentration, we can detect problematic episodes associated with infant's respiration. An array of CO_2 sensors is mounted around the infant in the bars of the crib and they are wire-connected to a circuit board located at the end of the crib. This board consists of a processing circuit and a wireless transmission module transmitting signals to a compact receiver at the caregivers' location. We have designed and assembled the modules in printed circuit boards (PCBs) with commercial metal-oxide based CO_2 sensors. The sensor has been tested in sensitivity, selectivity and humidity dependence. The module has been tested with its transmission capability in various environments. The entire infant monitoring system has been tested showing desired functionality.

1. INTRODUCTION

Healthcare cost is an urgent issue globally. The costs for infant care are high due to highly intensive labor. For healthy infants, Sudden Infant Death Syndrome (SIDS) is one of the most critical problems needed to be addressed and it requires a great deal of care labor. SIDS is defined as any sudden and unexplained death of an apparently healthy infant aged from one month to one year. According to the National SIDS/Infant Death Resource Center, SIDS is responsible for roughly 50 deaths per 100,000 births in the U.S. in 2004. The SIDS rate has been declining due to the awareness in caregivers and parents but it is still far higher than one would expect in such a developed country like the U.S. The costs and suffering due to the tragic occurrences of SIDS to families and societies are significant. Reducing the sudden death rate in infants by an effective monitoring and alarm system is a challenge for researchers considering the syndrome usually has no obvious warning signs or symptoms. There are some proposed infant monitoring systems, such as cardio-pulmonary monitoring, vision monitoring, oxygen consumption monitoring and multi-purpose monitoring. Many of these approaches are invasive making both the infant and parents uncomfortable while some of the monitoring systems are not effective enough due to the unrecognized signs or low response of SIDS. In many SIDS cases, the infants stop breathing without any signs of trauma.

We propose a new method using CO_2 sensors placed in the crib around an infant to non-invasively monitor the exhaled air concentration variation from him/her. By monitoring the outputs of CO_2 sensors, we can detect if there is anything unusual with the infant's respiration. The output data is sent wirelessly to activate an alarm or logged for further diagnoses.

Infants may take various sleeping positions and the exhaled air may spread in many directions due to air circulation. Thus, an array of CO_2 sensors needs to be

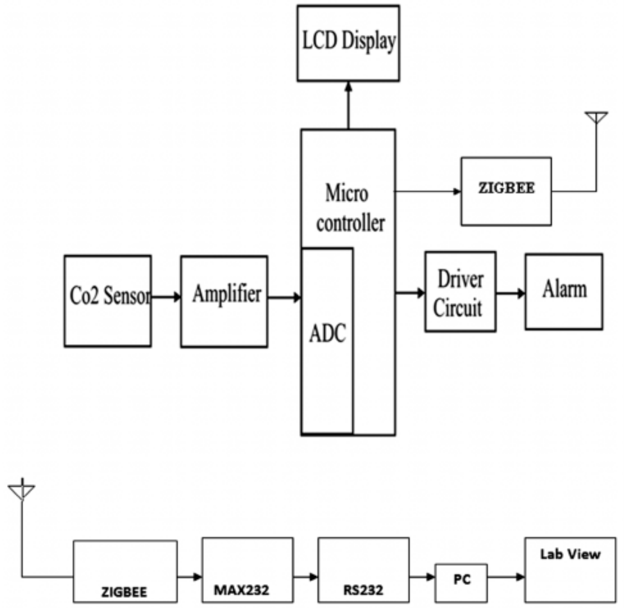

Figure 1: Block Diagram

placed around the crib on the bars to provide sufficient information. A circuit board connected to the sensors is placed outside the crib to process the data. The circuit board includes a wireless module for transmitting and receiving information. The wireless module is placed away from the infant to ease parents' concern of electromagnetic waves from the module.

2. IMPLEMENTATION

It consists of a wireless transmitter and a receiver both are operating at 2.4GHz frequency. The transmitter circuit monitors the infant condition and the receiver receives the data from the transmitter and it is displayed in the PC. Circuits have been designed and assembled with two-layer printed circuit boards (PCB). Fig. shows the schematic of the transmitter, receiver.

The transmitter circuit shown in fig consists of PIC16F877 controller and Zigbee transceiver module and CO_2 sensing circuit, LCD and alarm. PIC16F877 controller consists of five ports: PORTA, PORTB, PORTC, PORTD, and PORTE. Among these five ports PORTA, E can be used as analog inputs. The sensor is designed for sense the CO_2 gas level. In the CO_2 sensor the supply voltage is given to input terminal. The sensor output terminals are connected to non inverting input terminal of the comparator.

Here the comparator is constructed with operational amplifier LM 358. The reference voltage is given to inverting input terminal. The reference voltage depends on the concentration of CO_2. When the concentration of CO_2 is lower, then the non inverting input is grater then inverting input so the output of the comparator is positive voltage which is given to the base of the switching transistor BC 547. Hence the transistor is conducting. Here the transistor is act as switch so the collector and emitter will be closed. The output is taken from collector terminal. Now the output is zero which is given to hex inverter 40106.

When the concentration of CO_2 is higher, then the inverting input voltage is grater than non inverting input. Now the comparator output is -12V so the transistor is cutoff region. The 5v is given to hex inverter 40106 IC. Then the final output data is directly given to the port pin of microcontroller to determine the CO_2 concentration. LCD is used to display the concentration of CO2 and other related parameters and is interfaced with PORTD pins of the controller. The 8 data lines of LCD are given to 8 pins of PORTD, and the three control signals RS, R/W, EN are given to RB5, RB6, and RB7 of PORTB.

The controller is designed to control the buzzer; it is connected to RB1 pin of controller. The buzzer ON and OFF is controlled by the pair of switching transistors (BC 547). The buzzer is connected in the Q2 transistor collector terminal.

When high pulse signal is given to base of the Q1 transistors, the transistor is conducting and close the collector and emitter terminal so zero signals is given to base of the Q2 transistor. Hence Q2 transistor and buzzer is turned OFF state.

When low pulse is given to base of transistor Q1 transistor, the transistor is turned OFF. Now 12v is given to base of Q2 transistor so the transistor is conducting and buzzer is energized and produces the sound signal. When the CO_2 concentration of infant is high, then the controller sends a low pulse to the alarm circuit then the buzzer is energized and produces the sound.

Controller has two pins named as TXD, RXD for serial communication these two pins are given to the Zigbee module and the data is transmitted to the receiver through wireless antenna tuned at 2.4GHz frequency. The receiver circuit consists of Zigbee, MAX232 and RS232 cable. The data is received by the Zigbee and then it is given to the T2IN (10) pin of MAX232. MAX232 is used for voltage level conversion. Since the circuit has to be interfaced with PC using RS232 serial port the voltage levels of RS232 (operated at TTL logic) will differ from controller. The R2OUT pin of MAX232 is given to TXD pin of RS232 and the cable is interfaced with the PC through serial port. Thus infant condition is monitored on the PC.

3. RESULTS

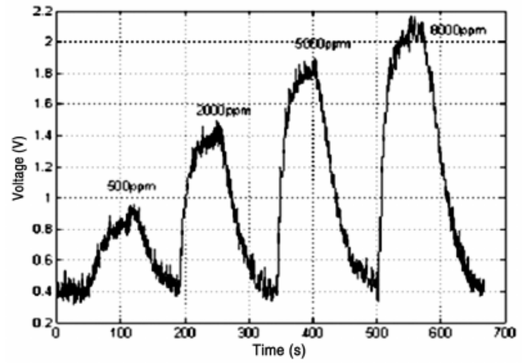

Figure 2: Processed Sensor Signals

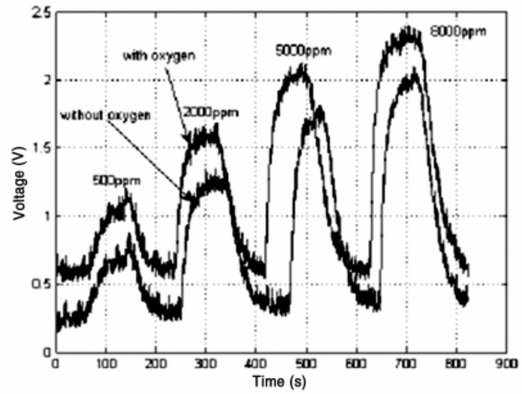

Figure 3: Responses of the Composition with 16.5% O_2 and the One without O_2

4. CONCLUSIONS

We have proposed a new wireless approach for an infant monitoring system using multiple CO_2 sensors. The system provides advantages such as lower costs non-invasive Sensing mechanism, and wireless transmission. They will provide reduce caregivers' workloads monitoring SIDS. A proof-of-concept system has been designed, assembled and characterized. There are some improvements needed. The uniformity among devices introduced variation in the outputs between two different sensors and the outputs from a certain sensor were not repeatable identical for the same concentration of gas. This will require individual calibration for each sensor and increase manufacturing costs. The output signals drift over time for the same concentration. Although those changes are relatively small, it may issue false alarms and desensitize caregivers' attention. A sensitive yet stable sensor with performance uniformity will be an ideal choice. The inherent humidity dependence issue due to adhesion of water molecules to the metal-oxide membrane, hindering the chemical reaction between the target gas and the sensing material, can be resolved by adding a humidity sensor in our sensor boards. The threshold voltage will be accordingly adjusted by a feedback loop. The variations of outputs due to the changes of sensor distance to the infant can be overcome by an array of sensors and a sophisticated signal processor which coordinately checks the concentration variations around the crib.

REFERENCES

[1] J. Bunker, M. Kejariwal and G. Monlux, "SIDS Home Monitor with Telecommunications Capabilities", In *Proc. of IEEE EMBS International Conference*.

[2] National SIDS/Infant Death Resource Center http://www.sidscenter.org

[3] American SIDS Institute. http://www.sids.org

[4] S. Singh and H. Hsiao, "Internet Based Infant Monitoring System", In *Proc. of the first Joint IEEE BMES/EMBS Conference*, **2**, Page 674, Oct 13-16, 1999.