*Sindh Univ. Res. Jour. (Sci. Ser.) Vol. 48 **(4D)** 83-86 (2016)*

SINDH UNIVERSITY RESEARCH JOURNAL (SCIENCE SERIES)

Development of Respiratory Monitor using Smartphone VIA Bluetooth for Bedridden Elderly or Patients

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Received 28rd August 2016 and Revised 17th October 2016

Abstract: The vital sign is a clinical measurement such as pulse rate, temperature, respiration rate and blood pressure. This project to design and develop a prototype of an electronic gadget which is used to detect respiration rate of bedridden elderly and the patients. It consists of LM35 as a thermal sensor, microcontroller 16F767, App-link Bluetooth module, LED and buzzer as an indicator and an android smartphone. The LM35 sensor converts the temperature into voltage. The scale factor for LM35 is 10mV/°C meaning whenever the temperature changes per °C, the reading output of LM35 is 10mV depend on the temperature increase or decrease. If the temperature increase, the output is +10mV and if the temperature decrease it will -10mV from the output of LM35. LM35 is detecting the temperature from the surrounding first and stored in microcontroller 16F767, during exhale, the microcontroller will count the amount of temperature increased from the surrounding and process the data. LM35 is placed on the nebulizer mask and place right in front of the nostril. The data is transmitted via Bluetooth module into the android smartphone with installed application to display the respiratory rate. If there is no signal the microcontroller will detect as the patient is not breathing and the device will send the text message via smartphone and alarm is turned on. The main objective is to implement and design of wireless real-time respiration monitor (Bluetooth) using a smartphone has been achieved.

Keywords: vital sign, respiration rate, blood pressure, Bluetooth

1. INTRODUCTION

There are severe ways to monitor the vital sign (Alan *et.al*, 2013). The Vital sign is measurements of the body's basic function and in major healthcare, there are four mainly being monitored: body temperature, pulse rate, respiration rate and blood pressure (Archita, 2013). Respiratory rate has been recommended as a sensitive index of acute illness in the elderly (McFadden *et.al*, 1982). When a person stops breathing or slowed breathing, there might possibly they are suffering from Intracerebral Hemorrhage or Central sleeping apnea which can cause a greater problem if not treated. Many of the elderly have various degrees of disabilities and dependent on others for their activities of daily living. Some of them remain bedridden due to various causes (Kannan *et.al*, 2013).

Currently, the wireless techniques in hospitals are based on the WMTS and WLAN standards. There are no sustainable solutions for short-range data transmission from patient sensors to patient monitors, but potentially usable techniques in the future are based on the WPAN standards such as Bluetooth, ZigBee and UWB (Paksuniemi *et.al*, 2006).

Wireless technology was developed in many applications that becoming a part of the human daily activity. Wireless sensor network (WSN) is crucial in monitoring system application as the wireless sensor network has some advantage such as scalability, power and flexibility of the architecture. The wireless technology used in this project is Bluetooth via app-link Blue-tooth module. It will connect with an android smartphone for real time monitoring and continuous precaution for the stop breathing.

The purpose of this project is to detect the respiration and notice the family or person in charge immediately if the patient is stop breathing. Time is important in detecting the person is not breathing, an immediate action such as Cardiopulmonary resuscitation (CPR) may be able to save a life. This device is using the thermal sensor as a detector which able to display the breathing rate by detecting the changing of temperature during inhaling and exhale.

2. MATERIALS AND METHODS

This project involved both hardware and software development. As a part of the hardware development, the microcontroller is used as a processing medium. The microcontroller that has been used in this project to process the input from the thermal sensor.

The output is important in order to communicate the result that has been processed. For this project, the output being sent to the smartphone via Bluetooth

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technology to display the result. The main purpose of this project is to detect human breathing routine and alarm when to stop breathing. To measure the breathing rate, the LM35 sensor is used. This means, the input for this project came from the LM35 sensor.

2.1 Block Diagram

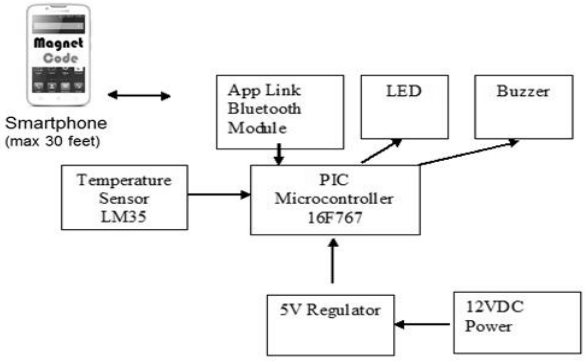


Fig 1: block diagram of the project

(Fig-1) shows the system of the project in measuring the human respiratory rate. The whole system consist of a power supply as an input to the system, LM35 sensor to measure the temperature during exhale (input), microcontroller 16F767 as a processor to process the data and do the comparator on the LM35 reading, app-link Bluetooth module to connect the device with android smartphone and LED and buzzer as indicator on the device. The result of the device is displayed on a smartphone.

2.2 Data acquisition

The LM35 placement is inside the nebulizer mask so that it will able to be directly in front of nostril as in **(Fig-2)** The reason this project use a nebulizer mask as a container for LM35 is so that the LM35 able to detect more accurate when place right in front of the nostril. While another part of the device is placed on the box, connected to LM35 using a cable that less than 20cm to prevent the inaccurate result.

The LM35 sensor converts the temperature into voltage. The scale factor for LM35 is 1mV/C meaning whenever the temperature changes per °C, the reading output of LM35 is 10mV depend on the temperature increase or decrease **(Fig-3)** If the temperature increase, the output is +10mV and if the temperature decrease it will -10mV from the output of LM35. In this project, I use a digital comparator, which means when the system start, the LM35 will detect the surrounding temperature and calibrate. When the calibration was done, whenever a person breathing, the temperature is slightly higher from the surrounding, which written in microcontroller programming, when the temperature increase in 2°C (in voltage changes 20mV from the actual reading of surrounding) the program will count as 1 breathes. When there is no reading, indicate the person is not breathing, thus, the microprocessor will send an alert to a smart phone.

The result of the system is displayed on the android smartphone apps which called magnet code. The smartphone is connected to the system using Bluetooth technology. On the smartphone, the display is shown the respiratory rate which is in breathes per minutes. There are also add-on features which can check the incoming voltage for the system, as a battery monitoring. This project can be powered either from battery or DC power supply. Whenever there is no reading on breathing, the app in the smartphone will trigger the alarm and also can send a short text message to the person in charge, as the number can be set on the apps itself.



Fig-2: placement of LM35 inside of nebulizer mask

2.3 Data programming

This project is using a PIC 16F767 microcontroller. The program is to run check on temperature from LM35 sensor and battery voltage from voltage detector circuit. The microcontroller will receive a command input from smartphone apps. In this project there is three input use where first input is RUN mode, the second is STOP mode and the third mode is shown voltage on LCD. RUN mode is where the microcontroller will proceed with the timer process and detect the temperature changes in LM35, in this program, I set the timer 10second. To get the breathe per minutes, the result of microcontroller reading need to multiply by 6 to get total 60second or 1minute. STOP mode is where the program will suspend any running program and keep idle. Show voltage on the LCD mode is to check the voltage supply on the project, as this project need more than 7V DC to power up, it is crucial to monitor the battery voltage.

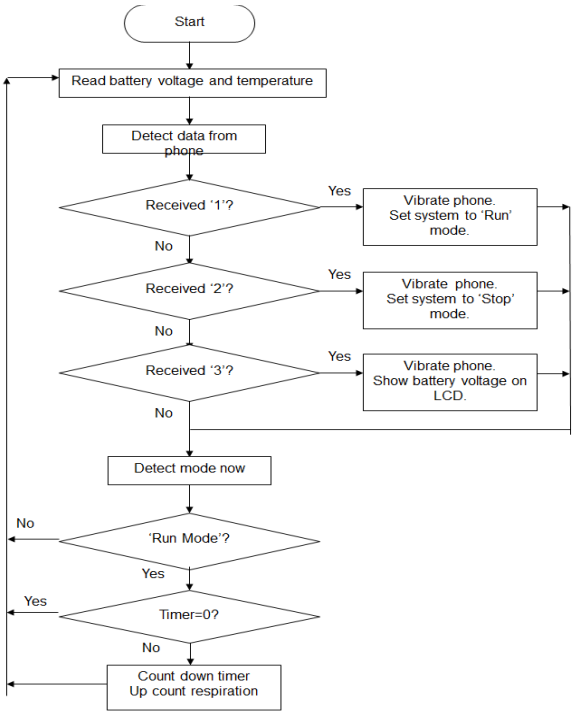


Fig 3: flowchart of the system

3. DISCUSSION



Fig.4: User interface on the android phone



Fig 5: Android apps showing breath per minute (BPM)

(Fig. 4) shows the user interface on the android smartphone. A bizchip company come with the magnet code together develops the apps.



Fig 6: Android apps showing voltage of supply

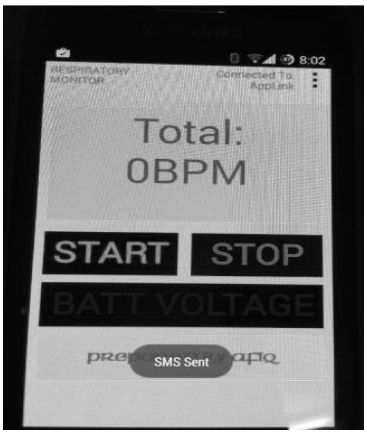


Fig 7: android apps showing 0 reading when the person is not breathing



Fig 8: A short message sent to another phone via GSM

From the **(Fig-5)**, the smartphone is displaying the breathes rate of a person that use the device. The

features of power supply check can be seen in **(Fig. 6)**, the device is connected to 12VDC supply. When the breath per minutes reading is 0, as shown in **(Fig. 7**), the alarm will trigger on the smartphone and on the device itself. Whenever the breathing rate is 0, the application will send the text message to another phone as shown in **(Fig. 8)**. The results produced by the device needs to be determined the validity. It is necessary to ensure that the readings are accurate and can be applied. Furthermore, this result maybe has a false alarm to determine whether the patient is breathing or not. Data sample for this project is collected and tabulated in **(Table 1)**.

Table 1: The data is from several volunteers.

Subject(S)	No. of breathe per minutes	Time taken for alarm trigger	No.of false alarm
S1	22	10	0
S2	20	10	0
S3	22	10	0
S4	19	10	0
S5	24	10	0
S6	24	10	0

From **(Table 1)**, the numbers of breath per minutes for six subjects are in normal range. If the rate exceed 25 breathes per minutes, it can be considered as an abnormal breathing rate. The time for not breathing alarm trigger is 10 second as set on the microcontroller. From six subjects, there will be no false alarm. So, the device is high efficiency and the results are acceptable.

4. CONCLUSION

This project has included only small number of subject samples for testing. More number of subjects should be incorporated in future study. Tests on method repeatability and reproducibility are also required to justify the accuracy of the device. Nevertheless, the main objective is to implement and design of wireless real-time respiration monitor (Bluetooth) using a smartphone has been achieved. The project also has shown that Bluetooth and able to demonstrate the respiratory rate and alarm when the patient is stop breathing The advantages are to reduced cost, power efficient, and portable. As the result from collected data, this project able to show the respiratory rate of a person wears the device. And it also able to detect when the person intentionally stops breathing and able to send the alarm to the smartphone and also text messages.

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