International Journal on Recent and Innovation Trends in Computing and Communication ISSN: 2321-8169
Volume: 5 Issue: 6 605 – 607

Real Time Respiration Rate Measurement Using Temperature Sensor

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Abstract: Respiration rate is a vital indicator of an individual's health, and therefore it is monitored when performing clinical evaluations. There are many different approaches for respiration monitoring, but usually, they can be classed as contact or non-contact. Respiration Rate is one of the important signs that need regular monitoring among unhealthy individuals. There are a variety of medical devices developed to observe human health condition among them respiration rate monitor is one. The Respiration rate monitor is a device that measures the individual's respiration rate non-invasively. The objective of the planned work is to design and develop an affordable Respiration rate monitor for clinical applications. The respiration rate of the patient is measured with the assistance of temperature sensor that measures even the slightest change in the temperature while an individual is inhaling or exhalation. And according to the reading obtained the alert message will be sent to the patient's mobile phone via GSM module that is connected to the device.

Keywords: *- Respiration rate, Vital signs, Non-invasive, Temperature sensor, GSM module.*

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I. Introduction

Breathing is an important physiological task in living organisms. For humans, thisprocess results in air containing oxygen being inhaled into the lungs, where gas exchange occurs across the alveolar-capillary membrane [(1)]. Carbon Dioxide is excreted as part of the process, in the air released through the nose or mouth. The entire process from the inhalation to exhalation is known as a breathing (or respiration) cycle.

Respiratory rate is a vital sign used to monitor the progression of illness and an abnormal respiratory rate is an important marker of serious illness. There is substantial evidence that alterations in respiratory rate can be used to predict potentially serious clinical events such as cardiac arrest or admission to the intensive care unit [(2)]. These studies have shown respiratory rate to be better than other vital measurements such as pulse and blood pressure in discriminating between stable patients and patient at risk [(3)]. Using changes in respiratory rate measurements patients could have been identified as high risk up to 24 hours before the event with a specificity of 95% [(5)]. Hospital systems such as the Paediatric Early Warning System (PEWS) have been developed to encourage appropriate responses to abnormal vital signs including an elevated respiratory rate.

Evidence from a recent audit of febrile children in our unit suggests that in both the emergency department and the acute medical admissions unit, respiratory rate was only measured in around two-thirds of children on arrival. Reasons for omission were given as "crying" or "unsettled" and in many of these children experienced nursing staff was unable to obtain an accurate reading. However, it is in these children that this measurement would potentially be most useful and important According to Murthy [(6)]; existing devices for monitoring respiratory rate only estimate the actual breathing rate due to their limitations. These devices can be classified in different ways, depending on the manner in which they operate and how they are used. In contact respiration rate monitoring, the device makes direct contact with the subject's body. However, in noncontact monitoring, the respiration rate is measured without the instrument being in contact with the individual's body. There are clear advantages to noncontact respiration monitoring methods. These include improved patient comfort (especially for long term monitoring) as the subject is not tied to an instrument and improved accuracy as distress caused by a contact device may alter the respiration rate.

There have been several studies reporting developments in both contact and noncontact respiration monitoring. A review of non-invasive respiratory monitoring in medical care was provided by Folke et al. [(7)]. This paper aims to review the literature on contact and non-contact methods of respiratory rate monitoring, including two methods currently being developed by our unit.

II. Material and Method

Component (Software & Hardware)

1. Arduino IDE
2. Temperature sensor (LM35)
3. GSM module (SIM 900)
4. LCD Display

The block diagram of the system is shown in figure. The system takes up temperature readings from the individual's body. The system consists of Temperature sensor (LM35) which is interfaced with Arduino. The obtained values are

 ISSN: 2321-8169
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displayed on the LCD screen. And GSM module (SIM 900) is connected which will send the message to the patient's cell phone about the readings obtained. In the case of patient monitoring if there is any abnormality in physical parameters alarm is generated, and an alert message will be sent to the cell phone.

Block Diagram

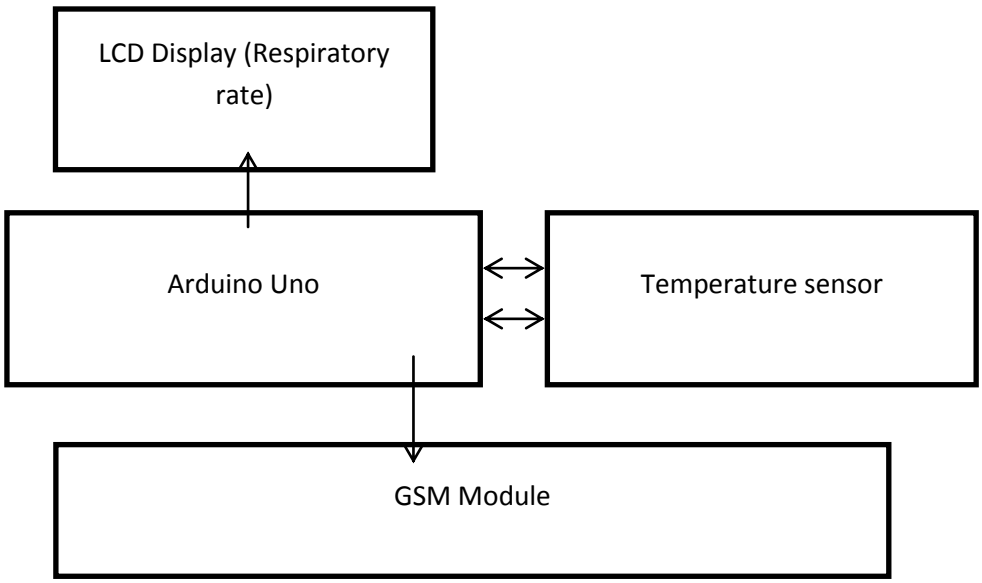

Fig: Block diagram of the system incorporated

For temperature sensing purpose, LM35 is used which is a rapid, low-cost, integrated-circuit temperature sensor manufactured by Texas Instruments. It is a linear temperature sensor which is directly calibrated in °Celsius with the scaling factor of 10mV/°C. Supply voltage required by the sensor is spanned over a dynamic range of 4 to 30 V. It has also very low self-heating of less than 0.08°C in still air due to its very low input current drain of less than 60 µA. [12]. LM35 is used to measure the skin temperature of the human skin at the wrist. From skin temperature, the body temperature can be estimated by different methods but with the rough estimation, human body temperature is 5.1°C higher than skin temperature [8].

For breathing rate measurement traditional methods used for breath rate sensors include Thoracic Expansion Measurement, Thoracic Impedance Pneumography, and Capnography. The main shortcoming of these methods is that they are expensive, complicated and unacceptable for long term sleeping patients [18].Our breath rate sensor consists of a 50K negative temperature coefficient thermistor fitted in a nebulizer mask in a voltage divider configuration. The resistance of the thermistor decreases during exhale due to comparatively hot air and increases during inhaling. This resistance change is detected in the form of an AC signal and fed into a band pass filter to remove dc as well as other high-frequency noise. [9, 10, 11]

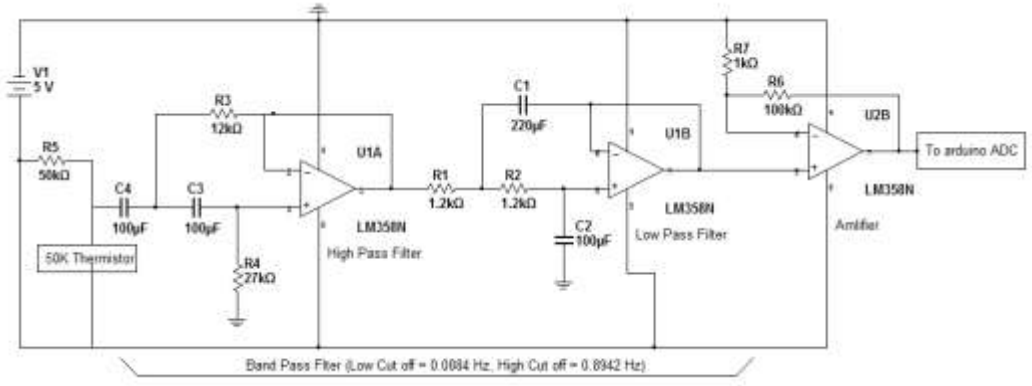

Fig :Circuit Diagram of Breath Rate Sensor

We are using the most popular module based on Simcom SIM900 and Arduino Uno for this project. We use SIM900 GSM Module – This means the module supports communication in 900MHz band. In India, most of the mobile network providers operate in the 900 MHz band.

In this case, the communication between Arduino and GSM module is serial. We use serial pins of Arduino (Rx and Tx) now we need to connect the Tx pin of GSM module to Rx pin of Arduino and Rx pin of GSM module to Tx pin of Arduino. GSM Tx –>Arduino Rx and GSM Rx –>ArduinoTx. Now we connect the ground pin of Arduino to ground pin of gsm module.(12)

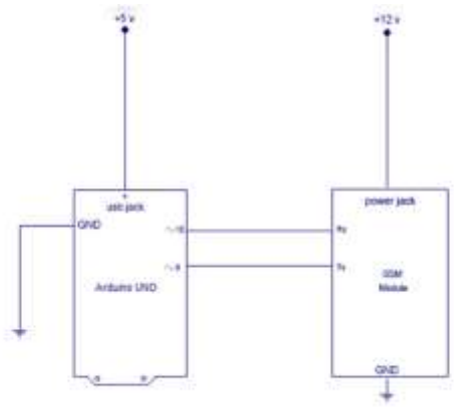

Fig :Aurdino and GSM module interfacing

III. Result

A prototype system has been developed and tested. The incorporated system can be easily adapted to observe patients and athletes respiration rate in hospital and gymnasium respectively. After counting the breathing for a minute, the system displays the Respiration Rate, and it sends the Respiration Rate through GSM unit. If the Respiration Rate crosses its higher and lower threshold limit, the system provides the warning alert and it sends the SMS as "Warning" through GSM unit.

IV. Conclusion

Respiratory rate is one of the central signs that are seen as the standard for observing patients on unbearable facility wards. To quantify Respiration Rate a portable device is developed. The sensor gives the best response throughout respiration process. In this work, output result at every stage is studied and the device is able to provide the desired result. Since the apparatus uses the temperature sensor, the device is cost effective and it gives the real-time output. And also the system is capable of identifying eupnoea, tachypnea, and bradypnea.

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