Thermistor-Based Respiration Monitor
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ABSTRACT

Respiration rate is a standard physiological measurement taken for monitoring a patient. Existing respiration monitors used in medical centers are unsuitable for low-resource environments. We have developed a low-cost respiratory monitor to address this issue. This device calculates a patient’s breathing rate by detecting changes in temperature through a thermistor when the patient breathes into a mask. Features of the device include an alarm through a piezoelectric speaker which sounds when the patient stops breathing, and a low-battery indicator signal for when the battery powering the device dips below a threshold voltage. The design and implementation involved several different hardware components, as well as software functions. Our initial prototype of the project accomplished our main objectives, and experimental measurements indicate that the device measures a patient’s respiration rate with relative accuracy.

SOFTWARE DESIGN

1. Take voltage measurements: The MCU takes a voltage sample across the battery, under battery operation, to keep track of the power level of the device.
2. Take thermistor measurements: The resistance over the thermistor drops when its surrounding temperature increases, and does back down when the temperature decreases. Accordingly, the voltage drops when a patient inhales and rises when a patient exhales, which is detected by the MCU.
3. Output alarms: The device generates two different PWM signals for alarms through a piezoelectric speaker. The first alarm, higher in pitch, sounds when the patient is not breathing. The second alarm is an indicator that the device is running on low battery.
4. Calculate respiration: This task does the actual measurement of the respiration rate, which is calculated to be a weighted average of the previous rate and the newest difference in the peaks detected in the respiratory signal.
5. Turn on display: To conserve power, the user must hold down a button to turn on the display to read the respiration rate. This prevents the user from leaving the display on by mistake and draining the battery.
6. Display respiration rate: Respiration rate is measured and displayed in breaths/min onto an LCD. This allows whoever is monitoring the patient to see if the patient is breathing too fast or too slowly.

FUTURE WORK

• Measures respiration rate with error of less than 10%
• Takes less than 5 seconds to determine if patient is not breathing
• Calibration and startup time is about 30 seconds
• LCD only receives power when the display button is held down
• Piezoelectric speaker is activated when patient is not breathing or the battery is below 7.5 V. Different sounds are used for not breathing vs. low battery
• Speaker is automatically turned off when the patient begins to breathe again

ACKNOWLEDGMENTS

The authors would like to acknowledge Professor Bruce Land, Senior Lecturer at Cornell University, for encouragement and inspiration during this senior design project. Their gratitude also goes to Amrit Singh and Mike Kilzer, TAs for the course, who helped through various issues with the project. While the majority of the source code for this project was developed by the authors, the library to display onto an LCD was borrowed from Scienceprog.com.

RESULTS

- Integrating a microphone with device to prevent “false alarms”
- Packaging the device into a more portable prototype
- Further experimentation with respiration rate averaging algorithms
- Developing a sterilization protocol for device

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Full documentation for this project can be found at: http://people.ece.cornell.edu/land/courses/ece4760/FinalProjects/2012/htq2_mg573/htq2_mg573/index.htm