International Journal of Electronics Signals and Systems

Volume 2 | Issue 3 Article 15

January 2013

ESTIMATION OF RESPIRATORY RATE FROM ECG

M. R., NAGADEEPTHI
Biomedical Signal Processing & Instrumentation, Dayananada sagar College of Engineering,
nagdeepthi@gmail.com

SUSHRUTHA M. BHARADWAJ
Biomedical Signal Processing & Instrumentation, Dayananada sagar College of Engineering,
sushrutha.bharadwaj@gmail.com

B.G. PUSHPALATHA
Biomedical Signal Processing & Instrumentation, Dayananada sagar College of Engineering,
pushpa.gangu@gmail.com

ESTIMATION OF RESPIRATORY RATE FROM ECG

[1]NAGADEEPTHI M. R., [2]SUSHRUTHA BHARADWAJ. M & [3]PUSHPALATHA B.G.

Biomedical Signal Processing & Instrumentation, Dayananada sagar College of Engineering
E-Mail : [1]nagdeepthi@gmail.com, [2]sushrutha.bharadwaj@gmail.com, [3]pushpa.gangu@gmail.com

Abstract - Clinical investigation of some sleep disorders, stress testing, ambulatory monitoring requires simultaneous monitoring of heart rate and respiratory rates. [3] Numerous methods have been reported for deriving respiratory information from the electrocardiogram (ECG). [1] Initially ECG signal is sent to microcontroller AT89S52 through ADC0848. The digital samples are once again transmitted to personal computer via a cable. The digital data is read with the help of graphical user interface software – Visual C++ (serial port programming).

The data is stored in an array and the QRS peaks per minute are detected & heart rate is calculated. As these QRS peaks consist of respiratory information, an algorithm will be applied onto the QRS data to find the number of slopes per minute, which gives the respiratory rate. Hence the Heart Rate & Respiratory Rate per minute will be calculated and displayed real time on PC.

I. INTRODUCTION

MANY investigators have pursued the derivation of a patient's respiratory signal by digital signal processing of the electrocardiogram (ECG) which is called the ECG derived respiration (EDR) signal and several clinical significances of the EDR signal have been reported [1].

Several methods have been reported for deriving the EDR signal like based on removing baseline wander noise, using plethysmographic signals, Gauze mask based on pyroelectric transducer ect… These previously reported methods for EDR derivation are typically very computationally intensive, performed offline (non-real-time environment) [1-2] and some require simultaneous recording of multi-lead ECG signals. The accuracy and reliability of these techniques has been somewhat limited as reported. Moreover, the consideration of duration of RR data to process is very large.

Monitoring of respiration rate and the influence of activity on respiration is important for sufferers of a variety of chronic diseases and sleep disorders. In this paper the author describe the algorithm and its testing in a real time environment called visual studio C++. The consideration of duration of RR data to process is very large (i.e. 20 sec).

II. METHODS

In the current work the amplitude of RR wave will be considered as data which will be obtained from two leads ECG hardware. This analog signal will be converted into digital signal using an analog to digital converter called ADC0848 .

Then, the digital ECG values will be sent to the microcontroller AT89S52 through ADC0848 at the rate of 250 samples / sec, which will monitor the sampling rate. The digital samples are once again transmitted to a personal computer via a female cable called RS232 with a baud rate of 9600 bits / sec. The digital data is read with the help of graphical user interface software – Visual C++ (serial port programming) as shown in the block diagram (1). The data is stored in an array and the QRS peaks per minute are detected & the heart rate is calculated.

An algorithm will be applied onto the QRS data to find the number of slopes per minute, which gives the respiratory rate. The Heart Rate & Respiratory Rate per minute will be calculated and displayed real time on PC.

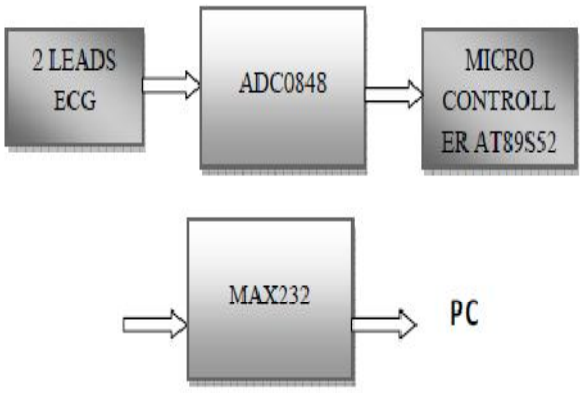

Fig (1): Proposed block diagram for derivation of respiratory rate from ECG.

2.1. TO FIND NUMBER OF R-WAVES AND ITS VALUES FOR 20 SECONDS

After extracting and converting the ECG signals to digital form by using microcontroller and ADC, the data will be moved to the PC via RS232 cable. Only 250 samples/min are extracted for 20 seconds & stored (20 sec x 250 samples=5000 samples) into an

array i.e. 'array1'. Then only 1000 samples from 'array1' are stored into 'array2'.

By applying sorting technique on 'array2' the maximum value of those 1000 samples is calculated. Based on this maximum value two values are considered as threshold values, i.e.'Threshold1' = 80% of max and 'Threshold2' = 60% of max. Now, 1st value of 'array1' is compared with the 'threshold1', if the 1st value of 'array1' is greater than 'threshold1', then storing the 'array1' 's value in 'temp1' and 2nd value of 'array1' in 'temp2'. If the value of 'temp1' is greater than 'temp2', then the 'ECG_PEAK' value will be incremented by one and the 'temp1' value will be stored in 'array3'(i.e. based on "T-P Knots" algorithm). Else, storing the further values and check for the condition. So, this is how the number of ECG_PEAKs will be calculated.

The while loop is applied to check the condition weather the value of 'array1' is less than 'threshold2' or not, if yes incrementing the values. Else breaking the while loop and going back to the previous step and check, weather the 1st value of 'array1' is greater than 'threshold1'. But this step will always get break, because the 'threshold2' (60% of max) will always be less than 'array1' (as 'array1' is already greater than 'threshold1' (80% of max)). This step is added only to calculate the total number of ECG_PEAKs first and then the program will move on to calculate the number of Respirator rate.

After calculating the total number of ECG_PEAKs program will enters in to a 'for' loop. Now the 1st value of 'array1' will be assigned to 'temp1' and the 2nd value to the 'temp2'. If 'temp1' is greater than 'temp2', then increasing the value of 'RR_PEAK' by one, else going back to the 'for' loop and check for the condition. Total number of RR_PEAKs will give the Respiratory rate of a person. From the above calculation RR_PEAK variable will have respiration rate for 20 seconds, hence RR_PEAK variable is multiplied by 3 to get respiration rate for 60 seconds or 1 minute.

III. RESULTS

The results obtained in the process of respiratory rate analysis using visual C++ software are discussed in this chapter. The analysis part should start from acquisition and processing on ECG signal, but the ECG signal has not been acquired yet. Simply the digital points that can be stored in an array have been stored as ECG signals and the coding part has been done.

As discussed earlier, the input signals are considered as 5000 samples (i.e. 20sec* 250samples). These samples are stored in an array called 'array1' in the form of digital points. 1000 samples are again stored in another array called 'array2'. By using sorting technique maximum value of the 'array2' will be calculated. The two threshold values considered based on maximum value of 'array2' will be compared with the values present in the 'array1' to calculate the number of ECG-PEAKs present in 5000 samples. And these values will be again compared with each other; the greater point among two points will be counted as respiratory rate. The total number of respiratory rate will be multiplied by three to get the respiratory rate for a minute.

The codes to calculate respiratory rate, heart rate has been written in the 'filename.cpp' format. The result screen will be showing the 'heart rate' and 'Respiratory rate' of a person for a minute with subject's ECG wave. The color, size of the box, data name and title are user defined.

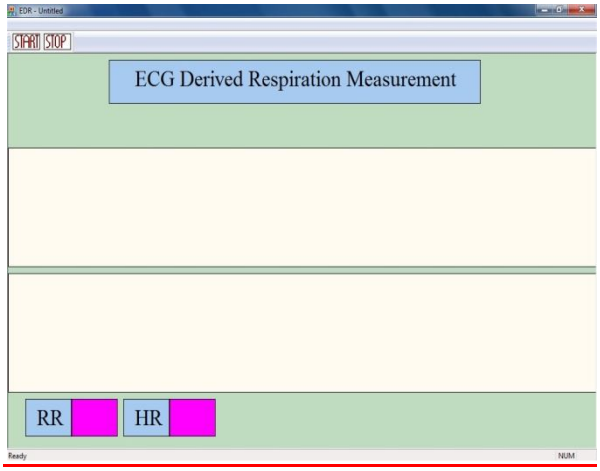

Figure (2): The output screen

IV. CONCLUSION

The current research consists of the hardware design of EDR circuit. The software part has implemented using Visual Studio. The technique which has been used to implement to this project is completely different when compared to the previous available methods. The consideration of duration of RR data to process is very small compared to all papers; one to two minutes only. The patient can do all the activities with normally during the test process. It is a real time project, and can be easily implemented in any hospitals.

The analog ECG signal acquired from human body with the help of 2 lead ECG circuit will be sent to a microcontroller through an analog to digital converter at a rate of 250 samples / second. The digital samples from microcontroller through a driver IC (MAX 232) are once again transmitted to personal computer. The digital data will be read with the help of graphical user interface software – Visual C++. The number of QRS peaks and its values will be detected and the heart rate / minute will be calculated. An algorithm will be applied to the collected QRS data to find the number of slopes within the data, which gives the respiratory rate / minute.

4.1. SCOPE FOR FURTHER RESEARCH

- The two lead ECG circuit will be used to extract the ECG signals from the subject.
- The analog signal will be converted in to digital form by using 'ADC0848'.
- These digital signals will be moved to microcontroller 'AT89S52' via 'RS232'.

REFERENCES

[1]. Shivaram P. Arunachalam, and Lewis F. Brown. Real-Time Estimation of the ECG-Derived Respiration (EDR) Signal using a New Algorithm for Baseline Wander Noise Removal. 2009. pg.no. 5681-5684.

[2]. Justin Boyle, Niranjan Bidargaddi, Member, IEEE, Antti Sarela, Member,and Mohan Karunanithi Automatic Detection of Respiration Rate From Ambulatory Single-Lead ECG. 2009.

[3]. K. Venu Madhav M Raghuraml, E. Hari Krishna and K. Ashoka Reddi. A Model Based Method for Deriving Respiratory Activity from Photoplethysmographic signals. 10th International Conference on Information Science, Signal Processing and their Applications (ISSPA 2010).

[4]. A. Espíritu Santo,C. Carbajal Respiration Rate Extraction from ECG Signal via Discrete Wavelet Transform. 2010.

[5]. Dan Wu, Guan-Zheng Liu, Mica Vee Man Wong, Yuan-Ting Zhang. The Accuracy of Respiratory Rate Estimation Using Electrocardiography and Photo plethysmography. **Websites referred:**

[6]. http://www.alldatasheets.com

[7]. http://www.en.wikipedia.org/wiki/Human_heart

[8]. http://www.en.wikipedia.org/wiki/Human_lung

[9]. http://www.en.wikipedia.org/wiki/ECG