"Tele-Monitoring System Using Gprs And Ecg Compression."

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Abstract

Care of critically ill patient requires prompt & accurate decisions so that life-protecting & lifesaving therapy can be properly applied. Because of these requirements, ICUs have become widely established in hospitals. This paper is mainly based on continuous monitoring aspect of ICU patients, the electrocardiogram (ECG) data compression by using adaptive discrete cosine Fourier Transform that can compress and recovery ECG data for online processing is presented. Difference equation is applied in this algorithm for generating the reference input used in the adaptive Fourier system. This technique can reduce the memory required in generating cosine function. Moreover, the proposed system does not require the input data to detect a period of signal therefore it reduces an input buffer. In addition, it has a high compression ratio and low percentage of root mean square error.I have designed, developed a reliable, energy efficient patient monitoring system. It is able to send parameters of patient in real time. It enables the doctors to monitor patients parameters (temp, heart beat , ECG) in real time using http protocol The timely manner of conveying real time monitored parameter to doctor is given highest priority. Hence On line Real time for the ICU patients.

INTRODUCTION

In present, a heart disease is a big problem in the world populations especially in the development country because of the lack of medical instrument. A doctor usually monitors and diagnosis heart diseases by checking the abnormality of electrocardiogram (ECG) signal obtained from patients. People who can access medical attention in time can be saved from death, but not for others who stay far from hospital or anyone who needs closely monitor or frequently check. Later, the method of sending ECG data signal to the hospital has been used. However, the problem of correctly transferring the continual ECG data signal is that it requires large bandwidth. Compression is one of alternative techniques to solve such problem because it can reduce the data of ECG signal.

1.1 Patient monitoring in Intensive care Units

There are different categories of patients who need physiologic monitoring like patients with a suspected life-threatening condition, patients at high risk of developing a life-threatening condition; patients in a critical physiological state .Because of these, ICUs have become widely established in hospitals. Such units use computers for the following purposes.

- To acquire physiological data frequently & or continuously.
- To communicate information from data-producing systems to remote locations .
- To store, organize, and report data.
- To integrate and correlate data from multiple sources.
- To provide clinical alerts and advisories based on multiple sources of data.
- To function as a decision-making tool that health professionals may use in planning then care of critically ill patients.
- To measure the severity of illness for patient classification purposes .
- To analyse the outcomes of ICU care in terms of clinical effectiveness & cost-effectiveness.

That is why, the efforts in direction of “On line real time monitoring of patients

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using ARM7 processor using no. of sensors."

1.2 Problem Definition:

As we know that the monitoring of movable patient is done using different wireless protocols. But the main complexity is that we can not use the same system or unit for the patients which are fixed or in ICU. So for the critical patients we need to develop fixed monitoring system which monitors data of that patient in real time.

In general health monitoring system (fixed) the parameters data is continuously monitored but not transmitted to remote server in Real Time. If there is any abnormality occurs in the parameter values then only the parameters data is transmitted / send to the server or remote PC via different wireless technologies, like Bluetooth, wi-fi, zigbee etc. It means that the data is not analysed continuously at each instant of time. Also due to the range limitations of different wireless technologies we can not send this data in real time over long distance (eg. physician / Expert).

So to overcome all the above limitation related to monitoring systems of patients in ICU, we have to design a new system which operates in real time and sends all the data of patient at remote server& the adaptive cosine Fourier series algorithm is developed to compress ECG signal without detecting a period of ECG signal. The proposed technique does not require an initial process for collecting the input data to detect a period of ECG signal. It thus reduces an input buffer and can be operated online to transmit the continual ECG data signal. In addition, the proposed adaptive algorithm is developed by using the difference equation structure to generate reference cosine input signal. With this technique, it can not only reduce memory for calculating but also provides high CR and low PRMSE.

1.3 The projected system :

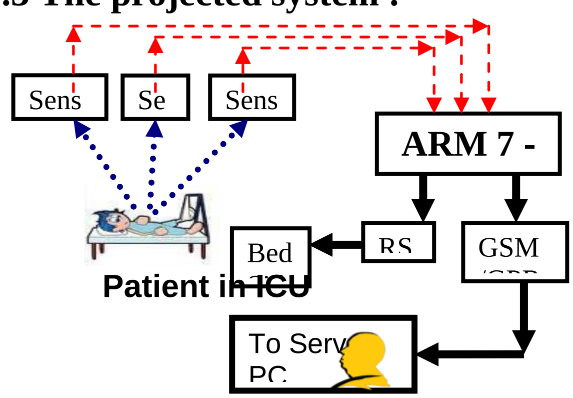

Fig.1 Proposed system

The above figure shows the proposed system. The projected system on the whole focuses on the transmission of parameters in real time, on line over a long distance server PC via wireless technology (GPRS-HTTP). The proposed system is constructed such that it senses different parameters of patient end which is in ICU, without any interference. Vital parameters like temp, heart rate, ECG can be measured. Sensors at patient end play a vital role in monitoring of parameters. The measured parameters are collected by microcontroller and converted into digital form.& collects all the parameters data and put in the form of array and then transmits this data by converting it into packets to remote server via Modem by establishing the HTTP (Hyper Text Transfer Protocol) connection with remote server. On server side we get all transmitted parameters waveforms continuously in real time. If parameters are exceeding the limits; which are already specified, then an automatic buzzer or alarm is generated to concerned physician / Expert doctor. The proposed system is constructed with low power consumption so that it would not cause much obstruction to patient and also less interference.

1.4 ECG COMPRESSION PRINCIPLES

A. Adaptive Filter

The scheme of ECG compression based on the adaptive filter [5], can be depicted in Fig. 2.The main idea is that the ECG signal is assumed to be periodic signal, hence, the Fourier Series is applied for obtaining signal component in sine and cosine signal. The relationship between input and output signals of the system can be written as

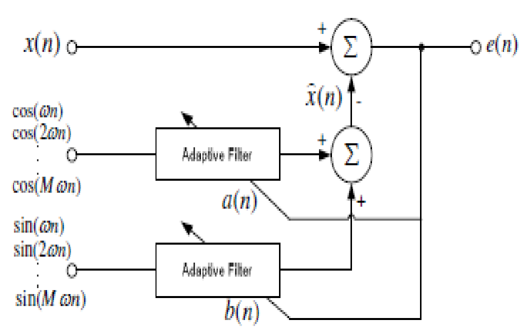

Figure 2. ECG compression based on the adaptive filter [5].

$e(n) = x(n) - \hat{x}(n)$ (1)

where $e(n)$ is the error signal, $x(n)$ is the ECG signal and $\hat{x}(n)$ is filtering output signal. Let the ECG signal is approximately represented in form of Fourier series as

$\hat{x}(n) = \sum_{i=1}^{M}(a_i \cos ni\omega + b_i \sin ni\omega)$ (2)

where a_i and b_i are amplitude of cosine and sine, respectively. From (2), amplitude and phase of signal respectively are

$\alpha_i = \sqrt{a_i^2} + \sqrt{b_i^2}$ (3)

$\phi = \tan^{-1}(\frac{b}{a})$ (4)

In the adaptive system, the coefficients a_i and b_i will be adapted by means of least mean square (LMS) for adjusting amplitude of component signals in the ECG signal. The parameters are adjusted by following equations

$a_i(n+1) = a_i(n) + 2\mu_a \cos(ni\omega)$ (5)

$b_i(n+1) = b_i(n) + 2\mu_b \sin(ni\omega)$ (6)

where μ_a and μ_b is step size that is a real number between 0 to 1.

B. The Proposed Algorithm for Compression ECG

As shown in (5) and (6), sine and cosine sequences are required in the updated algorithm. In this paper, these sequences can be generated by using difference equation to reduce required memory in the system, which is given by

$y(n) = 2\cos(\frac{2\pi}{p})\, y(n-1) - y(n-2)$ (7)

Let the initial condition of (7) be

$y(-1) = 2\cos(-\frac{2\pi}{p} + \phi)$ (8)

$y(-2) = 2\cos(-2\frac{2\pi}{p} + \phi)$ (9)

where ϕ is phase which is 0 for cosine sequence and $-\pi$ / 2 for sine sequence. For 2 π /P which is the minimum frequency, it is selected to be 5 2 π ×10− in this work. The reason is that this fundamental frequency can be employed to represent various frequency of ECG signals. As previously mentioned the weaknesses of the compression method in [5] are that it relies on periodic detection and needs large memory.

Therefore, the algorithm in Fig. 1 is modified in this work as shown in Fig. 2. Then (5) and (6) can be rewritten as following

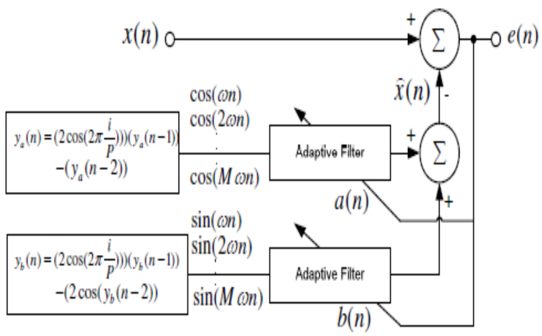

Figure 3. ECG compression based on the adaptive filter of the proposed system.

$$a_i(n+1) = a_i(n) + 2\mu_a \left[2\cos\left(2\pi\frac{i}{p}\right) y_a(n-1) - y_a(n-2) \right] \qquad (11)$$

$$b_i(n+1) = b_i(n) + 2\mu_b \left[2\cos\left(2\pi\frac{i}{p}\right) y_b(n-1) - y_b(n-2) \right] \qquad (12)$$

The sequences y_a and *yb are* cosine and sine sequences that are constructed by using (7). These M parameters represented as a compressed version of the ECG signal are transmitted to the receiving site. At the receiver, the reconstruction process is achieved by using (7) to generate cosine and sine sequences. These sequences will be employed with the received *i a* and *i b* coefficients to generate the recovered ECG signal by

$$r(n)=\sum_{i=1}^{M} a_i \left[2\cos\left(2\pi\frac{i}{p}\right) y_a(n-1) - y_a(n-2)\right] + b_i \left[2\cos\left(2\pi\frac{i}{p}\right) y_b(n-1) - y_b(n-2)\right].$$

It simultaneously adapts all Fourier coefficients to provide the best coefficients at the each adaptive step. As shown in Fig. 3, the results of the reconstructed ECG signal using 300 Fourier coefficients obtained from adapting the system for 3000, 6000, and 10000 epochs, respectively, are compared with the original ECG signal. The resulted PRMSE of using 3000, 6000, and 10000 epochs are 1.8025%, 1.4847%, and 1.8023%, respectively. In this work, the number of epochs is selected to be 10,000 which is large enough to cover low frequency ECG signal. For the step size in this algorithm (μ_a and μ_b), this value should be small and by using trial error, it is chosen to be 0.0001.

CONCLUSION

In this paper, the adaptive Fourier system is presented to compress the ECG signal. Since the ECG signal is periodic, it thus can be represented in a Fourier series. Hence, by using the proposed adaptive Fourier system, the adapted Fourier coefficients will be compressed and used as a representative of the original ECG signal. The proposed system can be applied online processing and can analyze frequency of the input ECG signal when enough input samples are applied in the system. Also we can conclude that we are able to transmit the data which is sensed from ICU patient to the server PC by establishing http communication to server via GPRS .The data is transmitted to server in real time. We can also check the data transmission and data downloading status on hyper terminal. So that we can remove the error if any. The leads of the ECG sensor must be stick properly to the patient, which is nearest to the chest side of patient.

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