A PROPOSAL OF WEB BASED SNMP MANAGEMENT FOR EMBEDDED SYSTEM APPLYING IN PATTERN RECOGNITION USING WAVELET TRANSFORM

ABSTRACT: Nowadays, due to the great variety of resources applied for medicine and telemedicine applications available into clinical environment, mainly in biomedical signal processing, it is been necessary to make use of management applications. In face the important tasks of management and monitoring of the acquisition and processing of biomedical signal, the present article proposes an integrated architecture of hardware and software, applied to the research of pattern recognition methods through wavelet transforms in ECG processing signal.

KEY WORDS: Embedded System; Pattern Recognition; Resource Management; SNMP; Wavelet; Web Based Application.

INTRODUCTION

In ambulatory and hospital environment, the ECG devices represent the most important diagnostic and monitoring tool for a cardiac patient. In the past, many studies have been carried out on ECG analysis and research results in various methods to identify and classify the most important characteristic points of ECG signal. Thus, the knowledge required to provide the pattern recognition of ECG complexes and correctly measurement of heart rate was made possible.

Many other techniques for this proposition are known nowadays. For instance, the pre-processing technique of Pan & Tompkins proposed in [4] and Hamilton & Tompkins in [5]. In this article, we present a proposition of wavelet transforms in the recognition of wave forms in complexes of periodic signals in the ECG.

The resulting algorithms will be applied in embedded devices in the acquisition of the ECG on patients during the diagnosis process or during the monitoring of cardiac malfunction. With the aim of a distributed architecture and concuring acquisition of biomedical signals, a support of wireless network links is added to capture devices for promoting all mobility needed to be applied in intensive clinic in hospital environment.

Thus, with the purpose of offering the specialist physician management tools able of centralizing this environment, it is proposed – besides the processing ECG devices – a remote management support of this integrated architecture, composed of hardware and software tools of the capture station, host servers and embedded capture devices, via SNMP protocol (Simple Network Management Protocol) that is supported on Linux platform through the Net-SNMP package. Besides a management console for a multiplatform application, web based and conceived in Java language, including support to SNMP JAVA API (Application Program Interface)

SNMP MANAGEMENT

The SNMP is a management protocol used to manage TCP/IP networks. Nowadays, it is widely used in several commercial networks, since it is a relatively simple protocol, but powerful enough to be used in the management of heterogeneous networks. The SNMP management comprises an agent, a manager and a MIB (Management Information Base), as shown in Fig. 1.

The MIB is a database composed of objects that will be managed and/or monitored through the SNMP protocol. A manageable object represents a real resource in
the network, such as a rotator, a switch and also the final system resources, like, for example, CPU, memory, etc. Each manageable object has a set of variables of which values can be read or altered by the agents.

The management agent is a software resident in a final system or in some network device about to be managed that collects information from the MIB and send it to the managing process. The latter (NMS – Network Management System) resides in a management station (by acting remotely), or in a local station (by acting in the site) and sends messages to the agent processes in order to read or alter the value of a manageable object.

The agents use SNMP primitives to read or change the values of the MIB objects [6]. These are some examples of primitives: get-request, get-response, get-next, set-request and trap [3]

THE WAVELET, THEORETICAL REVIEW

Wavelets are functions that satisfy certain mathematical requirements and are used in representation data or other functions. This idea is not new. Approximation using superposition of functions has existed since the early 1800’s, when Joseph Fourier discovered that he could superpose sines and cosines to represent other functions. However, in wavelet analysis, the scale that we use to look at data plays a special role. Wavelet algorithms process data at different scales or resolutions. If we look at a signal with a large window, we would notice gross features. Similarly, in the small window, we obtain small features [7]. The wavelet analysis procedure is to adopt a wavelet prototype function, called mother wavelet. Temporal analysis is performed with a contracted, high-frequency version of the prototype wavelet, while frequency analysis is performed with a dilated, low-frequency version of the same wavelet. Because the original signal or function can be represented in terms of a wavelet expansion (using coefficients in linear combinations of the wavelet functions), data operations ca be performed using just the corresponding wavelet coefficients [7].

ECG

The electrocardiogram, in this article referred to as ECG, it is a repeated signal with some variation of time as shown in Fig. 2. This electrocardiographic signal observed from some parts of the body is a package of composed basic waves called P, Q, R, S and T.

Based on this wave packet, the ECG is divided in three phases or complexes: PQ, QRS and ST, each one associated to different stages in the electrical stimuli of the heart; the energy registered by the ECG signal corresponds to polarization and depolarization phenomena of cardiac cells. The QRS complex waveform is an important feature of ECG signal, once it reflects the electrical activity of the heart when a ventricular contraction occurs. Because of that, it is used as the basis for the heart rate determination algorithms, as an feature for classification schemes of the cardiac cycle and automated ECG analysis algorithms [9]. In our approach, the identification phase of QRS complex and P and T waves, consists in the application of wavelets transform, adequate to the required resolution by the properties of QRS complex and P and T waves. The wavelets have the property of, in high frequencies, having a good resolution in time and a weak resolution in frequency, though in low frequencies the opposite happens, i.e., a good resolution in frequency and a poor resolution in time. This property is extremely useful to the ECG, which, in short, is a signal occurrence with high frequency components, short intervals, combined with components of long intervals in low frequency. The Morlet wavelets transforms are excellent to achieve high frequency resolution; its counterpart, the Mexican Hat wavelet has a poor frequency resolution, but a good time resolution. Thus, the utilization of both wavelets transforms can be combined so that the continuous wavelet transform (CWT) Gabor-8 Power is used to analyze the morphology of ECG signals, to determine the position of waves P, QRS and T through the Mexican Hat CWT as shown below in (1):

\[
CWT(a,b) = \frac{1}{\sqrt{a}} \int_{-\infty}^{\infty} f(t) \psi^* \left( \frac{t-b}{a} \right) dt
\]  

(1)
**ECG Acquisition Signals Devices**

The embedded system, applied nowadays in medicine, has in its features, many resources for assisting the medical professional. In this scenery, a range of acquisition, processing and representation devices of biomedical signal has been widely used in the last decades; mainly those applied in the electrocardiogram register, whether with long or short intervals. The register and the centralized monitoring of those ECG exams would enable medical professionals to have a better management of concurrent data, under his care. The combination of hardware and software elements that together offer management, register and processing of ECG signals picked by capture units. The physical link proposed is 802.11g in hospital usage.

![Diagram of Capture and Manager Station](image)

**Fig. 3 - Block Diagram of Capture and Manager Station**

**WEB BASED APPLICATION PROPOSAL**

The Web Based Application Proposal is formed by station of capture and management, as it is shown in Fig. 3. It also included the embedded device for acquisition, processing and transmit ECG signal, shown in Fig. 4, and a java application web based for browsing and remote management, based on the usage of SNMP protocol, shown in Fig. 5.

**THE CAPTURE AND MANAGEMENT STATION**

The capture and management station proposal in Fig. 3, represents the main element of the architecture presented, a brief description of owner modules is given below:

- **Net-SNMP Module:** is an package of tools that implements: an extensible agent, an SNMP library, tools to request or set information from SNMP agents and tools to generate and handle SNMP traps [10], this module offer a remote message query in MIB across of SNMP protocol. The version of SNMP includes: SNMPv1, SNMPv2 and SNMPv3.

- **Management Agent:** this module perform the important update task of MIB through primitives: get request, set request, get response and trap messages.

- **Server Process of Biosignal Remote Capture:** represents the major process responsible for the mediation between layers of management proposed, and the data stream originated from the acquisition devices of ECG signals via

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**Fig. 4 - Device of ECG Signal Acquisition**

![Diagram of ECG Signal Acquisition](image)
Every adjust parameters sending to embedded device would have its values updated in the MIB and the mutual exclusion from the concurrent access to shared resources would be in charge of modules: console monitor and manager module of the application web based.

**THE JAVA WEB BASED APPLICATION**

The applications destined to the web environment provide a rupture in the crashing among the available platforms. In any management environment such property gathers a great capacity of mobility and possibility of remote access by the specialist professional. This way the applications of telemicine and management of resources distributed are the highly privileged. Keeping this in mind, this module offers remote access in capture station, see Fig. 5: executing management and navigation actions of data together with the detailed logs of each transaction of ECG capture. This module is composed by the following components described below:

- **User Authentication Module**: The access to browsing and managing functions will be allowed through identification and priority level attributed to each user. The register of system users will be made in capture and management stations.

- **Browse Data collected**: The set of data is composed of two origins: the first source is a flow of signals from the application devices of ECG that will be stored in WFDB format and in the last logs of capture transactions among other parameters that needs a complete identification of signals stored. Thus the information retrieval will occur in two phases: initially, a query in SQL data will locate the parameters of register in the ECG, and once it possesses a unique identification of the signal acquired, the server processor will retrieve the file in WFDB format, forwarding all the in numeric values, allowing a reduced stream of information in the link. With the stream values, this module will plot the shape of signal waves.

- **Manager Module**: through the program interface application, JAVA SNMP API, it is possible to access the primitives of the protocol SNMP and to operate the access and to modify the values of objects in the MIB, which will directly reflecting the status of the capture device, therefore allowing remote management of capture devices. As mentioned before, all mutual exclusion controls required to concurrent access of these resources would be in charge of the critical section of each module through distributed devices of signalization and synchronization.

**CONCLUSION**

The related architecture offers all functionalities of a remote management environment of embedded devices used in biomedical applications. These features are especially useful to the requirements of telemicine applications. But the aspects of latency of execution and transaction can make the proposal for this application impossible to some resource arrays. The worst response time will be known so that with this, the application of a
Quality of service (QoS) management would offer levels of constant available resources.

For instance, the throughput of internet link on the end-system of users for the web application in SNMP transactions and to refresh status on graphical representation objects. Therefore, this proposal can be easily integrated to any environment whether there are integrated resources concurrently operating or not, being enough just the building proper agents. These agents and server processors as approached in this article, perform the function of proxy in all architecture, that together with SNMP protocol offer a powerful solution application to remote management to be joined in any infrastructure of services for telemedicine and remote diagnosis.

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REFERENCES


