Medical assistance system for geriatric patients based on expert systems and biosignals

Tania Lira Baca
FES-Cuautitlan
UNAM
Cuautitlan Izcalli, Mexico
ITSE.LIRA@gmail.com address

Miguel Borbolla Melchor
FES-Cuautitlan
UNAM
Cuautitlan Izcalli, Mexico
bm.mike07@gmail.com

Roberto Hernández Sanchez
FES-Cuautitlan
UNAM
Cuautitlan Izcalli, Mexico
line 5:
roberto.her3130@gmail.com

David Tinoco Varela
FES-Cuautitlan
UNAM
Cuautitlan Izcalli, Mexico
dativa19@hotmail.com

Fernando Gudiño Peñaloza
FES-Cuautitlan
UNAM
,Cuautitlan Izcalli, Mexico
fernando.gudino@comunidad.unam.mx

Abstract— ***Smart homes are efficient, cost-effective, and efficient automated homes that use a user-friendly interface for that purpose. Elderly patients and people with disabilities can benefit them by improving their quality of life. In this project, the monitoring of sleep patterns is proposed, in order to improve living conditions by establishing a home automation environment adaptable to the individual needs of the inhabitants of the house- room.***

Keywords— ***Expert System, Biosignal Acquisition System, Pattern Classification, Web Service, Man Machine Interface, work in progress.***

I. INTRODUCTION

Sleep is clinically linked to several serious conditions including diabetes, obesity, and a number of heart conditions. Additionally, sleep data, such as airway data, can be an indicator of worsening conditions such as chronic obstructive pulmonary disease (COPD). Despite this, data collection and monitoring of an individual's sleep has been limited primarily to high-cost labs for a limited time. To develop this system, our method is a multi-signal technique for sleep monitoring in which a set of physiological sensors generate data that an expert system uses to help care for patients in a remote home automation system.
This information is then analyzed to detect known sleep disorders and also stored to build a large database for investigations later and possibly diagnose other diseases [10,13,15].

Although it is known, older adults are the most prone to have this type of disease, which is why in this type of patients smart home care is chosen, which benefits both health care providers and their patients. For providers, the automatic monitoring system is valuable for many reasons. First, it frees up human work from 24/7 physical monitoring, reducing labor cost and increasing efficiency.

Second, wearable sensing devices can detect even small changes in vital signals that humans can miss, for example, heart rate and blood oxygen levels. Promptly notifying doctors of these changes can save human lives.
Third, the data collected from the wireless sensor network can be stored and integrated into a comprehensive medical history for each patient, which helps physicians make more informed diagnoses. Finally, the analysis, diagnosis and treatment process can also be semi-automated, whereby a human physician can be assisted by an "electronic physician".

Healthcare patients benefit from better health as a result of faster diagnosis and treatment of diseases and other issues are supported for a better quality of life, such as privacy, dignity and improved comfort thus the ability to provide services in the patient's own home.

II. METHODOLOGY

To develop this system, our method is a multi-signal technique for sleep monitoring in which a set of physiological sensors. This information is then analyzed to detect known sleep disorders and also stored to build a large database for further research and possibly diagnosing other diseases. The elements of the system are those shown in Fig 1.

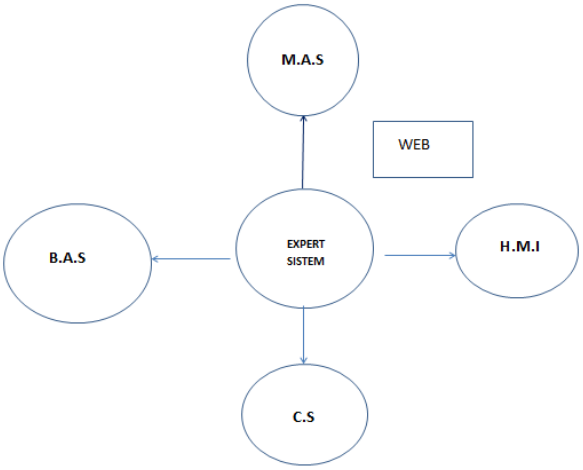

Fig.1. Proposed architecture for an assistance system based on home expert systems. The system is made up of a biosignal acquisition system (SAB), the pattern recognition and classification system (SC), a remote medical assistance system (SAM) and a series of interfaces: Man-Machine (HMI) and mobile-Web connection. In addition to the General expert system.

A. Expert System

The expert systems used in artificial intelligence are software that emulates the behavior of a human expert in solving a problem [1,2]. Expert systems work in such a way that they store specific knowledge for a given field and solve problems, using that knowledge, through logical deduction of conclusions. With them, an improvement in quality and speed of responses is sought, thus leading to an improvement in the productivity of the expert.
Expert systems can be rule-based, that is, they have predefined knowledge that is used to make all decisions (applying heuristics), or case-based (CBR, Case Based Reasoning), applying case-based reasoning, where the solution to a similar problem posed earlier is adapted to a new problem.

B. Remote Medical Assistance System (MAS)

The elderly are the most vulnerable patients since they require 24-hour nursing assistance, respiratory therapy, medical assistance and also continuous monitoring of their vital signs. Although it is true, on some occasions they require 24-hour nursing assistance, this does not apply to medical assistance, so the doctor makes an eventual assistance to make their respective medical follow-up, assessment and evolution.
That is why it has been seen the need to create new technologies and communication systems that allow medical personnel and health professionals to carry out permanent supervision of their vital signs through a remote monitoring system in real time of the associated patient. .

This System is responsible for monitoring in real time within the comprehensive health system made up of the team of responsible doctors who ensure the health of patients. This system is external to the expert system but supports the design and maintenance of our model with its experience [].
The remote medical assistance system through Web services and mobile technologies will include the service of access to medical records and antecedents via web and mobile to support the provision of remote consulting between doctors and patients.

In this area of the project is still under development, however, the system needs the following functional and non-functional requirements [4,5]:

Doctor.
-Consult and synchronization of agenda from web
-Details of the appointment
-Manage appointments
-Make a medical consultation from mobile
-Request for clinical exams from mobile
-Consult, update, conversion and save the patient's medical history from the mobile
-Publication, update and comments of the case
-Save information on mobile
-Register of medical personnel
-Perform disability order
-Generate, classify and consult medical appointments and procedures.
-Registration, consultation and administration of health providers

Patient or user.
-Arrange or request an appointment
-View details of your appointment
-Application for disability and order with a Medical specialist
-Request for medical prescriptions
-Consultation of health providers.

Other requirements

-The system must communicate with the server using HTTPS
-The system must use SOAP as protocol for communication
-System information must be kept on a server
-Communication must be done through web services
-The system must be tested on real equipment

C. BIOSIGNAL ACQUISITION SYSTEM (BAS)

Biosignals have shown their usefulness in the health care and medical domains for more than 100 years, the most studied being electroencephalography (ECG) and electrocardiography (ECG). Recently myoelectric control

has been gradually increased in medical devices and in mechatronic systems. Given its importance, the biosignal acquisition stage plays an important role in the treatment and classification of these signals.
Biosignals have been used in healthcare and domains. Currently, myoelectric signals (EMG) are being used for different applications [11]:

-Physical rehabilitation, referring to the measurement of muscle activation.
-Identification of pathologies by means of devices for medical applications.
-Control of mechatronic systems.
-Development of signal monitoring devices

In this investigation, an analysis of the characteristics of different EMG signal acquisition systems will be carried out, finding that each of these systems vary according to the application in: the characteristics of the sensing (type of sensors, number of channels and types of signals), the characteristics of the acquisition system (amplification, filtering, sampling frequency) and the type of computation used in the processing. The results obtained in this investigation will serve as a guide for those who wish to develop biosignal acquisition systems for specific applications [10,13].

D. Pattern Classification System (CS)

Pattern Recognition (PR) is the research area that studies the operation and design of systems that recognize patterns in data [12]. PR techniques are used to automatically classify objects and patterns and make decisions. Statistical pattern recognition assumes that the image can contain one or more objects and that each object belongs to one of several types, categories, or classes of patterns. Given a digital image that contains multiple objects, the pattern recognition process consists of 3 stages. The first stage is called image segmentation, where the objects of interest are isolated from the rest of the image. The second stage is the feature extraction, where the objects are measured.

A measure is a value of some quantifiable property of the object. A feature is a function of one or more measurements, computed in such a way that they quantify some important characteristics of the object. With these features, what is known as the feature vector is built.

For the pattern classification system, a conditioning of the biosignals will be carried out, for this, a line filtering, a small signal amplification, bandwidth reduction by means of a band-pass filter, a power amplification and a impedance matching. Said actions will be carried out for an optimal functioning of the system, as shown in Fig 2.

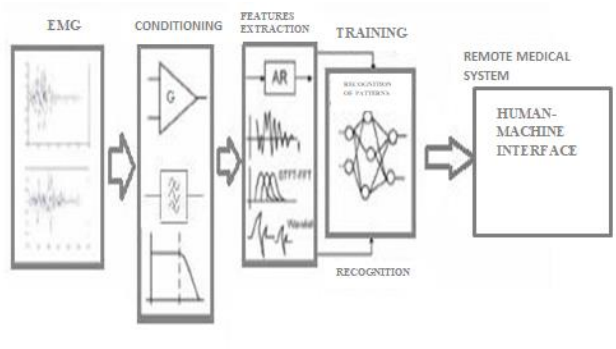

Fig. 2. Acquisition-conditioning process to enter the classification system

E. Web Service:

It is a software system designed to support the interoperable machine-to-machine interaction via a network [6,7]. A web service performs a specific task or a set of tasks, and is described by a description of service in a standard XML notation called WSDL (Web Services Description Language) [8].

The service description provides all the details necessary to interact with the service, including message formats (detailing operations), transport protocols and location. Other systems use SOAP messages to interact with the web service, usually using HTTP with an XML serialization together with other standards related to the web.
For our systems the messages will have the structure shown in Fig 3.

These messages will include the relevant information for the in charge of the remote assistance system. Such is the case of personal identification data, vital signs, alerts expert system and background and risk factors.

F. Human Machine Interface (H.M.I)

For people with some kind of disability, technological advances in fields such as robotics, communications, microcontrollers, computers personal, etc., open a whole range of possibilities of face to the improvement of their quality of life by providing them greater degree of communication, mobility and independence.
This is the field covered by Assistive or Assistive Technologies.

The Human Machine Interface (HMI) is the interface between the process and the operators, basically an operator panel [3,9]. It is the main tool with which operators and line supervisors coordinate and control industrial and manufacturing processes in the plant. HMIs serve to translate complex process variables into useful and usable information.

```
<ROOT>
        <PACIENTE>
        <ID>1234</ID>
        <EDAD>73<EDAD/>
        <PARTA>120<PARTA/>
        <PARTS>90<PARTS/>
        <RC>110<RC/>
        <ANOMALDETEC>SI<ANOMALDETEC/>
        <PACIENTE/>
```

Fig. 3. XML schema of information used by the remote assistance system.

III. EXPERIMENTS AND RESULTS

Acquisition of biosignals

The data was acquired by means of nfc sensors, which is a technology that allows the communication and exchange of data wirelessly in a short range and at a high frequency, likewise this type of card facilitates the acquisition. the results at different sampling frequencies are observed in Fig 4.

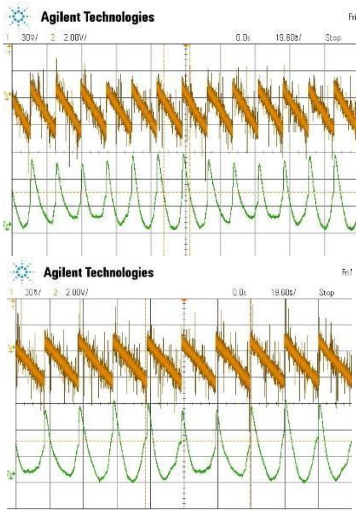

Fig. 4. Experimental input and output signal, where Vi = 5.10 mV and Vs = 5.3 V, the signal has been conditioned for use in the pattern recognition system.

We can observe the filtered signal at frequencies of 30 and 200 HZ, which is the range of useful EGM biosignals. At the moment it is the only thing that has been monitored in different elderly patients.

IV. CONCLUSIONS AND FUTURE WORK

In the following stages of the project, the interface must be developed, as well as an image acquisition system thermographic and oximetry for the development of the remote medical interface and the expert control system. Said control will be of a fuzzy expert type, since we need to be able to manage the system in ambiguous environments and often with missing and imprecise data typical of the interaction of the system with humans, which are difficult to model in any system. For the moment we can say that the acquisition of biosignals is an arduous and delicate job, but that it can be used not only as a reference input but also as a bio control system and trigger for more delicate events in a comprehensive home automation environment.

ACKNOWLEDGMENT

This project is carried out with the support of PIAPI2053 and PIAPIME 4.31.02.20

REFERENCES

[1] Adlassnig, K. P., Kolarz, G., Scheithauer, W., & Grabner, H. (1986). Approach to a hospital-based application of a medical expert system. Medical Informatics, 11(3), 205-223.

[2] Arsene, O., Dumitrache, I., & Mihu, I. (2015). Expert system for medicine diagnosis using software agents. Expert Systems with Applications, 42(4), 1825-1834.

[3] Bach-y-Rita, P., & Kercel, S. W. (2003). Sensory substitution and the human–machine interface. Trends in cognitive sciences, 7(12), 541- 546.

[4] Elles, L. Z. C. (2018). Diseño de un sistema para monitoreo remoto de signos vitales en pacientes críticos con atención domiciliaria. In [2019- LISBOA] Congreso Internacional de Tecnología, Ciencia y Sociedad.

[5] Joya, D. A. R., Vera, J. G. B., Mahecha, W. Y. C., Marin, C. E. M., & Garcia, P. A. G. (2010). PROTOTIPO DE TELEMEDICINA MÓVIL PARA ASISTENCIA MÉDICA DOMICILIARIA Y REMOTA. In Latin American and Caribbean Conference for Engineering and Technology.

[6] Machuca, C. A. M. (2010). Estado del Arte: Servicios Web. Universidad Nacional de Colombia, Tesis de Maestría.

[7] Natchetoi, Y., Wu, H., Babin, G., & Dagtas, S. (2007). EXEM: Efficient XML data exchange management for mobile applications. Information Systems Frontiers, 9(4), 439-448.

[8] S.A. ¿Qué es un servicio web? IBM KNOWLEDGE CENTER. En línea https://www.ibm.com/support/knowledgecenter/es/SSMKHH_9.0.0/c om.ibm.etools.mft.doc/ac55710_.htm

[9] SA. Interfaz Hombre- Maquina. En linea https://www.wonderware.com/es-es/hmi-scada/what-is-hmi/

[10] Stankovic, J. A., Cao, Q., Doan, T., Fang, L., He, Z., Kiran, R., ... & Wood, A. (2005, June). Wireless sensor networks for in-home healthcare: Potential and challenges. In *High confidence medical device software and systems (HCMDSS) workshop* (Vol. 2005).

[11] Tapia, B. R., Marrufo, A. I. S., Argüelles, V. T., & Arballo, N. C. (2017). Métodos de adquisición de bioseñales con sensores sEMG: revisión de sistemas actuales. In SOMI Congreso de Medición,2017.

[12] Tou, J. T., & Gonzalez, R. C. (1974). Pattern recognition principles.

[13] Umblia, T., Hein, A., Bruder, I., & Karopka, T. (2009, January). Marika: A mobile assistance system for supporting home care. In *MobiHealthInf 2009-1st International Workshop on Mobilizing Health Information to Support Healthcare-related Knowledge Work* (pp. 69-78). Portugal.

[14] Waterman, D. (1986). A guide to expert systems. Addison Wesley

[15] Zhou, F., Jiao, JR, Chen, S. y Zhang, D. (2010). Un sistema de inteligencia ambiental basado en casos para aplicaciones de asistencia en el hogar para ancianos. IEEE Transactions on Systems, Man, and Cybernetics, Parte C (Aplicaciones y revisiones) , 41 (2), 179-189.