

Prototyping of Mobile Health Monitoring System for elderly :

Using Android Python with SL4A And Logistic Regression Technique

Abderrahim BOUROUIS

STIC laboratory,
Abou-bekr BELKAID University
Tlemcen,Algeria

Mohamed FEHAM

STIC laboratory
Abou-bekr BELKAID University
Tlemcen,Algeria

Abdelhamid BOUCHACHIA

Software Engineering
University of Klagenfurt,
Austria

Abstract— In this paper we propose a prototype of pervasive mobile health system for monitoring elderly patients from indoor and outdoor environments. The system uses SpO2 and Heart Rate sensor worn by the patient and a Smartphone as a central node. The prototype is developed in Python using Scripting Layer for Android (SL4A) and regression technique in server side .

Keywords; *Mobile Health Monitoring, Smartphone, Android, sensors, Python, SL4A.*

I. MOTIVATION & INTRODUCTION

According to the Algerian National Office Of Statistics [1][2], the percentage of the total population of persons over the age of 65 has increased and is expected to increase further, the number reached 2.7 million out of a population of 35.5 million Algerians and it will reach 20 percent in 2030. In general, the greater part of elderly suffer from various chronic diseases, based on World Health Statistics (WHO) and other sources, chronic diseases and psychological pressures are behind the death of 80 percent of elderly people in Algeria [3].

Recent technological advances in wireless communications, sensor miniaturization and Smartphone processing power, offer great potential in the development of wearable systems for mobility monitoring[5].

An important area of the mobile healthcare service is the mobile monitoring of the patient's vital signs outside the clinical environment. Mobile healthcare can monitor common vital signs such as blood pressure, electrocardiogram (ECG), pulse rate, blood oxygenation (SpO2), breathing rate, body temperature, body activity and weight, and other measures; this could also be useful in management of chronic disorders and to provide feedback about someone's health in the form of behavioral feedback in order to prevent diseases[6] [8].

In this paper, we describe a prototype of mobile health system for monitoring elderly patients , it uses a wireless body area networks (WBAN) to collect and send data to the intelligent server through GPRS/UMTS[4].

The rest of the paper is organized as follows: Section 2 provides the short descriptions of the related works; in Section 3 we describe the overall architecture of the system and the functions of major components. In section 4, the implementation of the prototype is presented. Section 5 summarizes and concludes the paper.

II. RELATED WORKS

The first projects that introduced the mobile health monitoring is presented in [9], MobiHealth project is a health service platform based on a mobile phone as a base station for the wireless sensors worn on the body. It forwards their measurements wirelessly using UMTS or GPRS to a service centre, it provides three services: collecting and storage of the received data, forwarding of data to a doctor or medical centre, and analysis of the data received and the sending of feedbacks to a predefined destination using SMS.

Choi et al. [10] proposed a system for ubiquitous health monitoring in the Bedroom via a Bluetooth Network and Wireless LAN, the system uses Bluetooth and wireless LAN technologies, information gathered from sensors connected to the patient's bed is transmitted to a monitoring station outside of the room where the data is processed and analyzed.

Using the technologies of wireless body area networks (WBAN), Jovanov et al. [7] presented a Wearable health systems using WBAN for patient monitoring. The first level consists of physiological sensors, second level is the personal server, and the third level is the health care servers and related services.

Another example is the WiMoCA from Farella et al. [11] that is a custom-made WBSN where the sensing node consists of a triaxial integrated MEMS (micro-electro-mechanical system) accelerometer. The WiMoCa system's ability has to handle diverse application requirements such as posture detection system, bio-feedback application, and gait analysis.

Morón et al. [12] presented a mobile monitoring system, which can provide medical feedback to the patients through mobile devices based on the biomedical and environmental data collected by deployed sensors, sensors compiles information about patient's location and health status. These data are encrypted to be sent to a server through the mobile communications networks, the system provides access to patient's data, even from a smart phone by a J2ME application.

Dai et al. [13] designed a wireless physiological multi-parameter monitoring system based on mobile communication networks; this system monitors vital signs such as ECG, SP02, body temperature and respiration. Data is transmitted via mobile communications networks to a mobile monitoring

station and then to the hospitals central management system where, again, the data must be reviewed and interpreted by a physician or other medical personnel.

Lee et al. [14] presented a ubiquitous monitoring system using the ZigBee protocol to wirelessly transmit patient sensor data so that it may be monitored at a local health station. This sensor data is then transmitted through the internet to a local monitoring station where it is processed and analyzed by a reasoning server.

III. System Architecture

The prototype is designed to monitor the elderly : SpO2 and Heart Rate, health status and fall incidents. The system contains three following components :

1. Wireless Wearable Body Area Network (WWBAN)
2. Intelligent Central Node (ICN)
3. Intelligent Central Server (ICS)

1) Wireless Wearable Body Area Network (WWBAN):

WWBAN consist of two sensors put and adapted to the body of patient; the sensors gather their appropriate data and transmit that information to the second component (ICN) via Bluetooth communication protocol.

WWBAN is based on the star topology which implies a centralized architecture where the intelligence of the system is concentrated on a central node which is superior to the peripheral sensors in terms of resources such as processing, memory, and power [15].

2) Intelligent Central Node (ICN):

ICN is responsible to collect and process the data generated by the WWBAN sensor nodes, our prototype uses Smartphone with Android operating system as the intelligent central node (ICN). The application in ICN is developed in Python using Scripting Layer for Android (SL4A). It communicates with the ICS using GPRS/UMTS.

The basic architecture of SL4A is similar to what we would see in a distributed computing environment. Figure 1 shows in pictorial form the flow of execution when we launch SL4A and then run our script. Every SL4A script must import or source an external file, such as android.py for Python, which will define a number of proxy functions needed to communicate with the Android API.

The actual communication between SL4A and the underlying Android operating system uses a remote procedure call (RPC) mechanism and JavaScript Object Notation (JSON). We normally find RPC used in a distributed architecture in which information is passed between a client and a server. In the case of SL4A, the server is the Android OS, and the client is an SL4A script. This adds a layer of separation between SL4A and the Android OS to prevent any malicious script from doing anything harmful.

Security is a concern and is one of the reasons that SL4A uses the RPC mechanism.

SL4A enforces per-script security sandboxing by requiring all scripts to be authenticated by the corresponding RPC server. In order for the authentication to succeed, a script has to send the correct handshake secret to the corresponding server.

Although Figure 1 shows Python as the interpreter, the concept works pretty much the same for all supported languages. Each interpreter executes the language in its own process until an API call is made. [17][18]

This is then passed along to the Android OS using the RPC mechanism. All communication between the interpreter and the Android API typically uses JSON to pass information.

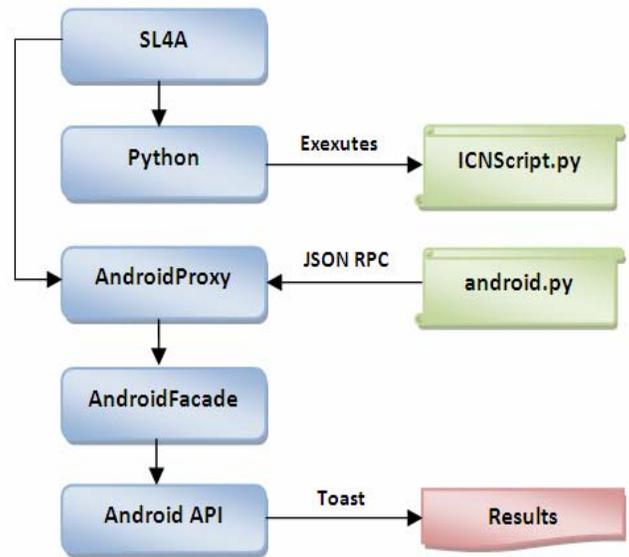


Figure 1. SL4A execution flow diagram

With the constant increase in processing power, allowing for sophisticated real-time data processing, Smartphone is a great choice as a central node and body gateway (figure 2). Other advantage is that Smartphone is often already integrated with sensors; such as accelerometer to determine mobility and global positioning system (GPS) for location, which makes them attractive for a fully integrated wearable mobility monitoring system.

Another advantage of using smartphones is the wide diffusion of these handheld devices in the market of consumer electronics and the familiarity of general users with these electronic gadgets as well as the quick and easy installation of applications.

ICN uses a comparison algorithm in order to determine whether to send the information to the ICS or not to save cost for the patient. Sensors Data must be sent when there is a change in collected parameters (health status).

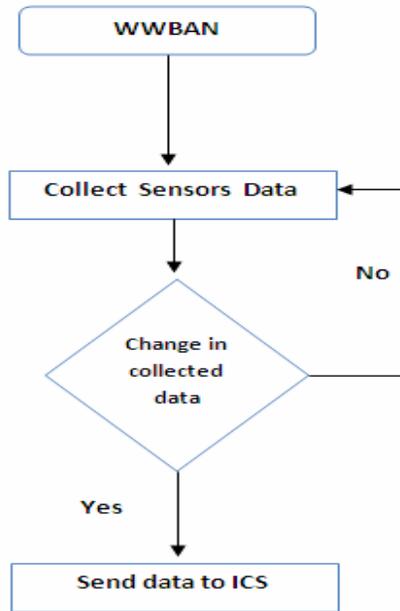


Figure 2. Flow diagram of the ICN function

3) Intelligent Central Server (ICS):

Intelligent Central Server (ICS) receives sensors data from the ICN. Once the data is uploaded to the server, it is stored in elderly's database to be analyzed. This analysis is performed autonomously, without human's intervention, comparing the patient's vitals against pre-existing knowledge of his/her condition as well as any recommendations prescribed by the patient's doctor or healthcare professional.

Our system uses logistic regression technique in ICS to mine data and predict health risk from knowledge of the bio-signal sensor data.

We used multivariable logistic regression to identify independent predictors of abnormal HRR and SPO₂ (ie, heart rate dropping by 13 beats at 1 min into recovery and by 22 beats at 2 min into recovery).

After processing the information, family members or medical authority can identify the real-time health status of the elderly through a web application. Once an abnormal situation is detected, an alert signal is sent to both give the medical professional an idea of the patient's health status and to alert him of the patient's current location in the case of an emergency.

IV. IMPLEMENTATION

We have implemented a prototyping system, the current sensor being used in the Wireless Wearable Body Area Network (WWBAN) component is the Nonin 4100 Bluetooth pulse oximeter. It measures blood-oxygen saturation levels (SpO₂) as well as heart rate (HR) [16].

We have considered a Samsung Galaxy S as hardware platforms of the intelligent central node (ICN) based on Android 2.3.3 operating System. We developed a Python

application for Android in ICN, which gathers the sensor data from Nonin sensor (SpO₂, HR). ICN uses Python APIs (Application Program Interfaces) to manage BT connections. Once data is received, ICN uses algorithms to compare current data with the previous; if it detects changes it forwards that data on to the ICS (intelligent central server). ICS includes MySQL database and Apache Server web. All server side functionality is implemented in HTML and PHP.

V. CONCLUSION

In conclusion, a ubiquitous mobile health system is presented for continuous monitoring of elderly patients. The system provides the architecture for collecting, gathering and analyzing data from a number of biosensors. The designed prototype system monitors location and health status through the use of a Nonin 4100 Bluetooth pulse oximeter as WWBAN and Samsung Galaxy S based on Android Python application as ICN. By providing capabilities for processing of the measurements and user I/O, the family members or medical authority are alerted in a timely manner when the state of elderly's health changes for the worse.

ACKNOWLEDGMENT

We would like to thank the STIC Laboratory personal Pr. Mohamed FEHAM for their publication support.

REFERENCES

- [1] R. S. Istepanian, E. Jovanov, Y. T. Zhang (2004), "Introduction to the Special Section on M-Health: Beyond Seamless Mobility and Global Wireless Health-Care Connectivity", IEEE Trans. on Inf Tech. in Biomedicine, vol. 8, pp. 405-414, Dec. 2004.
- [2] <http://www.ons.dz/index-en.php>
- [3] World Health Organization 2010, WORLD HEALTH STATISTICS 2010.
- [4] A. Bourouis, M. Feham, A. Bouchachia, "Ubiquitous Mobile Health Monitoring System for elderly (UMHMSE)", International Journal of Computer Science & Information Technology (IJCSIT), Vol 3, No 3, June 2011.
- [5] G. Hache, E. Lemaire, and N. Baddour, "Development of a Wearable Mobility Monitoring System," in Proc. Can. Med. Biological Eng. Conf., Calgary, Canada, May 2009.
- [6] C. N. Scanail, S. Carew, P. Barralon, N. Noury, D. Lyons, and G. M. Lyons, "A review of approaches to mobility telemonitoring of the elderly in their living environment," Ann. Biomed. Eng., vol. 34, no. 4, pp. 547-563, Apr. 2006.
- [7] E. Jovanov, A. Milenkovic, C. Otto, P. C. De Groen, "A wireless body area network of intelligent motionsensors for computer assisted physical rehabilitation", Journal of NeuroEngineering and Rehabilitation, 2005, vol. 2.
- [8] A. Van Halteren, R. Bults, K. Wac, D. Konstantas, I. Widya, N. Dokovsky, G. Koprnikov, V. Jones, R. Herzog, "Mobile Patient Monitoring: The MobiHealth System," The Journal on Information Technology in Healthcare 2004; 2(5); pp. 365-373.
- [9] D. Konstantas, A. Van Halteren, R. Bults, K. Wac, V. Jones, I. Widya, R. Herzog, "MOBIHEALTH: AMBULANT PATIENT MONITORING OVER PUBLIC WIRELESS NETWORKS," Mediterranean Conference on Medical and Biological Engineering MEDICON 2004.

- [10] J. M. Choi B. H. Choi J. W. Seo R. H. Sohn M. S. Ryu, W. Yi, A System for Ubiquitous Health Monitoring in the Bedroom via a Bluetooth Network and Wireless LAN". Proc. The 26th Annual International Conference of the IEEE EMBS, San Fransisco, CA, USA: Engineering in Medicine and Biology Society, vol. 2, 2004, pp. 3362-3365.
- [11] E. Farella A. Pieracci D. Brunelli L. Benini B. Ricco A. Acquaviva, "Design and implementation of WiMoCA node for a body area wireless sensor network," in Proceedings of the 2005 Systems Communications, 2005, pp. 342-347.
- [12] M. J. Morón J. R. Luque A. A. Botella E. J. Cuberos E. Casilari A. Diaz-Estrella, A Smart Phone-based Personal Area Network for Remote Monitoring of Biosignals, 4th International Workshop on Wearable and Implantable Body Sensor Networks (BSN 2007) IFMBE Proceedings, 2007, Volume 13, 3rd Session, pp. 116-121.
- [13] S. Dai Y. Zhang ,Wireless Physiological Multi-parameter Monitoring System Based on Mobile Communication Networks, In 19th IEEE Symposium on Computer-Based Medical Systems Based on Mobile Communication Networks, Washington, DC, USA: IEEE Computer Soceity, , 2006, pp. 473-478.
- [14] J. W. Lee and J. Y. Jung , ZigBee Device Design and Implementation for Context-Aware U-Healthcare System, The IEEE 2nd International Conference on Systems and Networks Communications, Cap Esterel, French Riviera, 2007, IEEE Computer Society, pp. 22.
- [15] Y. Guang-Zhong (Ed) Springer; 1st Edition. 2006, pp.147-149.
- [16] Nonin Medical ,<http://www.nonin.com/>
- [17] <http://code.google.com/p/androidscriptin>