Services of Ambient Assistance for Elderly and/or Disabled Person in Health Intelligent Habitat

Amina Makhlouf[1], Nadia Saadia[1] and Amar Ramdane-Cherif[2]
[1]LRPSI Laboratory, University of Science and Technology Houari Boumediene, Algiers, Algeria
[2] LISV Laboratory, University of Versailles-Saint-Quentin-en-Yvelines, Versailles, France

Keywords: Ambient Assistance, Services of Ambient Assistance, Intelligent Habitat Health, Petri Net.

Abstract: The life expectancy of people is increasing and related to that is an increase in the elderly population. The idea is to ensure that the elderly stay longer in their homes. A lot of projects work on ways allowing elderly persons to stay at home, these projects has focused to assess how a person copes by continuous monitoring of his/her activities through sensors measurements. The objective of this paper is to design a multimodal software system for managing two services of ambient assistance for elderly and/or disabled person in intelligent habitat health: Symptom Detection Service and Comfort Service. These services use several sensors installed in the home and on the persons, to collect information at any time about location and state of the person, and to ensure his comfort in the home. For helping decision maker choose appropriate assistance for these persons. This multimodal software platform is modeled by Colored Timed and Stochastic Petri nets (CTSPN) simulated in CPNTools.

1 INTRODUCTION

The world's older population has been growing more numerous for centuries, but the pace of growth has accelerated. The global population age 65 or older was estimated at 17.5% in 2011, an increase of 3.6% just since 1991. By 2060, this proportion is projected to increase to 29.5% (Dupaquier, 2006). In Algeria the older population (60 or more) is growing at a rapid pace. It was 5.7% of the total population in 1987; it reached to 7.4% in 2013. In 2050, it will reach 20.5% (Nkoma, 2011).

Today, the trend of older population in the world yields a lack of places and workers in institutions able to take care of elderly people. Especially as the elderly population is prone to several diseases of old age, like diabetes, rheumatism, hypertension, and especially Alzheimer's disease. Researcher teams all over the world try to tackle this issue by working on ways to maintain elderly people in their own home as long as possible; they proposed the ambient assistance. Ambient Assistance is a concept focused on the use of technology as a way to improve the independence and welfare of elderly or disabled people, at their homes. For example, some of them aim at detecting and handling emergency situations, helping the target users to accomplish activities of daily living (Perriot, 2013). Remote health monitoring functionalities and activity recognition (Fleury 2010), (Fleury, 2011) (Murdoch, 2013); are also considered, in particular for patients with Chronic Obstructive Pulmonary Disease (COPD) (Noury, 2013).

Objective of ambient assistance is to achieve three major goals; (1) The first is to assess how a person copes by continuous monitoring of his/her activities through sensors measurements, (2) The second is to ease daily living by compensating one's disabilities, (3) The third is to ensure security by detecting situations that is like a fear for the elderly persons.

In this paper, we contribute to the field of automatic monitoring by conducting a study of the daily activities of elderly people in their own home, in order to collect information at any time about location and state of the person, and to ensure his comfort at home, offering several ambient assisted services. For helping decision maker choose appropriate assistance for these persons. In the next section; we will define the ambient assistance for the elderly and/or disabled persons. Section 3; presents an overview of ambient assistance. We present in section 4, our architecture. Discussions and results

Makhlouf A., Saadia N. and Ramdane-Cherif A..
Services of Ambient Assistance for Elderly and/or Disabled Person in Health Intelligent Habitat.
DOI: 10.5220/0005147202250231
In *Proceedings of the International Conference on Agents and Artificial Intelligence* (ICAART-2015), pages 225-231
ISBN: 978-989-758-074-1

are presented in section 5.

2 AMBIENT ASSISTANCE

Ambient Assistance is an intelligent environment in which technology is used as a way to improve the welfare and independence of elder or disabled people living alone at their homes (Lauterbach, 2013). Among the prominent goals of ambient assistance are:

- Improve the quality of life of care giving persons.
- Reduce the need for external assistance.
- Reduce health care costs for the individual and society.

Ambient Assistance includes several categories of support application as: Information assistance, Intelligent environment behavior, Emergency case prediction, Security and Privacy. Technologies to develop Ambient Assistance application in these domains are: (1) Sensing, (2) Reasoning, (3) Acting, (4) Security, and (5) Interaction. (Foko, 2013)

Ambient Assistance aims to deliver a professional support in cases where personalized solutions are needed. It performs intelligent services that correspond to activities based on the application of professional knowledge to process a particular case. It is divided into many types, such as: (Rosas, 2014)

- Emergency treatment Services;
- Autonomy enhancement Services;
- Comfort Services.

3 OVERVIEW OF AMBIENT ASSISTANCE

In recent years, there has been an increase in the number of new technologies to improve security and to monitor the health of resident, using sensors and other devices.

Taking the activity of daily living (ADL) is an important parameter for monitoring the person (Wood, 2008). At the University of Lyon in France, they have developed a project "AILISA" as showed in figure 1, which is based on four smart homes placed in: (Noury, 2013)

1. CHU La Grave (Toulouse)
2. Hospital Charles Foix (Ivry-Sur-Seine)
3. Centre Geriatrique Sud-CGS (Grenoble)
4. HIS at Notre Dame (Grenoble)

The goal of this project is to ensure the home support for elderly people. Fleury (Fleury, 2010) used the infrared sensors for detecting presence, door contacts and the posture detectors (Noury 2013). Vacher (Vacher, 2008) used sound sensors for speech recognition classify the sound as speech or sound of everyday life and detect the distress sentences. Mascolo (Mascolo, 2007) proposed scales (ADL of Katz, IADL of Lawton and AGGIR) for detecting the degree of dependency of the person in their habitat.

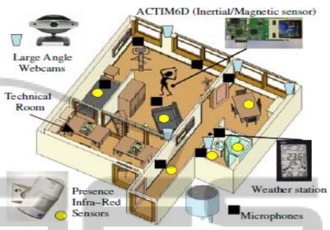

Figure 1: AILISA project.

EMUTEM platform (figure 2) (Souidene, 2008) is a muti-modal platform for medical televigilance (Medjahed, 2011), it contains:

1. Portable terminal RFPat: two terminals, one fixed and one mobile (on the person) for measuring physiological data, detecting movement and the fall. (Medjahed, 2008)
2. Smart sound sensor ANASON: contains four modules for the detection of sound events, classifying son / speech and analyzing of speech (speech recognition). (Medjahed, 2009)
3. Movement infrared detectors GUARDIAN: to detect the location and posture of the person at home. (Guettari, 2010)

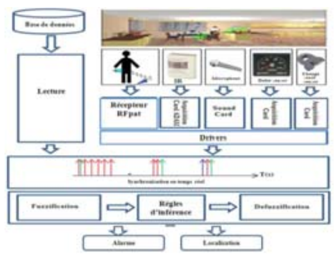

Figure 2: EMUTEM Architecture.

Our architecture is based on the collection of location information and status of persons in their home and ensure their comfort. Services offered in this article are among many services that can be put, adding more sensors and collect more information about the person.

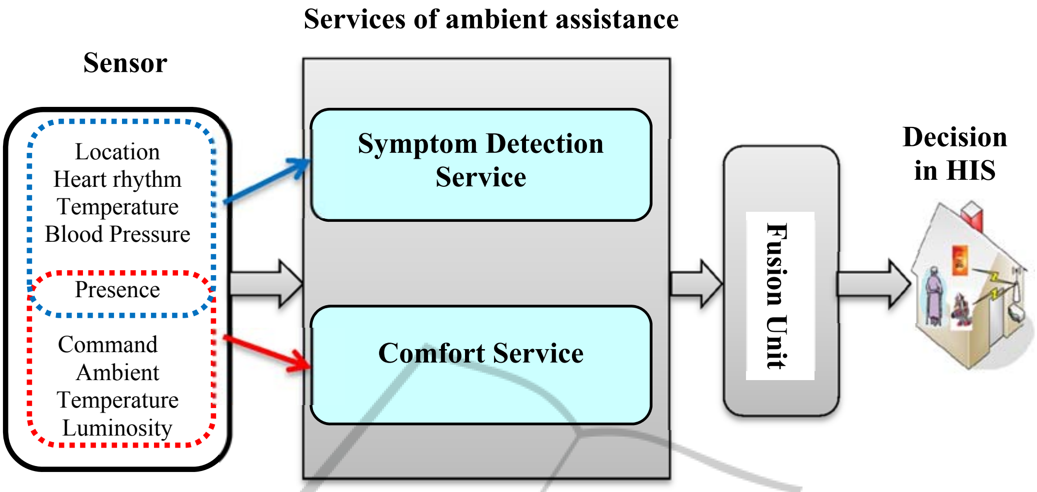

Figure 3: Global system architecture

4 ARCHITECTURE

The objective of our work is to design a system to manage two services of ambient assistance for elderly and/or disabled person in intelligent habitat health (HIS): Symptom Detection Service and Comfort Service. This system has as input many sensors information: the presence, command, heart rhythm, blood pressure, ambient temperature and luminosity... etc. Figure 3 shows the general aspect of our global architecture.

4.1 Symptom Detection Service

In this section, we will focus on data concerning the elderly and/or disabled person to identify his/her physical condition. The sensors used are:

a. Presence: to detect if there is a person in the home.

b. Heart Rhythm: an ECG sensor which will monitor the heart rhythm.

c. Blood Pressure: a blood pressure sensor.

d. Body temperature: a temperature sensor.

e. Location: a GPS for the location of the person in the home.

4.2 Comfort Service

In this section, we focus on the data relating to the environment and their setting. So we use:

a. Presence: presence sensor to detect if there is a person in the home.

b. Command: a choice if the command is manual or automatic.

c. Ambient Temperature: temperature sensor to *control* the temperature in home.

d. Luminosity: a luminosity sensor.

5 APPLICATION

The system response is the result obtained after treatment and fusion of inputs data, using Colored Timed and Stochastic Petri nets. Colored Timed and Stochastic Petri nets (CTSPN), is a language for the modelling and validation of systems in which concurrency, communication, and synchronization play a major role (Jensen, 2007). In the case of our application, we have proposed a formalization of the solution; we consider that inputs the sensor data:

If sensor 1 **and** sensor 2 **then** system response

5.1 Symptom Detection Service

For the control of physiological state of the elderly and/or disabled person, we proposed to control: heart rhythm is represented by ECG, body temperature is represented by Tm, and blood pressure is represented by Pr. For localization, we determined the location of the person in the home using GPS. These three sensors randomly generate two values 0 or 1. A value of 0 indicates that the person has a physiological problem, and the value 1 indicates that it is in good physiological condition. For localization, we determined the location of the person in the home using GPS, for our architecture we proposed to break up the habitat in four zones and each zone has a code 1, 2, 3, 4 respectively. As shown in the table 1 (Bates, 2010) and figure 4:

Table1: Codes Retrieved by the sensors.

Codes	**0**	**1**
Presence	No person	Person in the home
Command	Manual command	Automatic Command
Heart Rhythm	ECG < 55 beats per minute or ECG >75 beats per minute	ECG = 65 +/- 10 beats per minute
Body Temperature	Tm < 35.9°C Tm > 37.3°C	Tm = 36.6 +/- 0.7°C
Blood Pressure	Pr S < 110 mmHg ou Pr S>150 mmHg ou Pr D < 70 mmHg ou Pr D >90 mmHg	Pr S = 130+/- 20 mmHg Pr D = 80+/-10 mmHg

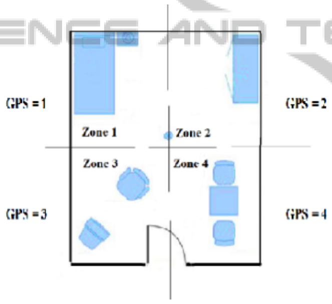

Figure 4: Representation of environments zones.

The table below shows all combinations of the proposed inputs in our architecture and the designation of each case after fusion:

Table 2: Result of the fusion of first service.

Pres ence	**(ECG, Tm, Pr)**	**GPS**	**Result of the fusion**	**Designation**
0	(-, -, -)	-	0	No person
1	(1, 1, 1)	1	1	Person in normal physiological condition Person in zone 1
	(1, 1, 1)	2	2	Person in normal physiological condition Person in zone 2
	(1, 1, 1)	3	3	Person in normal physiological condition Person in zone 3

Table 2: Result of the fusion of first service. (Cont.)

Pres ence	**(ECG, Tm, Pr)**	**GPS**	**Result of the fusion**	**Designation**
1	(1, 1, 1)	4	4	Person in normal physiological condition Person in zone 4
	ECG =0 Or Tm = 0 Or Pr= 0	1	5	Alarm (heart rhythm or temperature or pressure) Person in zone 1
		2	6	Alarm (heart rhythm or temperature or pressure) Person in zone 2
		3	7	Alarm (heart rhythm or temperature or pressure) Person in zone 3
		4	8	Alarm (heart rhythm or temperature or pressure) Person in zone 4

5.2 Comfort Service

Two parameters were monitored in the environment: room temperature which is represented by tm, and luminosity that represented by lu. It has a scale with three degrees, suggesting that the degree 2 is reserved for the ambient temperature and the ambient luminosity. Values of the temperature and luminosity are compared with this value if it is less or greater than 2, depends on this comparison, we will heat or cool the habitat; we will rise or reduce the luminosity. The setting of these two parameters is made after the decision of the person if it is automatic or manual encoded by two values 1 and 0 respectively (Cmd). As shown in the tables 1and 3:

Table 3: Codes retrieved by the sensors (*).

Codes	**1**	**2**	**3**
Ambient temperature	Tm < 17°C	Tm = 19 +/- 3°C	Tm > 21°C
Luminosity	Lu < 150 lux	Lu = 200 +/- 50 lux	Lu > 250 lux

The table below shows all combinations of the proposed inputs in our architecture and the designation of each case after fusion:

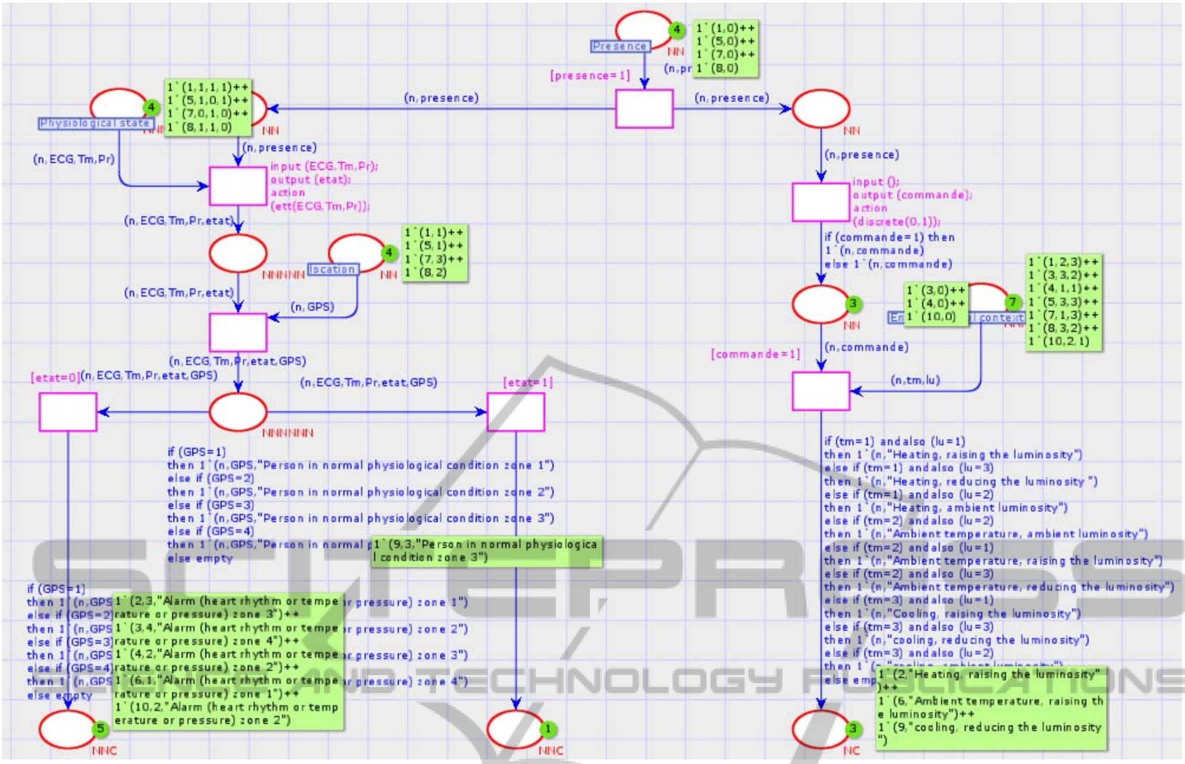

Figure 5: Implementation of architecture on CPNTools.

Table 4: Result of the fusion of second service.

Presence	Cmd	(tm, lu)	Result of the fusion	Designation	
0	-	(-, -)	0	No person	
1	0	(-, -)	1	Manual command	
1	1	(1, 1)	2	Automatic Command	Heating, raising the luminosity
		(1, 3)	3		Heating, reducing the luminosity
		(1, 2)	4		Heating, ambient luminosity
		(2, 2)	5		Ambient temperature, ambient luminosity
		(2, 1)	6		Ambient temperature, raising the luminosity
		(2, 3)	7		Ambient temperature, reducing the luminosity
		(3, 1)	8		Cooling, raising the luminosity
		(3, 3)	9		Cooling, reducing the luminosity
		(3, 2)	10		Cooling, ambient luminosity

6 IMPLEMENTATION ON CPNTOOLS

To evaluate the performance of this architecture based on Petri nets, we present in this section the simulation results obtained after running these programs using the software CPNTools.

A CPN model of a system is an executable model representing the states of the system and the events (transitions) that can cause the system to change state. The CPN language makes it possible to organize a model as a set of modules, and it includes a time concept for representing the time taken to execute events in the modelled system. A license for CPN Tools can be obtained free of charge, also for commercial use (Jensen and al, 2007).

Figure 5 shows the results of the simulation using CPNTools. Indeed, the results are obtained after fusion of proposed agents: The presence, location, command, heart rhythm, temperature and blood pressure, ambient temperature and luminosity. For each simulation the result is a message that indicates the status of the person or his environment, as for sample 3 the message displayed is “Alarm (heart rhythm or temperature or pressure) zone 2”.

7 RESULTS VALIDATION ON MATLAB

7.1 Symptom Detection Service

To further verify the results of our simulation, we recovered the input and output codes for 50 samples generated by the proposed architecture for both services. Each sample is assigned a message corresponding to the action performed.

Figure 6 shows the fusion agents: presence, heart rhythm, body temperature, blood pressure and location. We note, for example the sample 11 (indicated by a dotted line in figure 6), code output is 3 and the accompanying message is "Person in normal physiological condition, person in zone 3".

In the second example the sample 6, 22 or 38, the code is 0; the message is "No person". Indeed, the message "Alarm (heart rhythm or temperature or pressure), person in zone 3" accompanying the sample 17, it indicates that the person is in zone 3 and he has a problem at the blood pressure.

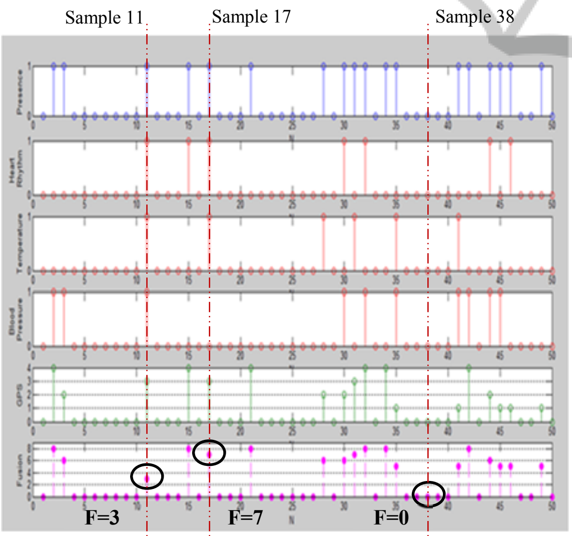

Figure 6: Graphical representation of the results of first service.

7.2 Comfort Service

Figure 7 shows the fusion agents: presence, command, ambient temperature and luminosity. We note, for example the sample 11 (indicated by a dotted line in figure 7), code output is 4 and the accompanying message is "Automatic command, heating, ambient luminosity". In the second example the sample 28, the code is 1; the message is "Manual command".

After checking all the samples, we can conclude that our architecture is able to handle the proposed services: Symptom Detection Service and Comfort Service of elderly and/or disabled person in their habitat.

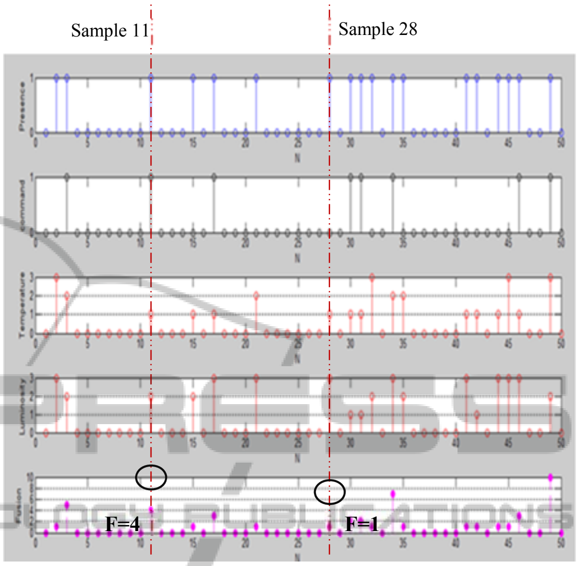

Figure 7: Graphical representation of the results of second service.

8 CONCLUSIONS

In this article we presented the ambient Assistance of the elderly and/or disabled person, it allows monitoring, comfort and security of people in their habitats, ensuring the intimacy of the inhabitants.

The ambient assistance consists of several services: emergency service, service of taking medication and alarm trigger service...etc. As against in our architecture we interested by two services: Symptom Detection Service and Comfort Services. We chose these services because an elderly person should always supervise his health and at the same time assure a comfortable life for him.

The validation of the proposed structure is done using CPN Tools and Matlab. We used the Colored Timed and Stochastic Petri nets (CTSPN) for modeling the proposed structure. The obtained results show than the proposed architecture collect information at any time about location and state of the person, and ensure his comfort in the home. The goal is to help decision maker choose appropriate assistance for these persons.

REFERENCES

Dupaquier, J., 2006. Le vieillissement de la population dans le monde. *Bulletin Rayonnement du CNRS, no 42.*

Nkoma, M., 2011. La sécurité sociale des personnes âgées en question. *Actes du Colloque international de Meknès.*

Perriot,B., Argod, J. , Pepin, J.-L., and Noury, N., 2013. A Network of Collaborative Sensors for the Monitoring of COPD Patients in their Daily Life. *2013 IEEE 15th International Conference on e-Health Networking, Applications and Services.*

Murdoch, O., Wan, J., Abdalla, S., and al. 2013. Sensor Infrastructures for Ambient Assisted Living. *In Handbook of Medical and Healthcare Technologies (pp. 435-452). Springer New York.*

Fleury, A., Noury, N., & Vacher, M. 2011. Improving supervised classification of activities of daily living using prior knowledge. *International journal of E-Health and medical communications, 2(1), 17-34. ISO 690*.

Fleury, A., Vacher, M., & Noury, N. 2010. SVM-based multimodal classification of activities of daily living in health smart homes: sensors, algorithms, and first experimental results. *Information Technology in Biomedicine, IEEE Transactions on, 14(2), 274-283.*

Noury, N., Perriot, B., Argod, J., & Pepin, J. 2013. Characterization of physical activity in COPD patients: validation of a robust algorithm for actigraphic measurements in living situations. *IEEE Journal of Biomedical and Health Informatics.*

Lauterbach, C., Steinhage, A., & Techmer, A. 2013. A large-area sensor system underneath the floor for ambient assisted living applications. *In Pervasive and mobile sensing and computing for healthcare (pp. 69-87). Springer Berlin Heidelberg.*

Foko, T. E., Dlodlo, N., & Montsi, L. 2013. An integrated smart system for ambient-assisted living. *In Internet of Things, Smart Spaces, and Next Generation Networking (pp. 128-138). Springer Berlin Heidelberg.*

Rosas, J., Camarinha-Matos, L. M., and al. 2014. Development of an Ecosystem for Ambient Assisted Living. *In Innovative and Creative Developments in Multimodal Interaction Systems (pp. 200-227). Springer Berlin Heidelberg.*

Wood, A., Stankovic, J. A., Virone, G., et al, 2008. Context-aware wireless sensor networks for assisted living and residential monitoring. *Network, IEEE, vol. 22, no 4, p. 26-33.*

Noury, N., and Hadidi, T. 2013. Simulation of Human Activity in a Health Smart Home with HMM. *2013 IEEE 15th International Conference on e-Health Networking, Applications & Services (Healthcom).*

Fleury, A., Vacher, M., Portet, F., and al. 2010. A multimodal corpus recorded in a health smart home. *In Proceedings of the Workshop on Multimodal Corpora: Advances in Capturing, Coding and Analyzing Multimodality in conjunction with LREC 2010 (pp. 99-105).*

Noury, N., Perriot, B., Collet, J., Grenier, E., Cerny, M. and al. 2013. ActimedARM-Design of a wearable system to monitor daily actimetry. *In Engineering in Medicine and Biology Society (EMBC), 2013 35th Annual International Conference of the IEEE (pp. 1851-1854). IEEE.*

Vacher, M., Fleury, A., Serignat, J. F., Noury, N., & Glasson, H. 2008. Preliminary evaluation of speech/sound recognition for telemedicine application in a real environment. *In Proceedings of the Interspeech 2008 conference (pp. 496-499).*

Mascolo, M., Gouin, A., & Noury, N. 2007. Habitat Intelligent pour la Santé-Vers un outil d'aide à l'évaluation automatique de la dépendance d'une personne âgée. *Actes des 2èmes Journées Doctorales/Journées Nationales MACS JD-JN-MACS, 10.*

Souidene, W., Istrate, D., Medjahed, H., Boudy, J. and al. 2008. Une plateforme multimodale pour la télévigilance médicale. *4th ws AMINA, Tunis.*

Medjahed, H., Istrate, D., Boudy, J., Baldinger, J. L., & Dorizzi, B. 2011. A pervasive multi-sensor data fusion for smart home healthcare monitoring. *In Fuzzy Systems (FUZZ), 2011 IEEE International Conference on (pp. 1466-1473). IEEE.*

Medjahed, H., Istrate, D., Boudy, J., Baldinger, J. and al. 2008. A Multimodal Platform for Database Recording and Elderly People Monitoring. *In BIOSIGNALS (2) (pp. 385-392).*

Medjahed, H., Istrate, D., Boudy, J., & Dorizzi, B. 2009. Human activities of daily living recognition using fuzzy logic for elderly home monitoring. *In Fuzzy Systems, 2009. FUZZ-IEEE 2009. IEEE International Conference on (pp. 2001-2006). IEEE.*

Guettari, T., Aguilar, P. A. C., Boudy, J., Medjahed, H. and al. 2010. Multimodal localization in the context of a medical telemonitoring system. *In Engineering in Medicine and Biology Society (EMBC), 2010 Annual International Conference of the IEEE (pp. 3835-3838). IEEE.*

Jensen, K., Kristensen, L. M., and Wells, L., 2007. Coloured Petri Nets and CPN Tools for modelling and validation of concurrent systems. *International Journal on Software Tools for Technology Transfer, vol. 9, no 3 4, p. 213-254.*

Bates, B., 2010. *Guide de l'examen clinique*. Wolters Kluwer France.

(*) http://temperatureideale.fr/post/temperature-ideale-piece-maison-appartement (consulté en Aout 2013).