Controlled monitoring in intelligent environments

Álvarez, M.A.[a]; Bellido, A.M.[a]; Álvarez, J.A.[a]; Ortega, J.A.[a]; Velasco, F.[b]
[a]Department of Computer Science, University of Seville, Seville, Spain
[b]Department of Applied Economics I, University of Seville, Seville, Spain
{migalvcon, antonio.bellido}@gmail.com, {afernandez, ortega}@lsi.us.es, velasco@us.es

Abstract

This article describes a new line of development focused on monitoring the activities of people living alone at home. To achieve this objective is proposed merging techniques of indoor location with real-time analysis of biomedical signals, extraction of knowledge of events from home and an examination of the interaction of the person with their multimedia content server. The last will be an important element in monitoring because television and radio (two of the most media used) are accessible via Digital Terrestrial Television (DTT) and these can easily be integrated into a computer.

1 Introduction

The development and integration of communication systems between doctors and patients for control of them is evolving every day. The fact that there are problems that they avoid an exhaustive control of the patient, such as the displacement from home to health center or the time available are some factors that have influenced this growth.

Starting from this assumption, we focus on the study of patients who suffer a heart condition and they must be under control for as long time as possible if necessary both by doctors and family members.

In this article, we discuss four main sections that they will make easy the patient's medical control: indoor location, biomedical signal tests, behavioral patterns and digital communication.

In each of these items, we will be studied and proposed several techniques that enable the objective local in each case as the location of the patient inside the home, the vital signs monitoring, the biomedical behavior from previous processing and the digital communication with the patient.

Finally, we propose an integrated system that allows fully integrate the above analysis.

2 Indoor location

In this section we want to achieve is to locate the patient inside the home. We will need to have some basic elements depend on the technology to use.

The location of the patient will be required to check things like the beaten tracks, the architectonic barriers or even the observation of irregular movement patterns such as falls (spending a long time in a room can be a cause of this).

Some of the technologies that allow check it are detailed below.

2.1 Wi-Fi

This technology allows to locate the patient's location within the effect range of the signal. This requires the triangulation from at least three access points located inside the home.

Since the signals move in a spherical environment in three dimensions, we can locate the position in houses with more than one floor. This requires that access points should be placed in different horizontal planes.

One of the downside of this technology is that to obtain the triangulation, we must depend of the signal strength and this can be affected by external agents such as other signs or barriers between the patient and access points. Although the location is not completely accurate, for this case is irrelevant because it is only necessary to know the room where the patient is located.

2.2 Bluetooth

Bluetooth technology is based on the same principles as the previous one as it depends on the broadcast signal. The difference is that the scope is much smaller and can be affected more strongly by other agents.

2.3 RFID

The way that RFID tags can be use to locate the patient in a room of the house is quite simple. It be only necessary place the cards at specific locations of the rooms. Doors or on significant objects that is within the room are valid.

When the patient interact with the card, this is able to transmit the information that it contain to alert the location where the person are.

The biggest problem that exists in this technology is that it requires direct contact between the card and the user. If contact does not exist, the RFID card does not perceive the change of position from one room to another.

2.4 FM radio signals

Another of the technologies exist to enable location are the radio signals.

The operation of FM radio signals is similar to any technology that relies on signal strength to triangulate a position in a place. Its disadvantage is the need for a space free of interference from radio frequency signals, something that is almost impossible today.

3 Biomedical signal tests

If we want know the health of a person, we will need a device capable of analyzing the cardiac signals. The device that we have used to analyze the biometric signals have two electrodes and a triaxial accelerometer.

We can obtain information from the device about the person's heart rate and the position of axis x, y and z.

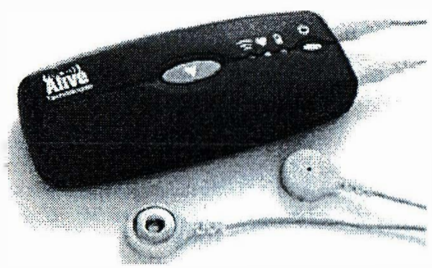

Figure 1: Device with two electrodes and a triaxial accelerometer.

3.1 Behavioral patterns

We will build on the two aspects that the previous device can collect for pattern recognition.

The first aspect that we analyze is the positioning of the device that the patient is attached to his body. We can distinguish the following states from the study of the values given by each of the x, y and z axis accelerometer:

- Still (seated or standing).
- Lying.
- Walking.

The first two states correspond to a fixed position of the three axes. The value of one axis corresponds to 0 in any of them and it depends how the device is worn in the body of person and will not change its value during the time period in which the person is in such states, that is, while he is still or he is lying the value of the axis will not change.

In the last state, the axis values are changing constantly and they take values within the range allowed by the device. In any case, none of the axes take the value 0 in the transitional.

We can differentiate the first two states of the third by the average of the values of the module obtained for each axis. This module will be much higher in the third state than in the first two.

The second aspect that we analyze is the heart rate. We can distinguish the following states from the study of the values given by the device:

- Stop.
- Normal.
- High.

Each of the states correspond to specific heart rates of each person. The first one corresponds to a detected cardiac arrest when the device does not receive the signal.

The second state corresponds to a user with a normal heart rhythm. This range must be defined for each user because that heart rate varies for each person.

The third state corresponds to a heart rate higher than the last. It is also different for each person.

Combining both, we establish various risk levels that determine the global states we want to analyze in patients:

- Cardiac arrest (Lying and Stop).
- Normal (any state of first aspect and Normal).
- Busy (Still or Lying and High).

4 Digital communication

One aspect that can be integrated is the digital communication. The family and the doctor can contact the patient at any time through the digital communication.

Currently there are numerous systems and software that allow the face to face communication. Algunos de ellos son Windows Live Messenger or Google Talk.

Our study allows the inclusion of a communication system via DTT (Digital Terrestrial Television). Thiss communication is possible through a web cam and a microphone on the TV.

5 Conclusions and future work

The most important aspect of this study is the analysis of the signals received by the device. From them, we can determine heart rate and position of the device.

It is necessary to properly define the boundary between normal and busy state to place correctly the state in which state the user is located.

As future work, we study the transitions between each of the states of the first aspect. This control will allow to define more clearly the state in which state the user is located.

Finally, we developed a software to allow automatically know the global state of patient.

Acknowledgments

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