Design of a System for Early Detection and Treatment of Depression in Elderly Case Study

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Abstract. One of the major diseases that afflict the elderly population in Mexico is depression. This document describes the process of designing a system for early detection and treatment of the state of depression in older adults, taking advantage of the technological development of the Internet of Things, the Context Awareness and the concept of e-Health to determine the Daily Activities living (ADL) using the gesture recognition log events to determine an abnormality in as a means to conclude the variations in the ADL.

Keywords: Component · Internet of things · Elderly · Depression · Detection · Pattern recognition

1 Introduction

Mexico's population is aging, this implies the need to design proposals that benefit the existing and growing population, specifically those called great seniors, many of them require special care involving wear deterioration in family and family finances among other.

One of the main diseases afflicting the population has to do with mental health. This paper proposed a system that serves to detect and treat early depression in older adults using as a model the concept of Internet of Things explained (IoT).

To carry out this investigation and proposed a theoretical approach, where we sought to establish the state of the art of IoT and related concepts as is the Context Awareness, e-Health and Gesture Recognition was performed. Similarly we define the concept of Older Adults and Depression in Older Adults. To achieve this 452 articles indexed journals, Web sites and books were consulted. He held a consultation with the authors of these articles, which saw fit to participate, as a validation of the thematic appropriateness and feasibility of the project.

On the other hand is in the process an empirical approach. This consists of a first stage of technological approach, developing basic prototypes that gave us the outlook for the selection of appropriate technology that would allow us to detect a state of

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depression. Prototypes were built with Arduino© and compatible sensors. For detection and gesture recognition OpenCV© and a webcam are used. In the second stage, which is under development, is being used for processing Raspberry Pi® and detection of movement patterns, coupled with pulse sensors, temperature and movement controlled by Arduino©.

It is working in the Universidad Autónoma Metropolitana in the Research Area of New Technologies in conjunction with the National Institute of Rehabilitation, Section of Psychology by MD. Morales to determine patients serving as a case study. Initially we are working with the design of the experiment that seeks, through the establishment of a "pattern of conduct" that will be digitized and identify the prototype variants can be identified as a type behavior. It is intended that the prospective employer to a state of depression, which will serve to identify and initiate treatment of it being approved. Is likely to have to include the acceptance or rejection of the use of technology by patients and the results to be obtained.

2 Theoretical Approach

2.1 State of the Art

Mexico is a member of the Organization for Economic Cooperation and Development (OECD) country in which a process of population aging is seen [1]. This growth involves common issues of aging population, such as the increase of diseases, ailments specific to the elderly and disabled, resulting in increased costs and family to wear [2].

The OECD adopted a definition for disability in older adults to report specific small or severe limitations and are reflected in day to day or in your Activity Daily Living (ADL). This is because they are considered common and disabling disorders to perform activities such as the personal care, eating, dressing, toileting, bathing, bedtime, getting out of bed and any other activity that can be clearly defined [2]. Likewise is associated to the presence of comorbidities, social isolation and depressed mood, necessitating the use of systematic evaluations for detection [3].

The ADL in older adults is impaired by increasing ailments where the main character is mental as related to mental disorders such as depression and Alzheimer.

Depression is a disorder, also called major depressive disorder or major depression, which affects the thoughts and feelings of a person, their ADL and to your body. It can be associated to various physical problems, such as sleep, appetite, energy, libido and various body pains. It also relates to a reduction in physiological activity in various physical systems, including emotion and cognition [4].

According to the World Health Organization (WHO), depression is common in many countries: 121 million people worldwide suffer from and more frequently in the elderly, where the prevalence of depressive disorders is 4, 5 % to 37.4 % in communities of 75 or more years old and can progress to major depression between 8 % and 10 % in older adults and more frequently in females [5].

For detection of depression there are various tools and methods such as the Geriatric Depression Scale (GDS) is one of the instruments used for the detection of depression in adulthood [3].

2.2 The Internet of Things for the Detection of Depression

Today the concept of IoT opens the possibility to make proposals and generate profits in the health sector, besides exploring can be proposed as early detection and treatment of depression in older adults.

The IoT has been defined as an evolution of the Internet or a "New Internet" that allows interaction between people, between people and objects with objects [6]. This raises new forms of communication using [7] "open" standards and "persuasive" services; [8] understood as "Open" (Open) to all software, hardware and related items that allow free use, modification and distribution. It also included the "Persuader" (Pervasive) or Penetrating the concept of Ubiquitous, Immersive element. Moreover said the IoT refers to the networking of everyday objects that are often equipped with ubiquitous intelligence [9].

The IoT aims to improve the ADL through proper management of information and transforming it, making the "processors" can perceive and integrate this to react in all sorts of aspects of the physical world [10].

Two aspects such as the Context Awareness (CA) and the e-Health arise within the model of IoT. The CA is a concept that arises from ubiquitous computing, with a technology that aims to acquire and utilize information about the context of a device, an environment or a person [11] to provide services tailored to a particular need, referring to the physical and social situation in which computational devices are integrated [12].

Moreover, the e-Health has used the rapid development of wireless technologies, especially wireless sensor networks and heterogeneous techniques to improve ADL through monitoring and treatment of patients ubiquitously [13]. In healthcare, sensors and data links offer possibilities to monitor the behavior and symptoms of a patient in real time and at a relatively low cost, enabling physicians to diagnose disease, sometimes better and faster and, if necessary, prescribe treatment regimens to more accurately [14].

The benefits of e-Health are according to the types of technology used for the care and technological devices or systems that can help the Elderly, caregivers or when kinship care through [15]:

- Delay or prevent deterioration of health status and limitations in daily activities.
- Helping older people to perform daily activities that otherwise could only be done with personal assistance.
- Allow family members, caregivers, to monitor activities and health status of a relative distance and, where appropriate, communicate with the patient.
- Provide patient information to people with access to health services based on Web.
- Provide family members in charge of the patient, information and advice to enable them to communicate with staff giving professional care and other family members caring.

Furthermore can be highlighted the increased use of mobile devices or smart phones with Internet access at relatively low costs, set the tone for the development of new applications for monitoring of patients with diseases. The concept of e-Health has been called m-Health (mobile health) when used for this purpose mobile devices [16].

3 Empirical Approach

Currently there are some studies that have tried to determine relations between psychological and physiological signals, in which to establish elements like temperature and heart rate to identify a mood or emotional. Gu [17] cites the case of Nasoz using conductivity, temperature and heart rate to achieve a recognition rate of 83.7 % for 6 emotions (anger, sadness, surprise, fear, fun and frustration) using the algorithm of Marquardt Back Propagation (MBP).

Given this, a system that could detect the state of depression and then execute actions to start treatment early, not integrated to reduce the severity of depression in older adults was proposed. All this under the model of the IoT, taking information from the CA and the proposed e-Health.

3.1 Detecting the Depressed State

Initially proposed to develop a prototype that would allow the state to identify depression by recognizing the context and you gesture recognition. The data collected to identify the CA would be built by obtaining the lighting data, the color of the environment, temperature and humidity. Moreover, the gesture recognition gesture would help identify the Elderly equipping gesture recognition elements that would allow detecting emotions [17] or if gestures. It was determined that a gesture is a sequence of postures linked by movements in a short span of time. Usually a sign consisting of one or more positions that occur sequentially in the time axis [18] and in the end, the collection of gestures would become a series of commands that should be learned by the system [19].

Given this, and according to the parameters used to detect the state of depression, states that the main parameter for identification of a state of depression is lack of physical activity, supported by the postural recognition is often a major goal of the recognition system activity for elder care [20]. As seek to register a "track" you to represent the ADL of the elderly, in addition to data from body temperature and heartbeat.

By identifying this "track" movement, governed by the ADL, a data model of space and time, pulse and temperature will reference. This model is constantly checking through gesture recognition and data, so that when an event is recorded (Event is defined as the abnormal situation in the "track" such as prolonged stay in one place, deviations, changes in body temperature and heart rate) is recorded and notice of the treating doctor for a message (either a SMS) and their dependents (see Fig. 1).

3.2 Prototype Design

The use of physical computing, understood as an approach to learning about how humans communicate through computers, considering how humans physically expressed as a requirement arises. In this case, the human body as a gift is made, and try to design computer applications within the limits of its expression [21], which highlights the software and hardware free or Creative Commons, specifically used Arduino©.

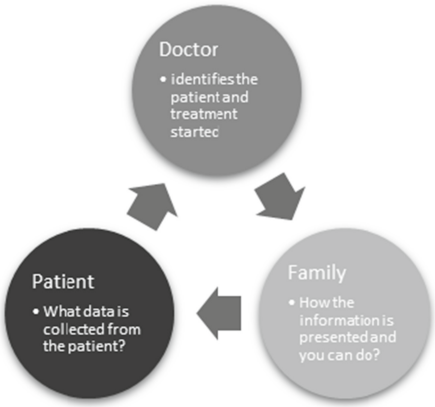

Fig. 1. Data collection and management to provide the necessary information to their respective users and their associated actions run.

It just got launched prototyping looking for information the doctor needs to detect a state of depression using data collected from the patient and the context, which sought to have a positive detection is the detection, treatment and early start where appropriate notify family of the patient (see Fig. 2). This arises through raise three modules: data collection module 1 as the ambient temperature sensor is (DS18B20), lighting (YwRobot 553 518), color sensor (TCS230) and humidity (DHT11) connected by a Arduino Pro Mini©. Module Two will connect a PIR motion sensor, two servos and a camera OV7670 SG90 FIFO controller using an Arduino Mega 2560©. Module 3 aims to collect user data (elderly) through a LilyPad© connecting a three-axis accelerometer (MMA7361), a temperature sensor (DS18B20), blood pressure sensor (pulse sensor©).

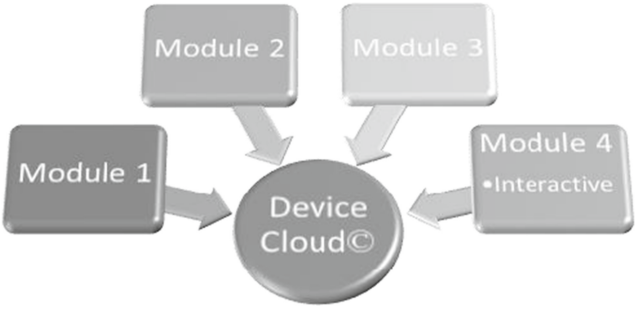

Fig. 2. Initial model of the prototype. 3 modules, the gesture recognition module 1, 2 for the context and for the patient 3

Each of these three modules would be communicating information through a network of point to point using Xbee® S2 module that will send the information to a receiver or main computer connected to the Internet and would be processed in Device

Cloud to implement the initial actions or if send the proper information. In Fig. 2 the model of management information obtained arises.

It is intended that the module camera do the gesture recognition pattern of behavior, establishing a "track" in space at a given time, together with blood pressure and body temperature. When a drastic change from the usual path is present, prolonged time spent on a point or changes in heartbeat rhythm or temperature are factors which determine the change in the state of depression and warning of a message by SMS the treating physician and the family, in addition to that the former can remotely monitor.

The data to be retrieved are the coordinates x, y, temperature and heartbeat. It should be noted that the reading of data in real time generates too many that could overwhelm the system, plus it seeks only to identify abnormalities, as mentioned above (Fig. 3).

3.3 Changin the Hardware

Tests with Arduino©, in any of its versions, was not suitable for image processing, so the Raspberry Pi was chosen as the main processor element for images, in addition to the OpenCV© gesture recognition technology for a Linux environment. However, we

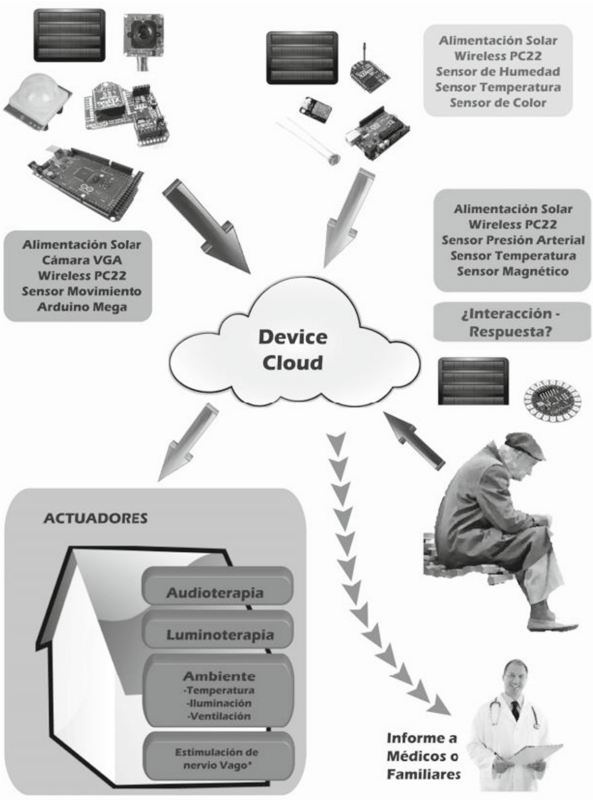

Fig. 3. Model for the prototype system detection and early treatment of depression

chose the Lilypad© and Xbee® to retrieve information from the Elderly body (see Fig. 3) and to place motion sensors controlled by Arduino© nano in places where it is necessary to maintain the privacy of the Elderly.

For operation of the Raspberry and gestural recognition is tested three distributions of Linux (Piadora, Raspbian and ArchLinux™) general purpose, selecting ArchLinux ARM because of its ability and ease of graphical interface, in addition to removing or installing applications not are required. The OpenELEC XBMC and distributions were not considered since they are aimed at media playback.

In addition to the Raspberry Pi B© card (Fig. 4), other peripheral devices were used as a wireless keyboard with touch panel for configuring the device, USB Web Camera HD, though the maximum resolution for video collection was not used. A powered USB Hub to power the Raspberry Pi© and USB peripherals.

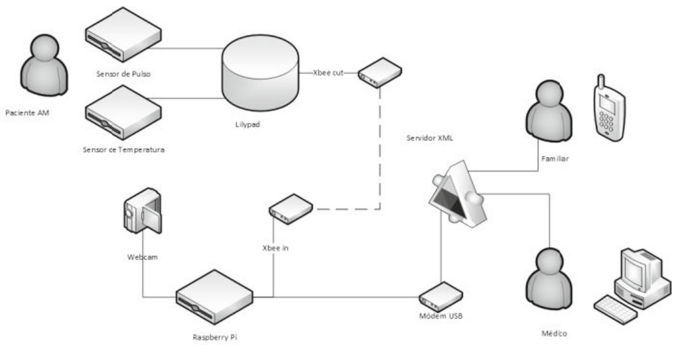

Fig. 4. Current version detection system of a state of depression in elderly

OpenCV© library for use as the principal object detection technique specifically "Haar-Cascade" for identifying the same (Fig. 5), this technique allows the detection of many forms that are in the database as circles or squares, to more complex objects such as faces, smiles or human figures. The technique tends to give some "false positives", but instead, consumes less computing resources, something very necessary for this project. The selected programming language is C/C + + , due to its speed of execution and compilation with "gcc" additional libraries and application development.

4 Work to Do

The next step is where laboratory work is to perform a "track" model, collecting data x and y, and movement in a predetermined base built in the "track" model time. The second step will be the design of the algorithm used to identify the events that can trigger the alert to the treating physician and the family caregiver.

For algorithm design methodology of decision theory is used, particularly the deterministic and probabilistic chaos that arises generate a model from the call been ideal or perfect scenario, which in this case will be "track" Dream given variables by X, and space, the T (time), the temperature T and P the heartbeat [22].

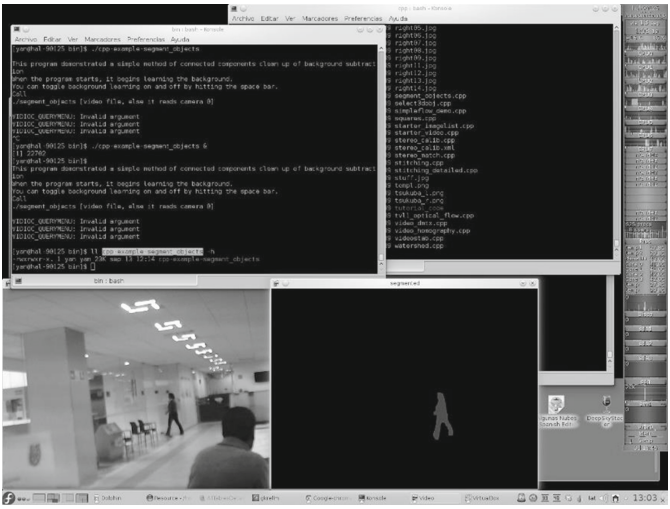

Fig. 5. Testing recognition of movement patterns using high resolution camera with OpenCV© and Raspberry Pi© modelo B

Once established and proven model apply to AM patients who have been diagnosed with some type of disorder and depression that can determine their "track" in the ADL and, where appropriate, identify depression Events.

5 Conclusions

At the moment it can be concluded that the proposal is viable. The technology available is sufficient to carry out the project with low cost and use of limited resources. It remains to laboratory testing and application to patients, however if collaborative and interdisciplinary work give positive expectations to reach a successful conclusion.

The applicability for other purposes, i.e., if it works as expected, the spectrum of applications may increase as in the case of detection of falls in older adults, monitoring Alzheimer looms and even increase variety of people with diseases that require identifying a pattern of behavior.

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