A wearable IoT device for users with mild cognitive impairment needs

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1) Introduction:

This document summarizes the research developed during six months by the Spanish student Ian Bastian Martínez Garcia who studies at the Polytechnic University of Valencia.

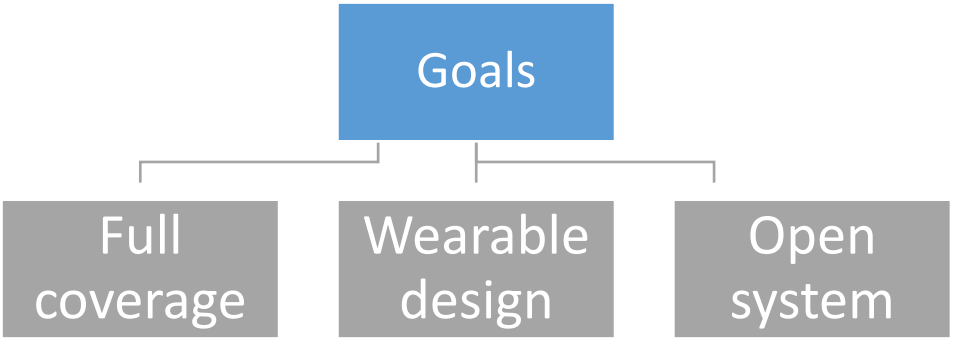
The process that will be described following started from the need of overcoming some of the limitations that Adamo System, the current **tele-assistance service** offered by the Company Caretek S.R.L.

Adamo is aimed to assistance elderly or disabled people. It consist of a plastic watch and a base station that is located at the user's home. This watch is in charge of collecting several physic parameters that inform about the user's general health. The base station implements the tele-medicine while managing the data that is registered by means of the watch, thus being automatically connected to a specialized centre in case of emergency or accident by means of an alarm system.

Studying the solution of some of the limitations presented originally for Adamo System has make it possible to configure **tele-assistance service** that is a closed system since not only the base station but also the watch and the specialized service are communicated exclusively among them avoiding the presence or the requirements of any new items. The covering is limited due to the existence of a base station located in the home which becomes unable to cover big distances between the base station itself and the watch.

With the purpose of overcoming these limitations, this project proposes the experimental development of a **prototype** which is able to cover the basic tele-attendance needs thus by being focused of the accomplishment of the following objectives:

1) Total **covering**: It implies getting available service not only inside the user's home but outside of it. (**Indoor / outdoor**).
2) **Wearable Device** with a reduced size. This trait facilitates the insertion of the device in patients' daily life. (Elimination of the base stations).
3) **Open system** that is able to be connected with different elements such **IoT** (internet of things) as well as with other devices, sensors, and data platforms, thus allowing it to store the collected parameters.



After the accomplishment of the first stage of this project, which was the setting the project goals, the following step consisted on the selection of the functionalities of the prototype to be implemented which would define the type of **tele-assistance service** that will be offered.
To be able to attend a fragile person it is essential to know his location. This consideration demands as a necessary functionality the **localization of the device**. Different entities such as the National Institute on Aging have stated the great importance of the control of the corporal temperature in elderly patients. For this reason, it was decided to count with a system which is able to **calculate the temperature of the device**. Besides, it is important to highlight that regarding elderly people, the World Health Organization selects the falls as one of the main causes of mortality and serious accidents at the present time. Related to this statement and with the aim of attending the most basic needs of this sector of our society it was decided to develop a prototype able to **detect users' falls**.
The three mentioned functionalities define the elements and functions to be implemented in the device.

2) **Device development:**

Figure 1: Location & temp system

The process of development of the device was carried out in a differentiate way, that is to say by implementing successively the different modules thus working on Arduino platform as it was considered the most suitable platform.
Therefore, the first subsystem was the one in charge of offering the **location of the device** and therefore the location of the patient who wears it. For this purpose, it was used the module SIM FONA808. Among SIM FONA808 functionalities they are highlighted the sending and reception of SMS, and the localization of the module by means of the mobile net by using **GPRS technology**.
The **monitoring of the temperature** was carried out by a **temperature sensor** which is part of a barometer: the BMP180. This sensor displays the temperature of the device within a range of values from 0 to 65 centigrade grades.
The algorithm for the **detection of the falls** was performed with the help of an **accelerometer**, the ADXL346 model, which is able to detect events such as the free fall and non-mobility in anyone of the three coordinated axes by means of the calculation of accelerations.
Each one of the components used had their own particular library of functions being this fact the reason that explains that the implementation process was based on the correct use of the functions of interest.
Once implemented the different subsystems, they were programmed for each one of them several useful different applications for the tele- assistance of possible patients.

3) Applications

a) **Geo-Fencing.** It was designed a system of Geo-Fencing by using the localization subsystem and taking advantage of the possibility to send short messages of text by the component FONA808: A previously defined geographical area, generally an area in which the patient is safe and sure, it is programmed an **alarm system via SMS** that will come activated in the moment that the user leaves the *sure area*. The text message contains the character of the alarm and a **link to Google Maps application** that indicates on a map the person's location while is sent to a previously configured telephone number.

b) **Temperature Alarm:** Using the localization module together with the temperature one it was defined an algorithm which monitors the temperature on real time. In the event of overcoming a previously defined threshold value the coordinates of the device are calculate and it is sent an **SMS** to the previously configured telephone number with the **link to Google Maps** while it is indicated that it is a temperature alarm.

c) **Fall Detection:** It was configured a system which is able to detect the falls and to distinguish between two different cases. In the first case, it is identified a possible fall followed by a period of mobility of the accelerometer. The system interprets that it does not constitute an alarm since the user is able to move and this way it does not generate any alarm. However, if a period of immobility of approximately 7 seconds is detected after the fall, it is generated an alarm that notifies a possible emergency.

d) **Database:** Finally, with the objective of evaluating the possible addition of new services regarding the device's evolutions, it was performed the **connection with an online database** platform by means of the protocol HTTP, it was possible to establish communication between the prototype and the platform, sending data regarding the location of the device. Related to it, it is important to consider that to store the data obtained in a database may suppose a significant improvement for future designs regarding the service they may offer.

4) Conclusion

Considering the objectives that are described along the first part of this document, it can be stated that the development of the project is considered greatly satisfactory since it is observed that the initial limitations detected are implemented by means of the prototype designed by this project. It has been accomplished a **tele-assistance service** that provides user's covering so much inside his home as much as outside it by means of using GPRS technology. The current dimensions of the prototype are approximately the same as the ones of a tobacco individual box so this characteristic makes it easy to insert the device in the users' daily life in a more simple way when comparing it with the base station. Finally, I would like to highlight that by means of the connection with a data platform it has been able to verify as the system implemented by this project allows the addition of new elements and components of **IoT** environment.

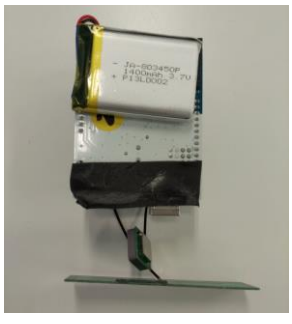


Figure 2: Back view

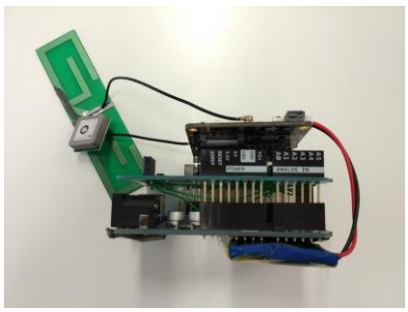


Figure 3: Lateral view