VITESSE - more intelligence with emerging technologies for health systems

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Abstract—VITESSE is a low cost system to support users in two scenarios: home care and accidents (fainting, trampling, etc.). Initially, the system was based on the digital TV technology in scenarios of home care. Nowadays, the system adds new functions to support urgent and emergency care of individuals in mobility. In both cases, the key idea of VITESSE is to improve the time of consuming process, taking into account the real time and contextual information, in particular in the case of accidents of mobile users. Therefore, VITESSE is a context-aware system that makes use of the concept of Internet of Things (IoT) and ontologies in the process of generating inferences, increasing the efficiency of health care systems.

I. INTRODUCTION

The Brazilian population is aging and the expectation of life among them is increasing since the 1960. Grows the number of elderly with health issues in home care situation that doesn't have a full time caregiver. On the other hand, individuals in mobility (on urban traffic, national or international travels - can pass through adversity situation like trampling, fainting, falls etc). In this case, usually response is a certain inertia both by voluntary people close to the individual as a part of the first responders.

This work presents the VITESSE, an intelligent system capable of providing greater speed and efficiency in urgency/emergency situation, both to elderly patient in home care and to people in mobility victim of accidents. The system was initially based on Brazilian Digital TV and home care only. It evolves in direction of urgency and emergency care to individuals in mobility situation. In both cases the VITESSE central idea is to provide speed to a lengthy process, in general, by the lack of availability of important information in real time, in special, in users mobility cases. The VITESSE, therefore, consists of five components: hardware (V-HARD), mobile application (V-APP), inference engine based on ontology (V-ONTO) and a specialized social network (V-NET)

The technological advance allowed the emergence of Internet of Things (IoT). It was considered a revolution in Information Technology and Communication (ITC) field [1]. The IoT provided the possibility of connect sensors, actuators and others devices to the Internet, extending the Internet that we known with the wireless connection of several smart devices. Faced with an increasing number of connected devices, arises a demand to explore and understand a heterogeneous large amount of data. Therefore, it was necessary both: connected objects on the edge of Internet and a system capable of communicate with them.

One of the ways to deal with this heterogeneous it's to use semantic models that can provide meaning about represented data. Based on well know technologies like OWL and RDF, the OpenIoT it's an open platform to integrate "things" in the cloud [2], [3]. Also provides access to devices connected to the platform, allowing the semantic access to real or virtual sensors.

This work is presented as follows: Related works to this proposal are described in section II. The VITESSE version to the home care situation, the version dedicated to users in mobility and aspects of implementation of prototype are described in sections III-A, III-B and V respectively. Finally, a conclusion and future works are presented on section VI.

II. RELATED WORKS

Several e-health solutions to monitor constantly the patient have emerge in the market with the goal to help in decision making in urgency/emergency situations. The Doro Secure 580 [4] is one of them. It uses a mobile phone made specially to monitor elderly people.

Another solution is the TeleHelp [4]. An emergency service that use a call center, devices with speaker-phone and a watch with panic button. In this solution, the user "calls" to the call center that take a number of actions, such as sending an ambulance.

The solution "Alert Motorola" [5] sends a SMS to registered contacts with the geolocation of the victim. With the emergency mode enable, send warnings to pre-selected contacts with periodically updates about the user location.

III. VITESSE SOLUTION

The VITESSE therefore, can work with 8-bits microprocessor, accelerometer and Bluetooth communication, manufactured with a simple baseboard with low-cost for the V-HARD module. The module V-APP is a mobile application to Android system that was developed to serve as a bridge between the V-HARD module and the services provided by the module V-NET. The ontologies on the V-ONTO module use the data acquired by the sensors. Finally the web application V-NET connects all modules together.
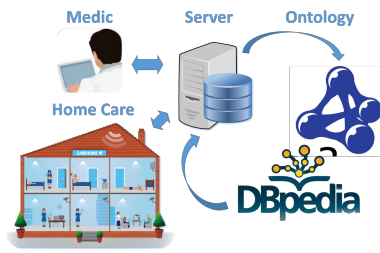
Fig. 1. Schematic vision: VITESSE-ID.

A. User Scenario - Home Care

The VITESSE was initially focused on home care environment (VITESSE-ID). The home care is performed by a caregiver (a professional or lay) or by a multidisciplinary team that assist to elderly people or patients with chronic medical conditions or not - but stables.

The figure 1 shows a schematic vision about VITESSE-ID, associated to Set-Top Box and a Digital TV with elements of communication and interactivity respectively between the user and the intelligent system based on ontologies [6]. The mobile technology from smart phones has an important role in the design of VITESSE that works with digital TV as a primary user interface [7], [8].

The caregiver and the patient are the main user of VITESSE-ID. The main idea of VITESSE-ID is to monitor the environment, collect data in different ways and finally cross this data with other existent using intelligent mechanisms. The Digital TV is the user interface to the user (caregiver or patient) and a inference system based on ontologies [9].

To achieve the desired efficiency in this project, data acquisition sensors are used, medical equipments, medicines, material and human resources according to the elderly condition. A simple procedure is the alert notification to caregiver. For instance, the VITESSE can suggest to caregiver, through TV or *smartphone* get in touch with the patient nurse or physician and depending on the case, send a message directly to this cited actors [10].

B. User Scenario - Mobility

Consider a scenario where a citizen has an accident (fainting, trampling e.g.) and face a situation of inertia by people close to the injured citizen. The elements that contribute to this inertia are the most varied forms. For instance, difficult identification of injured through personal documents or *smartphone* by volunteer/rescuer on emergency/urgency situation. The paramedic ignorance about injured particularities contained in electronic medical record is another difficulty for a quick support.

The result is, in general, a long wait in decision making to help the injured, which may cause his life. Therefore, the main issue that generated the VITESSE is: which actions could be used to give more agility on the emergency/urgency situation. These actions involve since send alerts and informations to the injured relatives, the support to an eventual volunteer who whats to help the victim or to facilitate the work of paramedics team.

IV. VITESSE MODULES

In this section we describe the modules that compound the VITESSE.

A. V-APP: An application activated by bracelet

If the victim don't feel well or suffer an accident the bracelet will send a signal to user's *smartphone* through Bluetooth, activating the application installed. This application will run several procedures, such as: call to a group of pre-registered volunteers or relatives, send the victim's geolocation to those mobile phones, turn available contextual information about the victim - this way the work of rescuers can be facilitated -, suggest actions to a volunteer etc.

B. V-ONTO: An intelligent system based on ontologies and context

The VITESSE is a context-aware system [9]. This way, various informations at real time are dynamically collected to feed a model of knowledge based on ontologies capable to infer decision making that turn VITESSE more efficient. Per example, the call to pre-registered telephones, describe in scenario III-B, should taking in account various factors: (1) the proximity of involved in the process, the availability level (previous declared) of involved, the complexity of the victim accidents etc. Another example: the system could suggest to the rescuer the best route to the hospital, urban traffic situation, availability and specialization of close hospitals etc. Finally, this system of inferences is important to the V-NET module describe next.

C. V-NET: The integrated social network

The main idea of V-NET consists in join people with common interests, to participate in the quick service in urgency/emergency situations. This way, in case of accident with one of social network user, further users that were closed to the victim of the accident (fainting, trampling etc) would be contacted intelligently (with V-ONTO help) taking in account the availability and skills. The V-NET module would have, initially, 3 types of roles , the normal users, volunteers and professionals, describe next:

- Volunteers users: health professionals that desire to participate of V-NET in a altruistic way;
- Paid users: health professionals that are paid: physician, nurses, dentists, paramedics etc that would be paid if their services were solicited. This option must be activated by the normal users; and
- Normal users: All users including the other two categories.

The inference process presented in subsection IV-B and the geolocation facilitate the location of above collaborators while the context would help with information about availability and profile of this users registered in V-NET.
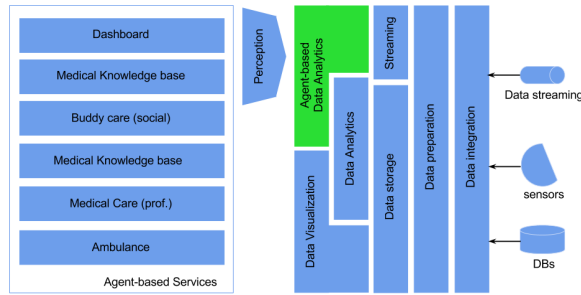
Fig. 2. Agent-oriented architecture VITESSE.

In short, the VITESSE system is compound by a device, like a bracelet or similar mechanism (V-HARD), one mobile application (V-APP), the V-NET that communicates with both: V-APP and V-ONTO - a system to infer. Consequently, the VITESSE actions could be classified as:

- Reactive: if a user is not feeling very well, himself can activate the communication protocol through the bracelet (V-HARD module), involving the other VITESSE modules; and
- Proactive: as well as an embedded system capable of identify a falling false positive the V-HARD module contains other sensors capable of send important information about the user to the system. This information will help the V-ONTO module to infer about possible treats to the user and issue warnings.

V. Aspects of Implementation

Figure 2 shows VITESSE's architecture. This architecture is a agent-oriented model in which three blocks are highlighted: Agent-based services (Dashboard, Medical Care, etc.), acquisition/storage data and Midlleware (integration, preparation and analysis of data).

The VITESSE application, which is triggered by the bracelet (pressing button or identifying fall), was developed in Java on Android platform. The application has a simple interface, where the actions REACTIVE/PROACTIVE mentioned in section IV are registered in the traditional Android menu. The menu has the features of:

- Device Registration: This feature aims to integrate external devices with the VITESSE, facilitating proactive communication that can be triggered when the user deems necessary.
- Contact Registration: This functionality helps to put all users in a list to facilitate sending the distress call.
- Turn on background execution: It leaves the application running in the background and, in the case of a user to fall down, the application notifies the contacts.
- Call for help: Make a call to all contacts will help the victim.

VI. Conclusion

The proposed application is in accordance with the practiced policy by the Ministry of Health, focusing the Primary Attention (preferential treatment to the patient in its home), such as the Family Health Program, Health Workers etc. The fact is that VITESSE is a low cost solution, highlighting potential of VITESSE as a commercial product and eventually as a solution to be adopted as public policy by municipalities, states and country. Some existing systems on the market partially propose what is intended with the our proposition. Most of them are not accessible to the population due to the high cost and they have not features proposed by VITESSE and/or they are not smart. Furthermore, LARA intends to advance research project to make increasingly intelligent using ontologies, as well as applying the context IoT (Internet of Things), more specifically with OpenIoT platform. A first VITESSE prototype was completed in LARA (Lab Computer Networks and Multimedia Systems Aracati - CE), involving the V-HARD, V-APP. The components V-REDE and V-ONTO are being development.

VITESSE is the subject of three dissertations, several scientific research (PIBITI) in IFCE Campus Aracati and it is a collaboration with the University of Evry (France). Finally, this work is part of a range of efforts that are being discussed currently in the TELE MEDIA labs in the context of the creation of iGinga, an institute that aims to intensify the Ginga middleware technology and its derived artifacts.

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