Enhancing the Safety Feeling of Mobility Impaired Travellers Through Infomobility Services

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Abstract. This paper describes the health emergency module (HEM) of ASK-IT, a European project, co-funded by the EC 6th Framework Program, within the e-Inclusion area. It identifies the functionalities and specifications of the HEM, as well as its scenarios of application, its requirements derived from the technical and legal analysis and how it interacts with other ASK-IT modules and the whole platform. Special emphasis is given to the User Interface designed, according to the specific user groups' functional characteristics.

Keywords: Safety, Emergency Management, Mobility Impaired People.

1 Introduction

There are many citizens that often require some kind of monitoring of several biological signals, which are essential for the healthcare professionals, in order to diagnose their conditions. Disruption of such bio-signals, for instance an unexpected increase of the patient's heart rate, can be interpreted as a sign of emergency. It is obvious that in these cases an emergency system, with the capability to monitor and evaluate these signals and to trigger a medical intervention, is needed. Moreover, it would be convenient to these patients to have the possibility to communicate at any time with their doctor or physician via phone, videoconference or any other mean, so they can report their symptoms, and the doctors can complete the diagnosis through the images and videos of the patient.

Emergency applications can provide a service, that enables the patient to inform an emergency medical staff in case of an emergency situation, such as a cardiac incident or an accident, in a convenient way [1]. For example, the patient is provided with a portable, wearable device, that can be used, to notify the medical staff that there is an emergency, even in case the patient is unable to use a regular or mobile phone. The

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patients' medical data are stored in a database and the emergency response is decided according to the patients' personalized needs.

Another service provided by emergency applications is the remote consultation for the patient or a nurse, that lacks expertise in advanced medical treatment, in case of an emergency, in which the patient is unable to go to a clinic because of his/her remote location or the severity of his/her condition. ICT could enable the doctor to evaluate the situation and advise the patient or the nurse on his/her treatment.

Systems that monitor patients' vital signs often have the capacity to trigger an emergency event, in case some of the signals are out of the normality [2]. Nevertheless, these applications usually lack either communication resources (to forward measured data or detected alarms) or interoperability capabilities (to take advantage of the existing infrastructure, wherever the user is), which would allow better assistance to the user at any place and in any moment.

The aim of this paper is to present the health emergency module (HEM) of the ASK-IT project [3], which aims to support and promote the mobility of Mobility Impaired (MI) people, by developing an Ambient Intelligence space for the integration of functions and services across various environments. The HEM will enhance the safety feeling of the MI user, both at home and when travelling.

2 Methods

In order to have a uniform and consistent visual language, in which to express the functional specifications, the modelling approach selected for the HEM has been the use of the functional specification language Unified Modelling Language (UML) [4].

According to the user requirements, the main functionalities defined for this module are the following:

- Capture of user-triggered emergencies, coming from panic buttons, and delivery of the user alert to the third-party social or medical emergency support centre, through the ASK-IT infrastructure.
- Capture and storage of medical data, coming from wearable sensors, in order to analyse them and produce automatic alerts to be forwarded to a third-party emergency support centre, using the ASK-IT infrastructure.
- Provision of an interface for the user to request external help (human or information) for a specific task (i.e. the user is trapped in an inaccessible place, cannot open a door, is lost in a city…). The user analyses the specific problem and establishes communication with ASK-IT support centre or a relevant contact point.
- Integration with local domotics services, to exchange alarms and analyse them, combined with the user health situation and location data, to improve his/her security coverage. It is also foreseen that some personal alarms would make possible the activation of any domotic device, as an answer to the generated alert.

All these functionalities take into account an important feature regarding emergencies: the physical location of the user. Occasionally, it will be useful to know

where to send the required assistance and, sometimes, to know the context of the user and analyze whether it has sense or not throwing an alert to the user.

Besides, and in order to provide these emergency services, several requirements should be taken into account, related to the manipulation of private personal and medical data, in agreement to the ASK-IT architecture [5]. This sensitive information has some limitations when it is sent and spread, as it is treated as confidential data, needing privacy guarantee. Therefore, security must be ensured, so that nobody may gain access to it, except the authorised healthcare personnel.

Finally, accessibility requirements come from the whole ASK-IT architecture, so as to provide usable tools for MI people. Also, interoperability requirements have to be taken into account, to interface with other ASK-IT modules (localisation, domotics, etc.) or external services (emergency management centres).

3 Results

According to the previous described requirements and functions, the functionality of the module was represented by a set of use cases. High-level use cases (HLUC) define the overall functionality of the HEM, whereas low-level use cases (LLUC) are described in more detail, containing all calls between modules, as they appear in the software coding, and all parameters types that are described in the ASK-IT developed ontology [6] to guarantee global interoperability. The two main scenarios identified that have been implemented are: "the user asks for help" and "system automatically triggered medical emergency". Fig. 1 shows an example of the representation diagram for the "User asks for help" use case.

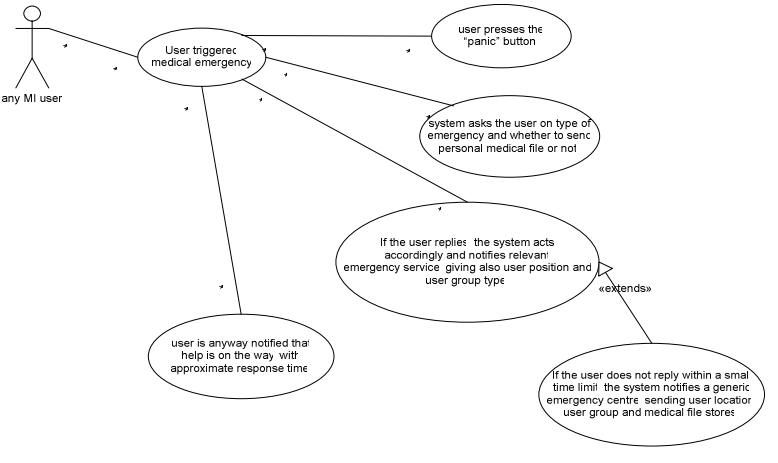

Fig. 1. "User asks for help" use case representation diagram

The HEMM architecture emanates directly from the functional specification analysis and aims at creating an information environment, that will enhance the safety

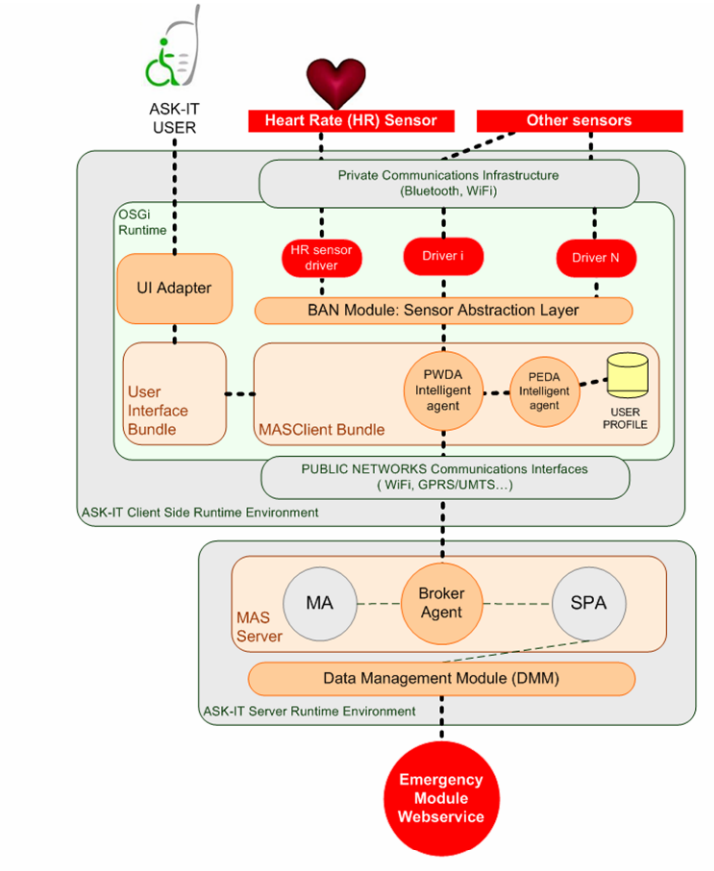

Fig. 2. The ASK-IT Health and Emergency Module chain

feeling of the MI user, while on the move. Fig. 2 depicts the HEM architecture in relation and its interactions with the ASK-IT platform elements.

Several ASK-IT components are involved in the health and emergency chain, mainly:

- ASK-IT user interface: shows a panic button for manual alarms; asks for additional user information; and presents feedback messages.
- Wearable sensors: dynamically acquire user's bio-signals (the first prototype will run with a heart-rate strap monitor from the MyHeart project [7]).
- Drivers/Body Area Network: integrates all peripherals and sensors with the user nomad device.
- PWDA intelligent agent: monitors user status and detects possible alarms.
- PEDA intelligent agent: retrieves the User Profile, to be sent to the emergency centre, if required.
- Broker intelligent agent: collects emergency calls and seeks the most appropriate service provider through the corresponding agent.

- Data Management Module (DMM): forwards the emergency request to the selected web service.
- Interface with Emergency Module (EM): receives emergency requests and assigns assistance resources to attend the user.

3.1 EM Interface

The EM module is an automatic call service, complementary to the ASK-IT architecture. It interacts with the ASK-IT framework, in order to obtain relevant information for the supporting staff in case of emergency (user positioning, medical data acquired by wearable sensors, etc.).

At present, there is a European initiative to integrate emergency service providers within the same intervention framework. This initiative is called eCall [8] and has defined an enhanced emergency call service (E112), which includes additional information (such as user location) for emergency providers.

The EM module interface has been defined, based on the eCall project; however it relies over TCP/IP data exchange (ontology, XML, web services), instead of voice/data phone calls. This way, it allows sending safely, over the communication infrastructure available (even domotic services), more significant information, like:

- Type of emergency: either manual or automatic, test or real call, etc.
- Alarm details: based on parameters as user location, confident position, alarm timestamp, etc.
- User profile: including user healthcare ID, reference healthcare centre, relevant personal data, etc.
- Medical profile: minimum/full clinical history, current bio-signals, etc.

The EM interface consists of a Web Service, which implements one main function *helpRequest* with several input parameters, in correspondence to the information listed above. The output of this function will detail the list of resources activated for attending the user, including information about the estimated arrival time.

3.2 Data Model

In case of an emergency, the ASK-IT framework collects and transmits to the emergency centre a minimum data set (MDS), containing the following information:

- when (timestamp),
- where (precise location and direction),
- who (user identification information),
- where to get more information (emergency centre data).

Additionally, if they are available, a full data set (FDS) can be sent, containing additional information related to the user's health condition and the medical bio-signals values, monitored by the sensors. The medical data is formatted according to the health-related standard HL7 [9] and contains helpful records, like:

- The medical record, detailing the different important illness suffered by the patient and which could condition the treatment.
- The surgical record, which specifies the most relevant interventions suffered for the patient, that could be of interest at the time of attending an emergency event.
- The patient's allergies. This field presents special interest by the time of administering any drug to the patient.
- The current treatments undergone by the patient, which could reveal compatibility problems with some drug administered by the emergency services staff.

In order to grant privacy for the users, a set of security requirements, that ensure confidentiality of these information have been defined and implemented:

- to store medical records in a secure way, we have to encrypt the information with a key that only the owner knows;
- to exchange medical data, we have to identify the other side of communication with an authentication service;
- to send the medical data, we have to encrypt them with a shared secret, known only by the user and the medical authorized staff or with a pair of public/private keys;
- to respect normative, all these requirements have to be implemented with standard and reliable algorithms.

Nowadays, there are many standard algorithms, in order to encrypt data and authenticate the user. The most accepted is by using X509 certificate, that contains:

- a private key, in order to store with symmetric encryption the users medical data;
- a pair of private/public key, in order to be authenticated as a user and in order to exchange sensible data over SSL connection, JADE-S platform or proprietary protocol with asymmetric encryption.
- for symmetric encryption AES with 128 bit key length and for asymmetric encryption RSA.

With AES, RSA and X509 the respect to all laws about privacy and confidentiality is guaranteed.

3.3 User Interface

This section shows the prototypes of the graphic user interfaces, developed for the HEM of the ASK-IT project. The graphical user interface for the end-users has taken into account existing guidelines, which are explained thoroughly in [10]. The approach followed usability and acceptability for mobile devices, with the purpose of providing the most efficient user interface for all future users.

Fig. 3 illustrates the "system automatically triggered medical emergency" use case, in which the ASK-IT system understands that the user is in an emergency (by wearable sensors or user not responding or other situation). It automatically triggers an alarm (the user receives warning for this and has a small time so as to abort it) to an emergency centre, sending user location, user group and medical file, stored in the

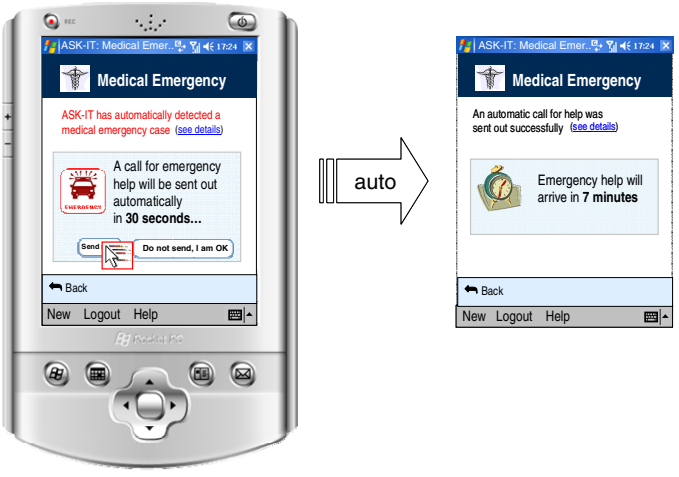

Fig. 3. The system automatically triggers an emergency

Fig. 4. The user requests help using his/her nomad device

device. The user is notified that help is on the way, with approximate response time. Optionally, it opens a voice communication line between user and centre.

The use case “User asks for help” is shown in Fig. 4.

The user is not feeling well or needs help and pushes a panic button. This should be easy to trigger but difficult to accidentally trigger. The system requests more data on type of emergency. If the user provides more data, the system contacts the most relevant emergency service and opens a communication line with it. If not, it sends notification to a generic emergency centre, sending also, if required, the user’s stored medical file. The user is notified about actions and estimated time until help arrives.

4 Conclusions

This paper has described the health and emergency module integrated within the ASK-IT framework.

A thorough analysis has been carried out, so as to identify the gaps of the matching of existing technologies with the user requirements, looking forward to provide a reliable safety feeling to the user, wherever s/he may be.

The main specifications and functionalities of the HEM system have been presented, in accordance to the generic ASK-IT use cases. These specifications were defined, keeping in mind current and future standard technologies for emergency support, even for autonomous resource assignments.

One of the main features of this module relies in the provided TCP/IP-based seamless connection with a health emergency coordination centre in case of an emergency, generated either automatically by the system (wearable sensors monitorisation) or by the user (panic button).

The system, in a prototype stage, will be validated through a series of pilots in different European cities. The pilot results will verify the viability of the system and will be the basis for future improvements and fine tunings.

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