A Mobile Health Device to Help People with Severe Allergies

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Abstract— **This paper presents, a Pervasive Mobile Health Device that can help patients with life-threatening allergies to manage their health in normal life and in emergency scenarios. With mobile context-aware smartphone technology, personal wireless networks and web-based interfaces, it is being designed to encourage the patient and their carers to learn about and safely manage their allergies and health. The design also includes an alarm that can be generated from sensed context so that if an anaphylactic reaction occurs, carers could be alerted or emergency services could be contacted.**

Keywords- Pervasive Computing, allergies, context-aware healthcare.

I. INTRODUCTION

The Royal College of Physicians [1] reports that Allergy is a major public health problem in developed countries and that this illness is increasing steadily, they also say that in the UK, allergic disease affects about one in three of the population.

In October 1993, a 17-year-old, Sarah Reading died after eating a lemon meringue pie served to her in the restaurant of a well-known department store. Sarah suffered anaphylactic shock - an extreme allergic reaction in which the blood pressure falls dramatically and the patient rapidly loses consciousness. The dessert contained peanut - to which Sarah was fatally allergic [2].

An anaphylactic shock occurs because the body's immune system reacts inappropriately in response to the presence of a substance (allergen. e.g. fish, shellfish, latex, bee stings, pollen, etc.) that it wrongly perceives as a threat. The treatment for a severe reaction includes the use of an immediate pre-loaded adrenaline (epipen) injection and an ambulance must be called, the symptoms of an allergy might include flushing of the skin, swelling of throat and mouth, difficulty in swallowing or speaking, alterations in heart rate, abdominal pain, nausea and vomiting, sudden feeling of weakness (drop in blood pressure) or collapse and unconsciousness, *ibid*.

A research team based on the Isle of Wight found in 2002 that around one in 70 children across the UK was allergic to peanuts, compared with one in 200 a decade before. The American Academy of Allergy, Asthma and Immunology (AAAAI) [3], highlights allergy as a very common disorder and more than 50 million Americans suffer from allergic diseases. In addition, they point out that allergies are the 6th leading cause of chronic disease in the United States, and that allergic rhinitis cost to the health care system in 1996 an estimated overall of $6 billion.

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II. RELATED WORK

Nowadays the increase and performance of wireless systems have motivated a large number of research projects in the personal medical device area. For example a health related device is the LifeGuard System [4], which has sensors situated close to the patient's skin. SensVest [5], another vital signs system, makes use of garments to hold their sensors. While handheld applications, more similar to this project, [6]-[8], use a PDA (Smartphone or Pocket PC) connected to vital sign sensors such as Electrocardiogram (ECG) or pulse oximeter (SpO_2) that sends wire or wirelessly signals to the mobile interface. The PDA then sends the received data to a PC, to the hospital or to the medical information office using a mobile network (WLAN, GPRS, etc) to produce a specific response.

After an analysis of the literature it is interesting to note that in the majority of cases, projects focus on the provision of information for the doctor and not for the patient, though there are applications where devices could be of great benefit with patient health management.

III. THE PROJECT, PRESENT AND FUTURE

The project is being implemented as a personal pervasive health device to help allergic people, not only to create an alarm if an anaphylactic reaction occurs, but also to encourage them to know, learn, manage and improve their own health, using mobile technology, wireless networks and web-base interfaces. After surviving a first anaphylactic reaction, people must quickly learn about their allergens and how to avoid them, understand issues of contamination and cross-contamination and learn about emergency procedures and how to ensure the people around them are trained in supporting them through emergency, for example, administering adrenaline.

A. *In normal life.*

We can imagine a scenario, Fig. 1 (Left), where the allergic person uses the Smartphone mobile interface device (created in Microsoft Visual Studio©) perhaps to check products or

ingredients using barcode picture detection for instance or to learn about their allergies by interacting with multimedia tutorials (audio, video, pictures and wireless internet) specifically relevant to their allergens. The device could help not only the patient, but also their carers to know how to help in the case of a severe reaction, improving their understanding about this and how and when to inject the adrenaline if it is necessary. The device will also be able to manage medical appointments or health activities and provide a personalised list of currently mislabelled foods and products containing allergens. This database could be synchronized with a desktop interface or a web server, encouraging the patient to maintain an updated medical history, storing important data such as details and symptoms of past allergic reactions, vaccines, etc. Furthermore the project is being visualised to have tools to help in the development of a crisis plan in case of emergency. It will also be possible to know about the user and their adrenaline status, via SMS messages coming from other Smartphones, for example on carer Smartphone.

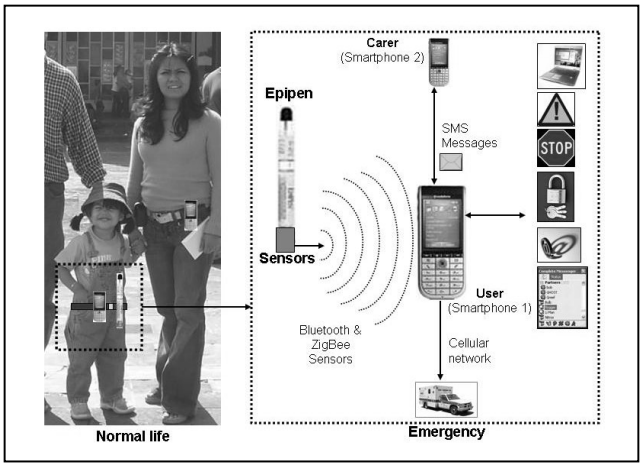

Figure 1. Two scenarios: Normal life (left), Emergency (Right).

B. *Emergency scenario.*

As shown in Fig. 1 (Right), one of the challenges for the project in this scenario is going to be that the mobile interface (Smartphone) must be able to respond reliably in the case of an anaphylactic event, and in that precise moment make an emergency call or send a message to the emergency services (hospital and ambulance). To accomplish this mission the system is being designed with an on body wireless sensor network and context awareness concepts to respond according to the events surrounding the patient, for instance, some sensors such as accelerometers are being used to catch the event when the injection be done, to know the condition of the user and the state of the adrenaline injector, other interesting parameters are, but not limited to body temperature and the user's heart beat.

C. *The interface*

The interface is being developed using Visual Studio 2005, taking advantage of icons, menu selection, some controls such as textbox, labels and specific API's of the .Net Compact Framework.

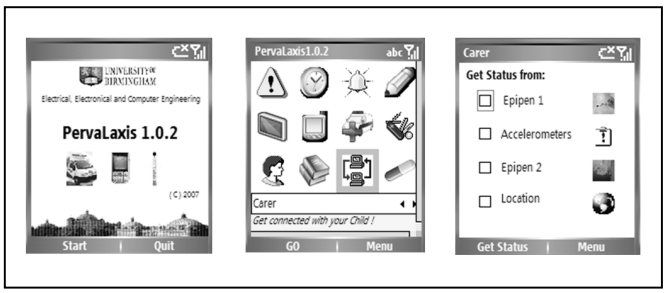

Figure 2. Smartphone interface created in Visual Studio 2005©.

1) *Applications*

The applications described in the two main scenarios have been designed and built into the interface, for example the creation of a list of allergens, a list of important contacts, the interaction between the career Smartphone and the anaphylactic user (Carer control), etc. Table I, shows a list of applications developed in the project.

TABLE I. THE APPLICATIONS

Icon	Application	Benefits for the User or Carer
	Allergens	Create a list of allergens and healthy food.
	Agenda	Create and manage a health history and medical appointments.
	Alarms	Configure alarms for normal life and for emergency scenarios.
	Adrenaline kit	Set up the wireless sensor network between the epipen and the smartphone device.
	Multimedia and E-learning	Let the user learn about his/her own health and allow the carers to know what to do in case of emergency, using videos and internet tutorials.
	Crisis Plan	Design a crisis plan to carry out in case of emergency.
	Contacts	Create a list of people that can receive data from the smartphone interface device automatically (Carer, Parents, Doctor).
	Carer control	Allow the carer to stay connected with the anaphylactic user through other smartphone or pocket PC.
	Prescriptions	Manage medical prescriptions on time.
	Dictionary	Know more about the allergic condition.
	Location	Know the allergic user's location.

2) The technology

The hardware and the software that has been used in the project involve the items mentioned in Table II.

TABLE II. THE TECHNOLOGY

	Hardware	Manufacturer
	Smartphone v1240, 200 MHz with Windows Mobile 5.0.	HTC-Vodafone
	iPAQ Pocket PC hw6500 with Windows Mobile 2003.	HP
	2.4 GHz Wireless 3-axis Tilt Sensor	SparkFun
	Epipen, Adrenaline kit	ALK Abello
	Software	**Manufacturer**
©	Visual studio 2005 (C# and Visual Basic)	Microsoft
©	SQL server 2005	Microsoft

D. Future work

The project aims to investigate three specific questions, whether a personal device could really help the patients and their carers to manage their health and take responsibility of their condition; to test the efficiency of an automatic alert system in the case of an emergency; and to evaluate the comfort and the usability of mobile devices in health applications. Moreover, the use of embedded technologies such as Windows CE and the .Net Microframework could be incorporated to the project to follow with the development of health applications for anaphylactic people and test their reliability in real life using both platforms.

IV. CONCLUSIONS

With the course of time the "Weiser Vision" [9] is becoming a reality, now in the streets, in the schools, in new buildings or even in the toilets, people use a large amount of ubiquitous technology unconsciously. However, in the medical area there is still much scope for taking advantage of new mobile and sensing technology to promote the welfare of people at low cost. There is a challenging panorama ahead for Personal Health Devices in allergy applications and particularly in attempts to support people with life-threatening allergies. To this end, this project is being developed to help patient healthcare by providing personalized support, helping minimize errors and stimulating the patients to manage their health by themselves in a context-aware environment.

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