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"AmI for health: chronic disease management".

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Abstract— **Several students of Bioengineering complain about the excess of theoretical classes and the difficulty to assimilate the subject taught.**

This work presents a strategy to mix theory and practice when teaching, thus motivating students to engage in their studies.

I. Introduction

Dealing with chronic diseases requires a longitudinal and team-based approach. So far patients have been always left a part from this "team": a shift towards a patient centred care is a promising first step towards the solution of difficulties that the European Health Systems are facing to handle chronic diseases which are, as reported by the World Health Organization, "the leading cause of mortality in the world". Out of the 35 million people died from chronic disease in 2005, half were under 70 and half were women [1].

Personal health systems (PHS) can play a major role as solutions to manage chronic diseases, prevention and to reduce costs in the medium-long period [2]. If PHS are conceived and delivered under the umbrella of the Ambient Intelligence (AmI) paradigm then the expected activities (vital sign measurements, medication intakes, observation of daily living tasks, etc.) that chronic patients are required to implement on a daily basis (according to the care plan and treatment agreed with medical doctors) will be carried out with a higher probability of success: the AmI vision consists in the creation of spaces and places where individuals interact with IT systems in a natural way, being technology invisible, immerged and integrated with normal objects. In this way is technology that adapts to users and their context and not vice-versa [3].

These kinds of services are progressively becoming a key element of the next generation healthcare systems, with an increasing active role of patients and families in self-care, health promotion and disease prevention. If one wants to succeed with this ambitious goals, these services must be provided through an environment in which individuals are surrounded in their everyday lives through intelligent and intuitive interfaces embedded in a wide diversity of media, in an environment capable of recognizing and answering to the user's presence in a friendly, non-intrusive way, with solutions for continuity and being frequently imperceptible. In such environment semantic 'plug-and-play' modules are integrated in "Family Healthcare Hub" according to the health-related needs of one family unit. Every particular configuration is arranged from the aggregation of individual care plans –supervisors, trainers, reminders, etc. – defined by the respective physicians and specialists, while being customisable to each user's **preferences** (personalized solutions are provided according to the patient profile and context) and **scenarios** (applications have been already developed for the management of chronic disease such as neurological, oncologic, cardiac, metabolic and psychiatric ones).

Two case studies are provided below.

II. Cases Study 1: METABO

The METABO project is an EU co-funded information and communication technologies (ICT) research project [4] aiming at designing, building and testing an IT platform to monitor glucose values and lifestyle/ pharmacological factors affecting blood glucose concentrations in patients with diabetes mellitus in real-life situations in order to provide structured information and therapeutic decision support to diabetic patients and their care givers.

<u>Real-world applications</u>

METABO provides different solutions to cover patient daily activities and routines in order to gather reliable data and provide real and adapted advice to the users. Each patient is an individual case differing from all others, responding differently to diabetes.

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Fig. 1. The METABO Ami Paradigm.

METABO is therefore not aimed at a physio-pathological classification of diabetes, but rather has defined a view of diabetes targeting each situation or problem confronting most patients daily. For this, six main context scenarios, that constitute the very foundations on which METABO is working to change the situation of diabetes in the world, have been defined:

1) Changes in the Environment: solutions are provided for conditions in which patients are exposed to changes in their usual environments or lifestyle, no matter what these changes are, that cause a disruption in their treatment routine, or a need to adjust the routine to the new conditions

2) Physical exercise: physical activity has a prominent effect on glucose metabolism and diabetes control: research and solutions are provided at both high-end physical training and at low-end lifestyle-related levels.

3) Sudden Hypoglycaemia prediction: one of the most important problems related to hypoglycemia is the fact that after living with the disease for some time, diabetics tend to lose awareness of the early, autonomic symptoms (reacting to glucose fall) of hypoglycaemia. This can lead to dangerous situations, especially in circumstances like driving, when reflects become vital for safety. The indirect study (and thus, invisible and unobtrusive) of aim to reach early detection of hypoglycaemia signs is an innovative approach to prevent hazardous conditions.

4) Lack of Motivation: in Diabetes Mellitus there is the need to deal with a very important psychosomatic complex that can lead to an instable metabolic state with serious health consequences. Its comprehension, as well as understanding ot the specific situations and behavior patterns that influence individual patients' self-management and compliance to therapy, is vital to provide the patients the adequate support and care.

5) Unstable Diabetes Control: METABO addresses the case of patients who cannot reach metabolic stability despite the best available treatment strategy has been put in place. METABO focuses in isolating the different factors that should be monitored in these cases, such as food intake, physical activity, lifestyle, insulin intake, glucose in blood.

6) Commorbidity disease management: patients (mostly elderly people) with concurrent presence of one or more major diseases (directly related or not to diabetes) represents a significant challenge for clinical medicine as one disease may affect progression and response to treatment of the other.

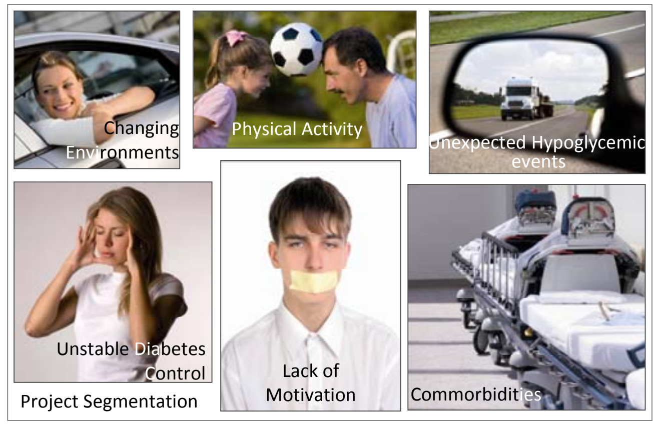

Figure 2 The METABO Scenario Contexts

It is worth to underline that the AmI paradigm is essential for delivering such kind of services because the same system, distributed and embedded in different environments, is automatically adapted and configured for each of the above contexts.

III. Case Study 2: PERFORM

Neurological disorders are diseases of the central and peripheral nervous system [5]. Parkinson's disease (PD) is a chronic, progressive neurological disorder of the central nervous system that affects motor skills and speech [6]. It is the second most common neurodegenerative disease, affecting more than 1 per 1 000 people in Europe. Although PD is most common in the over 60's, many people are diagnosed in their 40's and younger [5]. The primary biochemical abnormality in PD is a deficiency of dopamine due to degeneration of neurons in the *substantia nigra* pars compact [9]. The core symptoms are tremor, rigidity (stiffness), bradykinesia (slowness of movement) and postural instability (balance difficulties) [8].

Technology in general, and AmI technologies in particular, have the potential to become a reliable and affordable alternative for PD's patients' treatment and management. The development of platforms for remote health status monitoring, the qualitative and quantitative assessment and treatment personalization of these patients is expected to provide in the near future an overall improvement in the management of this disease, as well as a cut-off in the costs related to the treatment and hospitalization. In this sense PERFORM project partially funded by the European Commission, under the 7th Framework Program has developed a platform for remote health status monitoring of PD patients. In this sense, the PERFORM project [7], is based on the development of an intelligent closed loop system that seamlessly integrates a wide range of wearable micro-sensors, constantly monitoring several motor and signals of the patients.

Figure 3. PERFORM System prototype including accelerometers, gyroscope and data logger (left) System placement on the body (right)

Data acquired are pre-processed by advanced knowledge processing methods, integrated by fusion algorithms to allow health professionals to remotely monitor the overall status of the patients and adjust medication schedules and personalize treatment. In this way, the patient house becomes an AmI space, i.e. an intelligent hospital.

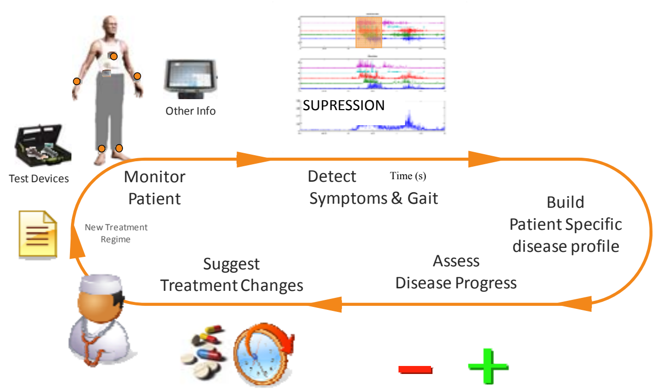

Figure 4 PERFORM medical and technological vision

PD patients are able to interact in a natural way with diverse tactile and voice interfaces inside their house, aiming at providing their GP with additional information about their medication and food intake. Besides, they can e establish visual contact with the health centre personnel by using a web cam.

The system has already been tested in hospitals in Navarra (Spain) and Ioannina (Greece). The integrated tests of the system will be performed in Modena (Italy) from March 2011. The results obtained so far indicate that it is a valid application, able to detect symptoms with a good accuracy level, with potential to improve the patients quality of life and the disease management process.

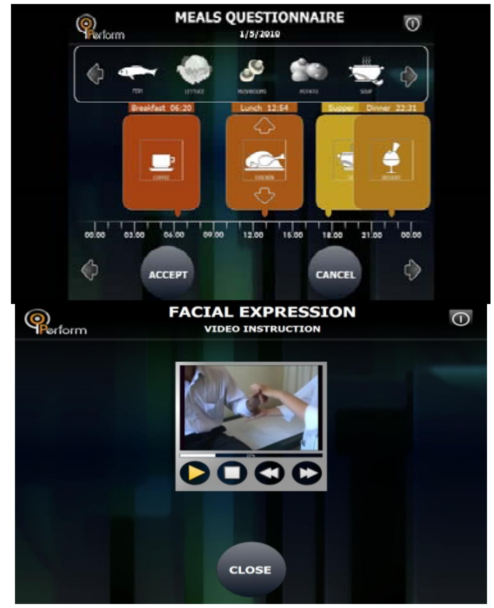

Figure 5 PERFORM Patient Interface. Food intake information (up). The patient performs tests that can be visualised by the health centre professional (down)

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