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DOREMI studies early signs of unhealthy dietary habits, sedentariness and cognitive decline

Welcome to the first newsletter from FP7 project DOREMI! Unhealthy dietary habits, sedentariness and cognitive decline are the three main causes of disease and premature death. In this project, we are studying early warning signs of malnutrition as well as physical and cognitive deterioration and are looking at possible solutions to improve older people's quality of life.

Monitoring lifestyle changes

A group of older participants taking part in a pilot study in Italy and in the UK will be introduced to food intake measurements, personalised metabolic control, exergames (video games that are also a form of physical exercise), social interaction stimulation and cognitive training programmes.

By recording and monitoring information about the use of the lifestyle-changing tools and programmes, it will be possible to track user performance over long periods, providing early warning of signs of malnutrition, physical and cognitive deterioration.

Designing products to prolong older people's functional and cognitive capacity

The collected data will be used by the project members to develop different products, which can prolong older people's functional and cognitive capacity by empowering, stimulating and subtly monitoring their daily activities.

We hope you will enjoy reading about the progress of our project.

Contents in this newsletter

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Game-based active ageing

Project partner Imaginary is designing and developing a game-based active ageing environment.

DOREMI is designing and developing a game-based active ageing environment, following all the data collected with the users, during the so-called 'participatory design' and starting from the clinical protocols. This gamified virtual environment will include cognitive games, exergames and a social section. Cognitive games are designed to help people to train and improve cognition. They involve guided repetitive practice on a set of tasks which have been designed to reflect particular cognitive functions such as memory, visuo-spatial skills, attention, language and executive functioning.

Furthermore, the gamified system includes motivational mechanism to perform physical exercises and social activities, both at home and outside. At present some cognitive games about 'short-term memory' were already developed and are being tested by the users. Results will be reported in the next newsletter.

In order to design and develop effective tools that will be easily adopted and accepted by the target users, DOREMI adopted a user-centered design approach with the aim to investigate their needs and expectations together with barriers to adoption. Different focus groups in Italy and UK were conducted and are planned in the near future. The aim of these activities is to analyse users' characteristics to make explicit for the design team the set of assumptions about the user population when creating the virtual environment and its interface.

Wireless sensor network environment

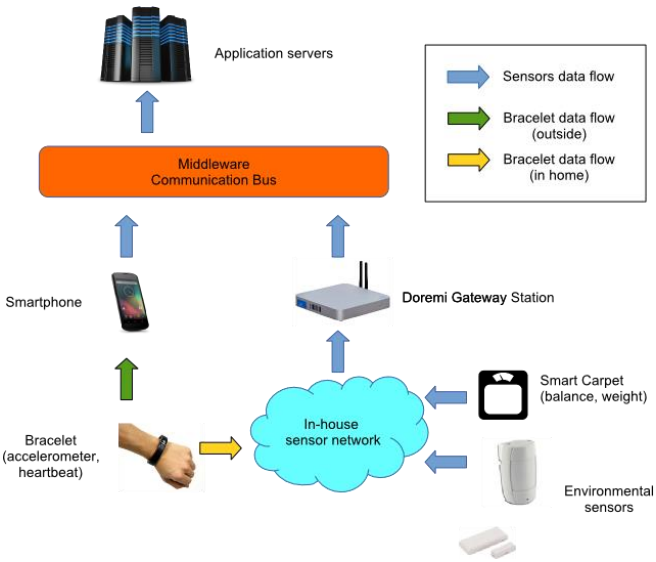
The main mission of work package 3 is to gather reliable, configurable and adaptive information from the users and their environment by measuring health parameters and home activity. The system to do this, the DOREMI wireless sensor network (WSN), consists on a set of custom devices specifically tailored to fit with the DOREMI lifestyle protocol requirements and a set of commercially available devices to complete the data with home environment information.

KPI type	KPI	Sensor	Device
Clinical	Weight	Weight scale	Weight scale
	Impedimetric analysis	Body impedance assess	BIA device
	Physical activity	Balance board	Balance board
		Accelerometer	DOREMI custom wristband
		Indoor location	
	Cardiovascular assessment	Heart rate sensor	
Social	Estimation of social interaction	Presence sensor	PIR sensor
		Open/close sensor	Door reed sensor
		Pressure sensor	Mat pressure sensor
		Microphone	Conventional microphone

Key performance indicators (KPIs) identified in the active ageing lifestyle protocol

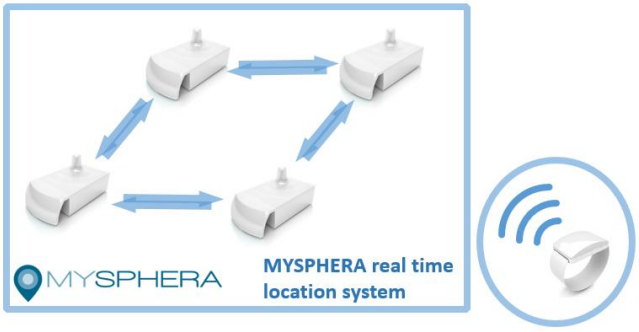
One of the project's first deliverables, the active ageing lifestyle protocol, was a starting point for the final definition of all the data sets required for the WSN. The set of devices present in the WSN have been defined from the relevant key performance indicators (KPIs) identified in the active ageing lifestyle protocol.

Since the DOREMI protocol requires the continuous acquisition of information from the user, the WSN have to deal with two different scenarios: indoor (when the user is at home) and outdoor (when user leaves home and only carries the wearable wristband). The DOREMI WSN architecture has been designed in conformance to the previously described requirements.



Network and custom devices

The DOREMI WSN for the indoor scenario has been developed starting from the existing and commercially available Real Time Location System (RTLS) of MYSPHERA. The system has been fully migrated to Bluetooth Low Energy (BLE) for its promising market perspectives in the near future.



The DOREMI custom wristband is based on the commercial wristband of MYSPHERA RTLS. This wearable will perform the operations for the RTLS and also will integrate an accelerometer for physical activity assessment and a heart rate measurement system.

A preliminary version of DOREMI custom wristband will be ready by April of 2015, when it will be tested by real users in Living Labs. After this first trial, the final version will be released in October of 2015.

Balance board

The first tests on this development have been performed with Wii Balance Board, a commercially available device with a reasonable price (about 55€) and good features for the project objectives, this board works with Bluetooth classic.

Environmental sensors

As part of the analysis of the DOREMI Lifestyle protocol, some commercial devices have been selected. The choice has been based on compliance with the DOREMI WSN and protocol requirements, affordability, and market availability. The devices to be installed will be based on Z-Wave wireless technology, which completely fits with the requisites.

Middleware and auto-configuration tool

All the information gathered must be adapted and processed in order to provide useful data to the rest of the high-level DOREMI modules (activity recognition, social and cognitive games). This is done by the middleware layer, which provides software-level integration among the different wireless technologies and an abstract data access layer for sensor-focused applications. Additionally, a configuration tool will be provided, in order to make it easier install and calibrate the system in a pilot phase.

A first version of middleware, named SensorWeaver 1.0 has been released with basic features. It is expected a second revision (SensorWeaver 2.0) and an integrated configuration tool to be launched in the next year of the project.

Supporting decisions in DOREMI: understanding the user progress and needs

In a usual day, the DOREMI user follows the active aging lifestyle protocol, which consists of keeping a prescribed diet and running physical and cognitive exercises under the constant and discrete monitoring by the DOREMI sensors. The user wears the DOREMI bracelet that measures steps, heart rate and temperature, while other sensors installed in the home measure weight and equilibrium (the intelligent carpet), the user position (localization subsystem) and the presence of visitors in the home.

Sensors assess daily progress

The information obtained from these sensors is used by DOREMI to assess the daily progress of the user, and to adapt the active aging lifestyle protocol accordingly, or to identify early any strong deviation that may require the intervention of doctors. At a first glance, the assessment of the user progress may appear quite simple and straightforward. Indeed, if performed by a human observer, this is often the case. However, DOREMI performs this task automatically, by analyzing only simple user parameters (such as the acceleration sensed by the bracelet, the user temperature and heart rate, movements, etc.).

Finding a link between these simple parameters and the user activities and performance (among researchers it is known as activity recognition), and taking decisions about the possible changes of the prescriptions (also called reasoning) is the role of the Work package 4 (WP4) of the project. The main workforce of this Work package involves researchers of the University of Pisa, the Institute of Science and Technologies of the Italian Research Council, and the Austrian Institute of Technology.

Activity recognition and reasoning

Recognizing or evaluating user activities based on data sequences produced by simple sensors, which are loosely coupled with the activities performed by the user, is not easy to achieve. Making a parallel with the sports, it is like playing tennis by sensing the ball only with the ears and with the eyes covered by a bandage. Still keeping this parallel with tennis, the reasoning takes decisions about which shot to play and how.

The approach to activity recognition of DOREMI is two-fold. In a first step, the researchers analyze the sensor data sequences obtained in a number of test cases by an explorative approach. With this approach, they try to understand the nature of the data and to find some features that may help in linking them to the user activities. The result of this work is the definition of rules and filters to be applied to the raw sensed data. In the second step, the sensed data are analyzed by using machine learning technologies, which move from the original biological inspiration to the state-of-the-art computational learning approaches in the fields of artificial neural networks. As a data-driven approach, artificial neural networks need first to be trained by observing a number of examples of the activities to recognize/evaluate, and only then, they can recognize the activity/performance of the user in the real life. In order to realize this, a relevant activity of DOREMI is to produce a large set of annotated data sequences obtained during real activities of the users, allowing the proper training of neural networks.

Finally, the information produced by the neural networks is used by the reasoning component, which embeds medical knowledge, to take decisions and to drive the reactions of DOREMI to the measured performance of the user.

Achievements during the first year

Although most of the effort in the first year of the project was devoted to the definition of the active aging lifestyle protocol and to the selection of the sensors, the WP 4 has already made significant progress. Specifically, it identified the requirements for the activity recognition and reasoning components and it defined the workflow of these components in the DOREMI system.

However, the most important achievements have been the definition of the format of the sensor data and the definition of user-specific activities and performance parameters to be monitored.

In cooperation with other work packages, WP4 also began the design of the intelligent carpet for the measurement of the user equilibrium. This also included the collection of a preliminary data set from the carpet prototype to perform a first explorative training of the associated neural network.

Upcoming events

- **Ageing Wealth Conference**
  16-17 October, Modena, Italy
- **E-health: Independence and Inclusion in the 21st century**
  21-23 October, Donegal, Ireland
- **Launch of the Ageing Well in Wales Programme**
  22 October, Cardiff, UK
- **Special Track on Mobile Health Care and Training**
  13-14 November, Thessaloniki, Greece

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Contact the coordinator

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