Newsletter #3
July 2017

This issue

Editorial

Since the last newsletter, the Consortium partners have worked to set up a first version of the FrailSafe system and have developed a couple of games to support the FrailSafe study for the volunteers to play. The latest achievements are detailed in the present newsletter.

End of May, the partners gathered in Nicosia to discuss the state of play of the project and how best to move forward. It was an excellent opportunity for the consortium to visit the local partner, Materia, its facilities and how they supervise the volunteers.

We hope you will enjoy the reading and we wish you a nice summer break,

FrailSafe Team

FrailSafe Medical Outcomes

FrailSafe Volunteers in Nancy, France

One of FrailSafe pilot sites is located in Nancy, France. They managed so far to enroll more than 130 volunteers to take part in the FrailSafe study. Every older person, aged 70 or plus, living at home independently, can join the study and help clinicians in their journey towards the detection of frailty.

The French volunteers underwent a first comprehensive Geriatric Assessment by a geriatrician at the time they entered the study. The assessment will be repeated several times during the whole study period (almost 2 years) in order to follow up their frailty status evolution. In parallel, they are supported by the nursing staff of Inserm, specialised in clinical research, with regular home visits and telephone contact. Depending on the study group they belong to, the volunteers will receive a fixed number of visits from nurses, where they will provide the volunteer with the different devices to be used for 5 days, explain the purpose of the devices, how to use them and how often. The series of devices consists in an electronic blood pressure meter (Fig. 1), a tablet with cognitive games (Fig. 2-3), a mobile phone with an installed GPS and pedometer (Fig. 4), and a chest strap calculating the heart and respiratory rate. After 5 days, the nurse gets the devices back and retrieves the data collected during these 5 days that will later be sent to the FrailSafe cloud for data analysis. But (s)he also collects the volunteer's feedback about the material to help improve and shape the final FrailSafe protocol.

Thanks to several informative sessions organized in Nancy together with local older people associations, the FrailSafe study achieved to attract many volunteers; however, the French clinical partner will gladly accept other volunteers to be able to collect as many data as possible and thus draw better conclusions to detect frailty among older people. A FrailSafe volunteer accepted to share his experience about the FrailSafe Study.

Why did you join the FrailSafe study?

I heard about the study thanks to a conference organized by the CHRU and ONPA. The project seemed interesting and was linked to ICTs, that's why I decided to join the study.

What is the added value of these devices?

Taking part in the study allowed me to check my blood pressure in the morning and the evening, for several days in a row. It's also very interesting to see how many steps I've made during the day, which tells me how active I am or could be.

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Would you recommend the FrailSafe study to your friends?

Yes, definitely. First of all, it's a good way to satisfy one's curiosity. Secondly, you get a more comprehensive assessment of your health status on a long period of time. Finally, I like the idea that our feedback and opinion can change the FrailSafe final product, even though at this stage, it's too early to visualize the changes.

Imagine one of these devices proves to be effective in detecting frailty, would you use it at home?

Yes. I especially liked the blood pressure meter, which is very easy to use and gives a result immediately and doesn't require too much of your time.


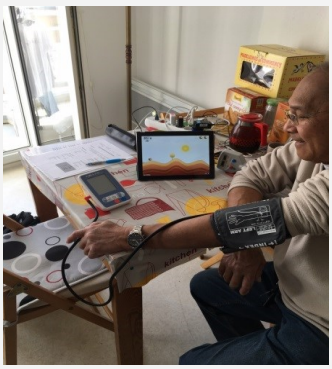

Fig. 1 - Volunteers using the blood pressure meter


Fig. 4. - Volunteers using the mobile phone and the GPS to count the number of steps of the day

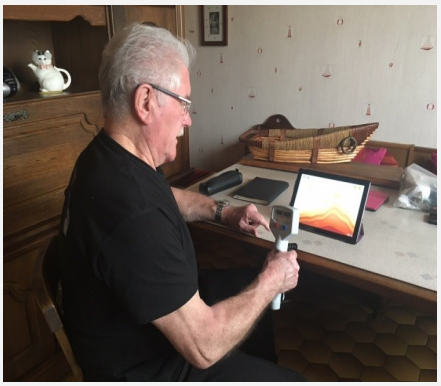


Fig. 2 - Volunteers playing the Red Wing Game on the tablet

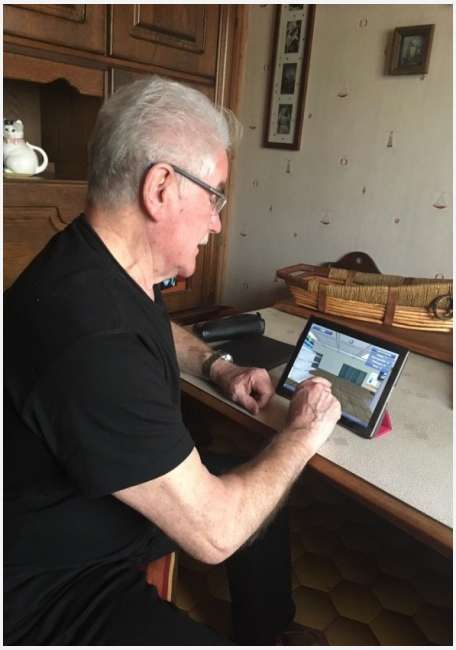

Fig. 3 – Volunteer playing the Virtual Supermarket Game

FrailSafe Technical Outcomes

1. Gravity Ball: FrailSafe Augmented Reality Game

Gravity Ball is a marker-based Augmented Reality (AR) game recently developed by FrailSafe partner CERTH and targeted for mobile devices. The game is designed to measure, record and train the hand stability of the user, as well as his eye-hand coordination skills through an immersive experience that supports casual, iterative, and stress-free playing while sitting. In practice, the user holds the AR marker using either one or both hands and observes the augmented reality upon it through the display of the mobile device (see Figure 1 and Figure 2).

The game presents a landscape of valleys and mountains with a hole as the finishing point. The game contains several stages of different complexity, designed with realistic and colourful textures to appeal to the player.

Gravity Ball currently offers two levels: a simple box-like terrain that serves as a tutorial for the player and a more complex level, showing the challenges that the user may experience in the game.

Each level of the game contains one or more holes. To complete the game, the user has to guide a virtual sphere into the finishing hole, as fast and as steadily as possible. To achieve that, the user can tilt the handheld marker accordingly and guide it through the routes that will successfully lead the sphere to the finishing hole.

For further information, contact Andreas Vasilakis (abasilak@iti.gr)

Figure 1. The user holds the marker with his/her hand and observes the game augmented upon it through the tablet

Figure 2. Visual rendering of the augmented reality through the mobile device

FrailSafe Technical Outcomes

2. Serious Game for Frailty Detection

To successfully support the FrailSafe study, a series of serious games will be designed. The first FrailSafe game, the Virtual Supermarket Game, was released last December and is used to detect Mild Cognitive Impairment (MCI) among our older volunteers.

The weakness of the hand grip strength is considered as one of the current frailty phenotypes. Therefore, a new game was designed to measure, record and train the hand grip strength and train the coordination and reflex abilities of the user. The game is called the **Red Wings Game**. The aim of the game is to control the flight level of the plane by putting greater or lesser pressure on the hand dynamometer, which will allow the biplane to avoid obstacles such as stones, balloons or trees. The volunteer will have to make it fly as far as possible, going through different levels of difficulty.

As mentioned above, the necessary devices are a hand dynamometer and a peered tablet to be able to play the game. Both devices are provided by the medical teams in the pilot sites. The users will have to have a good enough sight condition and healthy level of cognitive skills to be able to follow the movements of the biplane and perform as best as possible.

From a technological point of view, prior to playing the game, the medical staff will create a profile of the volunteer in the eCRF. The game will be able to constantly track the player's performance. When the database connection is available, the recorded performance data will be sent to the FrailSafe Cloud for post-processing and feeding the Virtual Patient Model (VPM). The analysis will help determine whether there exists a pattern that would explain the presence of frailty among the volunteers and thus help the older person take actions to prevent the onset of frailty.

For further information, please contact Javier Montesa.

FrailSafe Technical Outcomes

3. The FrailSafe Smartvest

The Italy-based company, Smartex, one of the partners of the FrailSafe project, has finalized the development of a wearable sensor device, called "Wearable WBAN System" (WWBS), designed to measure individual medical parameters related to heart, respiration and physical activity.

The system includes a shirt equipped with various sensors in the sleeves (more specifically on the upper arm) and the chest, as well as an electronic device collecting the measured data. Those data are then saved on a micro-SD card and/or transmitted by Bluetooth to a computer or an Android device to be analyzed in real time.

This garment has been developed to collect many different types of information while reducing discomfort to a minimum: e.g. a frontal zip enables people with limited mobility to put the sensorised shirt on and off more easily and the cloth is made of light, natural material, which makes it more comfortable to be worn in the summer and in hot countries. A Velcro strap on the back side of the shirt allows adapting the garment to people with different sizes and making it sufficiently adherent to the body.

Read more on the Wearable WBAN System in this article.

For further information, please contact Roberto Orselli (orselli@smartex.it)

Fig. 1—Frailsafe Volunteers in Cyprus testing the latest Smartvest prototype

4. FrailSafe First Integrated System Prototype

The Frailsafe project has the purpose to implement a system able to monitor, detect and potentially prevent or slow down the progress of an older person towards a frail status thanks to the use of technological tools such as softwares, sensors, games, wearables devices, and some others.

End of June 2017 a first version of the system, the so called "*First Integrated System Prototype*", was officially released.

System Integration meaning and System description

The role of the "System Integration" is divided into two main activities: The *Integration,* which is assembling the parts of a system in a logical, efficient and cost-effective way, and the *Test*, which means comprehensively checking the system execution and testing its adherence to the functional requirements taking the whole system into consideration.

The FrailSafe system is composed of different and separate parts designed to work together with other sub-systems as a unique and coherent body. All the individual processes of such a body must appear and co-operate in harmony to implement the expected FrailSafe functionalities (i.e. monitoring, data analysis, gaming, information visualization, interventions, alerting).

System objective

The objective of the integration task then is to enable a right and secure interconnection among the different parts of the system and to check that the expected functional requirements are correctly provided to the end-users.

To reach the objective of having a First Integrated System Prototype, a series of activities (see below) has been performed since March 2017.

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Work overview

To obtain this first integrated system, several consecutive activites were implemented to achieve the first basic structure of the current system.

The working steps were the following:

- The reviewing and finalisation of the overall system architecture, with the collaboration of relevant partners;
- The cloud infrastructure configuration and the security infrastructure implementation;
- Once this first "skeleton" of the system ready, the cloud resources for the hosting of all the other sub-systems were prepared;
- Finally, the already available sub-systems went in deployment progressively starting from the core ones

This is just the first stage of having a fully integrated platform able to provide all the system's features. From now on, the system will evolve, and be progressively enhanced and improved, moving closer the final full featured release of the FrailSafe system.

For further information, please contact Luca Bianconi luca.bianconi@grupposigla.it

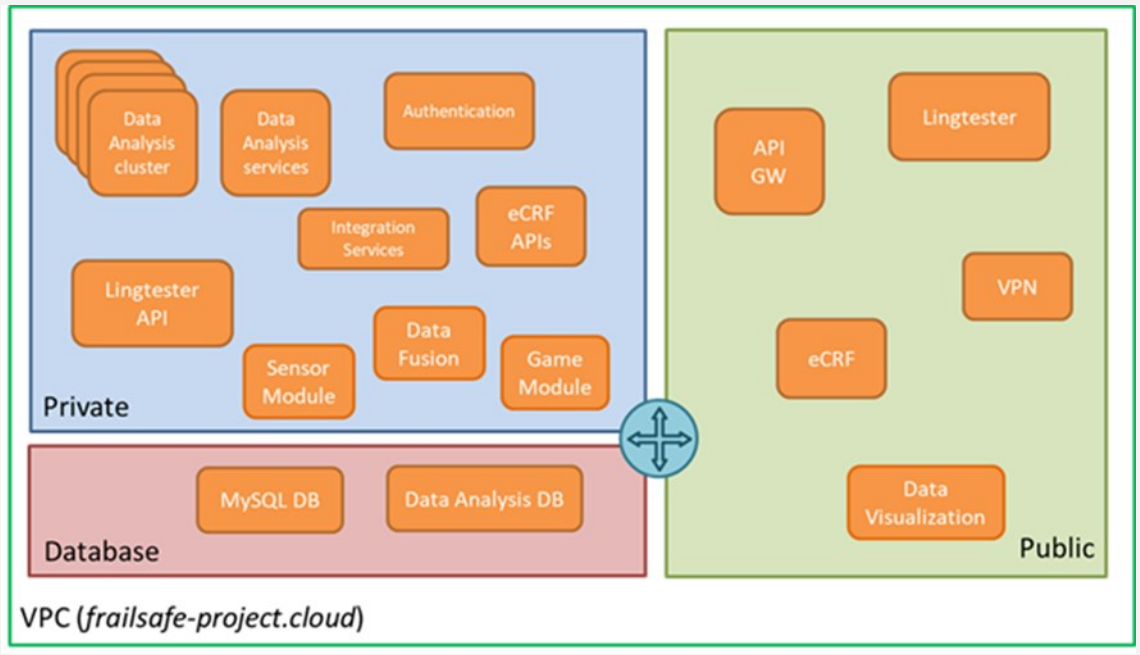

Figure 1 - FrailSafe system cloud infrastructure schema

5. FrailSafe Integration and Data Analysis

The data collected via FrailSafe's various devices are integrated by a management infrastructure with modular services and patient-specific applications and by the use of novel methods for the offline fusion and analysis of advanced technology data. The large data files that contain the raw sensor data generated by the devices, the medical records, and the analysis results produced by medical experts or by developed software, are stored effectively, fulfilling the data access requirements of the offline analysis. The data are then aggregated as shown in Figure 1, and are used to create a Virtual Patient Model which will guide the clinicians in the design of their interventions.

In the heart of the aggregation and storing system is a cluster of 4 machines using the Amazon web service EC2 (Amazon Elastic Compute Cloud). This cluster runs Apache HBase as a distributed NoSQL database and uses Apache Spark for data processing and aggregation. There is an additional Amazon EC2 machine called the "Data Grabber", which is responsible to collect the data uploaded to the Amazon cloud by the different submodules of the FrailSafe project, or the external servers of the machine vendors (Agaedio and FORA).

Apache HBase was selected because it is part of the Hadoop ecosystem, which provides a high scalability in data analysis and knowledge discovery algorithms. Specifically, Hadoop is an open-source software framework used for the distributed storage and processing of big data using the MapReduce programming model. It consists of computer clusters built from commodity hardware. All the modules in Hadoop are designed under the fundamental assumption that hardware failures are common occurrences and should be automatically handled by the framework.

In respect to the subsequent (offline) data analysis, we followed two pathways, (i) analysis of the clinical data from the eCRF platform and (ii) analysis of the multi-scale and multi-dimensional recordings from the sensors. Firstly, the clinical data from the eCRF platform were used to identify global group differences in the population. To that end, a group-wise univariate analysis was performed across three different splitting factors:

a. Frailty status-based analysis,
b. Age-based analysis
c. Gender-based analysis.

Secondly, the clinical measurements from eCRF were used for multivariate statistical analysis. Specifically, their predictive ability towards the development of a frailty index was examined.

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Two different frailty indexes (*FI*) were computed:

- one aiming to predict the discrete Fried classification score (FI_1) and
- one trying to estimate a continuous score as a linear combination of the 5 criteria (involuntary weight loss, slow walking speed, poor handgrip quality, reported exhaustion, low physical activity) related to Fried classification (FI_2).

The ultimate goal is to investigate whether the proposed frailty indexes are more reliable predictors of frailty transition than the standard classification scores. The prediction models were built using LASSO (Least Absolute Shrinkage and Selection Operator) regression method after performing data imputation to fill in missing values and variable standardization. Spearman's rank correlation coefficient between Fried's score and the proposed FI_1 score was 0.73, whereas Spearman's correlation between the 5 criteria related to Fried classification and the calculated FI_2 score was 0.66.

Finally, multi-dimensional time series analysis has been targeted for classification of activities of daily living (ADL) aimed at predicting frailty in our subsequent work. For the former, a human motion identification module was developed, which classifies basic ADLs such as walking, walking-upstairs, walking-downstairs, sitting, standing and laying. The multiclass prediction model uses a high-dimensional signature extracted in time and frequency domain from each frame, to classify it during testing. Classification was based on a two-step procedure, in which the individual decisions were weighted by their sensitivity to the training set and finally combined by a fusion function. For prediction of a frailty, some preliminary work has started on the investigation of deep learning techniques for seamless extraction of a features' hierarchy towards an in-depth analysis of the time series data.

For further information, please contact Dimitris Vlachakis (vlachakis@ceid.upatras.gr)

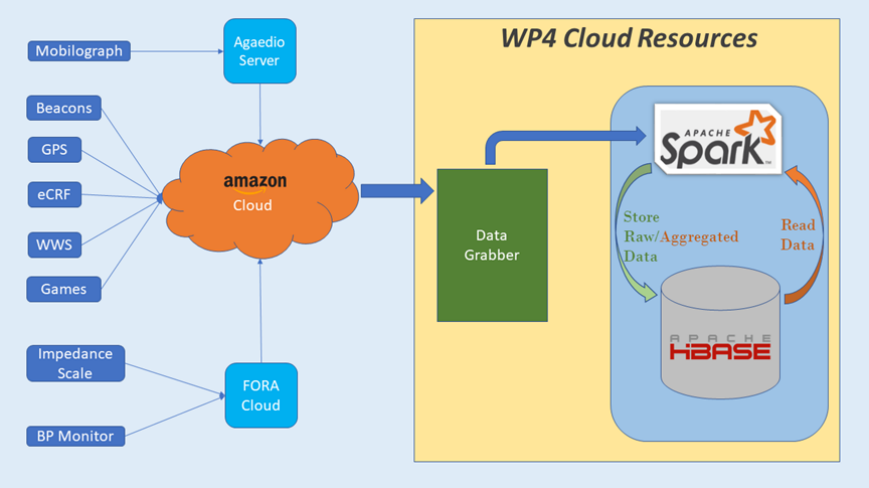


Figure 1: cloud resources for data collection and aggregation

Other News and Events

Important Conferences

- **ICGG 2017** : 19th International Conference on Geriatrics and Gerontology on 17 & 18 August 2017 in Barcelona, Spain https://www.waset.org/conference/2017/08/barcelona/ICGG
- **EUGMS Congress 2017** : 13th International Congress of the EUGMS on 20-22 September 2017 in Nice, France http://www.eugms.org/2017.html
- **Falls, Frailty and Bone Health Congress** on 9 & 10 November 2017 in Dublin, Ireland http://ffbh-europe.com/

FrailSafe Advisory Board

Like any other EU project, FrailSafe needs guidance and advice to ensure the success of its work. This role will be assumed by the Advisory Board. Its members are stakeholders from outside the consortium and will steer the partners in the right direction when needed and monitor and control that the project outcomes maintain commercial exploitability of results. Indeed, it is critical for the long term business success that the exploitation efforts and the development of the business plan are evolving in the right direction. Further information about the members is available here.

FrailSafe Medical Partners Meet EUGMS

The Executive Board of the EUGMS (European Union Geriatric Medical Society) took place in Athens on 26 June 2017. A special workshop was organised: "The Development of Geriatric Medicine: A perspective for a new approach towards the older patient." Prof A. Benetos, Academic Director of the EUGMS, delivered a lecture on the geriatric evaluation of patients with cardiovascular conditions and hypertension. He stressed the importance of taking into account the functional status and the frailty level of older people for determining therapeutic strategies. He also referred to Frailsafe, which by using advanced personalized models and advanced interventions, aims to sense and predict frailty.

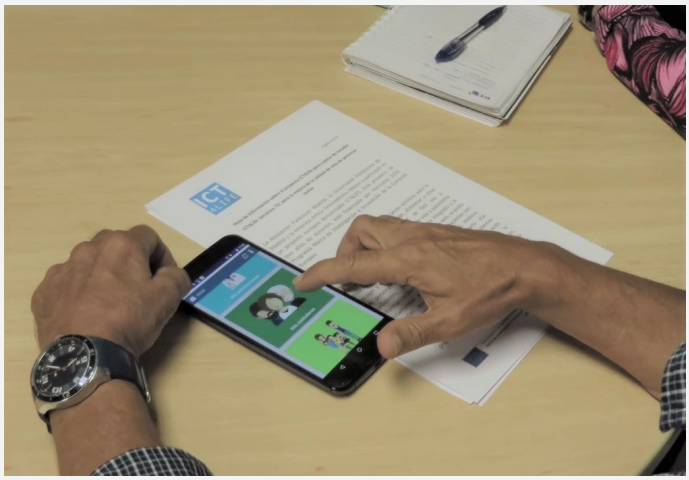
News from other H2020 projects

ICT4Life Testing Phase is in Full Swing!

Since last October, end users such as Parkinson's patients, seniors and caregivers based in Madrid and Paris have been testing ICT4Life technologies. Thanks to their personal experiences, they have been providing precious feedback!

Users performed easy housework while being monitored with cameras and smartbands. Additionally, users tested ICT4Life application interfaces for Smart TV, tablets and smartphones. The monitoring technologies and the apps will be then integrated to create a system that will connect patients, caregivers and health professionals, improving the communication flow among them and allowing intervention in case of abnormal behaviours or danger.

Want to know more? Visit their website and get in touch with them.



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