

FallWatch

“A wearable miniaturized fall detection system for the elderly”

Project summary

The general objective of *FallWatch* is the development of the Mini'Fall™ product, the first miniaturized wearable and radiocommunicating fall detection device for the elderly. It consists on a miniaturized radiocommunicating embedded electronics device patched to the person. It has to date no equivalent around the world in the area of health parameters monitoring of subjects with a health status demanding a permanent survey.

FallWatch project aims to overcome both ergonomics and reliability deficiencies of the existing products by developing a new generation miniaturized fall detector device (Mini'Fall™) integrated into a whole fall detection system able to manage a fall event from its detection, to its cause assessment and to medical services intervention. Mini'Fall™ is aiming to be the most effective technology in the market to minimize the consequences of falls in the elderly, having yet a highly competitive price close to the price found for the best performing present solutions. *FallWatch* focus its research and technology effort on developing the new generation fall detector device, but without leaving unattended the other parts that complete the whole fall detector system which are crucial to ensure the entire effectiveness of the marketable service.

The *FallWatch* system is a “context aware” system in opposition to past standalone systems. It consists on:

- The Mini'Fall™ device embedded on the holder to continuously measure the kinematics (postures, intensity of movements) from accelerometers and heartbeat frequency meter, and classifies the situation on a 3 degree scale (low activity, medium, high).
- The in-home control box continuously monitors the ambient activity from movement detectors (door contacts and infrared detectors) and classifies the situation on a 3 degree scale (inactivity, average, exceptional).



FallWatch realizes big enhancements concerning to the fall detection device and the specific decision making algorithm running in the in-home box. The fall detector device, Mini'Fall™, is miniaturized in order to allow a comfortable permanent wearing. It is worn stuck to the skin by means of a patch. The miniaturization of the fall detector device implies important R&D improvements in different issues such as energy (battery), electronics (circuit), biocompatible materials (package and adhesive) and nanotechnology (electro sensitive pigments). The peripheral elements will involve as well R&D work regarding to the software development (the multi-variable based decision making algorithm). Such a varied group of R&D activities are demanding a strong R&D effort as described in the following section.

Description of the work performed and main results

During the project execution, FallWatch has gone through technical as well as management and financial work. From a technical point of view, the work has been performed according to planning. The first part of the project has dealt with generating the new scientific knowledge needed for the successful completion of the project. The second part has dealt with the technical implementation and prototype validation.

The device miniaturization has involved two subjects complex enough to be thought as separated technological routes. These subjects are the electronics miniaturization (Multi Chip Module miniaturization)

and the battery miniaturization. The electronics miniaturization (Multi Chip Module miniaturization) has been performed by the design, implementation and validation of the MCM device on a triangular shape PCB card including the RF communication, acquisitions (i.e. sensors), microcontroller, connectors and related electronic components and embedding the **fall algorithm** for measuring and processing the heart beat frequency and acceleration and generating the alarm to be transmitted via wireless communication systems with the best possible performance (frequency band, antenna, communication protocols, peak current minimization).

Concerning the battery, the Li Carbon monofluoride (Li-CFx) thin flexible and custom triangle shape battery has been investigated, designed, manufactured and tested. The necessary researches on electrolytes were carried out to optimise the capacity and allow the cell to operate over a wide range of temperatures. The cell design has been optimised to allow the chemistry to be encapsulated within soft packaging without outgassing. A thin (4mm) flexible Li-CFx battery is shaped into a triangle (40mm) to fit in the package.

An electro-chromic display has been investigated, constructed and tested. Electro-chromic device concept is based on a working electrode, a red-ox chemical reaction and an electrical current driving through. A series of electrochromically active viologen derivatives were synthesized and liquid and gel electrolytes were tested. Finally the gel-based electrolyte mounted on a flexible support was demonstrated to be the most suitable for present application to diminish electrical consumption and tackle inherent device architecture and technical limitations.

A special development and manufacturing of functional mechanical biocompatible package has been performed for Mini'Fall. The material for the housing was selected flexible for the comfort of the user. The material is silicon with a light shore. In contact with the skin, a layer of gel should be enclosed in the capsule. The package encapsulates all the parts of the Vigi'Fall. The prototype has been delivered and the mould is ready for pre-series.

A new patch has been proposed and adapted to the size and weight of the Mini'Fall and coated on one side with the adhesive studied on the project. The main function of the patch is to maintain the Mini'Fall close to the body. It can remain 4 weeks without visible degradations. The patch is partially transparent in order to show the display colour and know the state of the battery.

The integration of the whole system: MCM, battery, electro-chromic device, package and patch, for completing and validating the Mini'Fall device has been successfully completed on a first version of the prototype that following the industrialization phase of the product, is being improving on a second run to definitively fix an industrial and commercial first version of Mini'Fall™ product. It will be commercialize following the plan fully described on final deliverable 8.1.



Final results

The *FallWatch* project final results are the following: a **Miniaturized Multi Chip Module (MCM)** multilayer (3D) structure for the Mini'Fall device that continuously measures the kinematics (postures, intensity of movements) from accelerometers and heartbeat frequency meter, and classifies the situation on a

3 degree scale (low activity, medium, high) and with capabilities of wireless communication with a Radio frequency card. Second Project Result: a **fall detection algorithm** using data fusion of signals from both the Mini'Fall™ wearable device and the peripheral detectors. Third Project Result: the development of biocompatible materials and design for Mini'Fall device's **biocompatible packaging**. Fourth Project Result: a battery charge indicator for Mini'Fall device using TiO₂-based nanostructures applied to an **electro-chromic device**. Fifth Project Result: **an adhesive patch** to comfortably stick the device to the user's skin. Sixth Project Result: the **battery** design optimized for Mini'Fall device to obtain the maximum energy density and to use soft packaging material. Seventh Project Result: the **Complete Mini'Fall system**, the relating to the integration of all of the preceding Project Results into a whole fall detection system able to manage a fall event from its detection, to its cause assessment and to medical services intervention.

Potential impact and use

The *FallWatch* project will be of great relevance to the SME partners in order to improve their competitiveness in the World arena and face the main market trends described for the sectors in which they are present. It will be an opportunity for SMEs in the **Miniaturized Multi Chip Module design sector**, allowing for a high-tech electronics control system development, SMEs in the **biocompatible materials sector**, by developing biocompatible packaging, SMEs in the **electro-chromic pigments sector** by developing a high tech battery charge indicator for Mini'Fall™ device and SMEs in the adhesive patch sector by developing a comfortable patch for Mini'Fall™ device. It will be an opportunity for SMEs in the **battery sector**, allowing for a high-tech battery design for Mini'Fall device. And finally an opportunity for SMEs in the **Human Health Market** to improve their competitive position by developing the Mini'Fall device, an innovative product able to detect falls on elder persons.

Related to the target or primary market the project is addressing: the social alarm European market, Mini'Fall™ sales trajectory can perfectly raises up to cumulated sales of **218,000 units by 2015** on a linear-wise progression. This will represent a European market share of **8%** at that moment. The consortium has a sound understanding of the market and profound study of competitors and demand has been carried out. The proposed enhanced performance is well focused on actual market demand at a competitive price, and relies on the large experience, solidity and international presence of the FallWatch supply chain, competent to deploy the commercialization plan designed for exploiting Mini'Fall™.

The international market will be addressed in Year 3 after European market, to minimize risk (the European market is well known by the Consortium). Nevertheless, we expect a slower penetration curve for the international sales. Even though the participation of Europ Assistance will ensure a world-wide market penetration, we have estimated sales out of Europe conservatively. We forecast **30,000 units** sold outside Europe by 2015, making a total of **248,000 units by 2015**.

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