

## EUROPEAN PROJECT “SMILING”

“Self Mobility Improvement of eLderly by counteractING falls”

### Authors

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### Abstract

The European project SMILING (GA n 215493-“ ICT and Ageing”) has begun its activity on 1 January 2008. Eleven research centers, universities and companies of 5 European countries, such as Italy, Switzerland, United Kingdom, The Netherlands, Slovakia, Israel and 25 scientists are involved in it. The main objective of the project, is to diminish age related impairments by interfering with mobility disability and improving carry-over into real life situations. Nowadays, mobility means freedom, flexibility and autonomy for all citizens, including older persons. But aging is characterized by functional changes in the sensory, neurological and musculoskeletal systems, affecting motor tasks including gait and postural balance. It is important to underline that more than 50% of falls occur during some form of locomotion and the percentage increases in people older than 80 years. The SMILING approach is intended to challenge the older people to solve motor problems in real time, by inducing variable environments which need active response and problem solving from the target population. The SMILING solution, a wearable computer-controlled device, is aimed to implement a systemic solution to re-model training sessions used prevalently in fitness clubs or home environments to facilitate and ameliorate walking schemas. SMILING will strongly contribute to a new organization of training and rehabilitation programs allowing the overcome of the limits of old traditional rehabilitation paradigms moving towards at the edge challenges in training and rehabilitation, keeping in account novel principles of neuro-rehabilitation and focusing on mobility enhancing. SMILING , a thirty months project, has been financed by the 7th Framework Programme of the European Commission, in objective ICT2007.7.1 "ICT and Ageing". It is co-ordinated by Fiorella Marcellini of Research Department of INRCA (IT), supported for technological aspects by Maria Bulgheroni of ABACUS (IT) and for scientific aspects by Simona Bar-haim of Step of Mind (IL).

**Keywords:** mobility, elderly, independent living, falling, training.

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### Introduction

Aging is characterized by functional changes in the sensory, neurological and musculoskeletal systems, affecting motor tasks including gait and postural balance. Gait and balance disturbances in elderly are the main risk factor for falling. Every third person aged over 65 years is at the risk of falling or has had an experience of falling.

Accidental falls represent the sixth cause of death among elderly. Approximately 25% to 35% of people aged 65 years or older experience falls each year, and the epidemiology of falls shows that more than 50% of the falls occur during some form of locomotion and the percentage increases in people older than 80 years. 90% of hip fractures result from falls and almost 60% of those who fell the previous year will fall again.

These falls cause physical injury, emotional trauma and mobility avoidance. The most effective way to counteract falls is to improve movement capabilities. This may be achieved by training and rehabilitation programs focused to enhance or recover the performance of real life activities through the application of problem solving in normal situations (walking on rough grounds, standing up, climbing stairs, overcoming obstacles). A problem solving approach means to address motor learning processes by directly influencing motor behaviour, i.e. the way an action is designed and not muscular force or joint mobility only.

The SMILING project plans to diminish age related impairments through the interference of diminished neural plasticity that limits walking ability and by continuing these functional improvements into real life situations.

Research undertaken in USA and Israel has shown strong indications that the vicious circle of muscle weakness and time delay in the Central Nervous System (CNS) that causes gait and balance impairment could be weakened by applying unexpected external motion perturbations. These perturbations can loosen stiff walking patterns and hence introduce more flexibility into the motor control system to give improved stability.

Elderly people at risk of falling can be considered to be suffering from an involuntary and stereotyped motor behaviour that restricts their participation in society. One method to overcome such a situation is to break the stereotyped motion schema and activate a new learning process to better approach real life tasks in a better way.

SMILING will develop an advanced near-to-market prototype of a system for improvement of motor functions (walking) and improvement in the mobility of aging populations at risk of falling by implementing a problem solving approach.

To pursue such a target, the SMILING project will use chaos theory and dynamic systems theory with applications in the training of the ageing populations.

Chaos theory describes the systems that respond disproportionately (non-linearly) to initial conditions or perturbing stimuli and dynamic systems theory describes the changes in complex systems composed of multiple interrelated sub-systems.

The SMILING solution, a wearable non-invasive computer-controlled system, will perform chaotic perturbations to the lower extremities during active walking through small alterations of the height and slope of weight-bearing surfaces. Chaotic perturbations will be adapted for the elderly population. Patterns of walking, flexibility and stability will be identified by the system and will trigger changes in the training program.

The prototype will provide a changeable yet safe environment that needs active response and problem solving by the user.

Very recent studies conducted by SMILING partners, particularly SoM in Israel, and two other groups at MIT (Massachusetts Institute of Technology) and RIC (Rehabilitation Institute of Chicago) have shown major improvements in motor tasks and transfer of

outcomes in real life environments if the training programs are based on non-linear dynamics and chaos theory. These research studies give confidence to the partners that their project will result in major achievements.

### The Smiling Project

Smiling Project was selected to be founded by the European Commission within the 1<sup>st</sup> ICT call, Seventh Framework Programme, Theme 7, ICT for independent living and inclusion. The total budget of the project is 2.868.050 Euro with the contribution of the EC of 2.250.000 Euro. The project has an expected duration of 30 months, starting at the 1<sup>st</sup> January 2008 and ending at the 31<sup>st</sup> of June 2010.

The participants are:

Participant Number	Participants name	Participants short name	Country
1 (coord.)	Istituto Nazionale Riposo Cura Anziani	INRCA	IT
2	University of Strathclyde	BDM- USTRATH	UK
3	Technical University of Kosice	TUKE	SK
4	Step of Mind	SoM	IL
5	Alma Mater Studiorum - Università di Bologna - Department of Electronics, Computer Science and Systems	UNIBO	IT
6	Stichting Imec-NI, (NL)	IMEC-NL	NL
7	Ab.Acus	ABACUS	IT
8	Ecole Polytechnique Federale de Lausanne	EPFL	CH
9	Centre Hospitalier Universitarie Vaudois	CHUV	CH
10	Mishan	MISHAN	IL
11	Geriatric Center Kosice	GCKOSICE	SK

Table 1 : List of SMILING participants

SMILING will develop innovative training programs for elderly people, to be accomplished at home, in fitness clubs and health centres, with the aims of improving walking and balance, and to prevent and counteract falling.

The overall objectives are:

1. To develop and construct an advanced prototype of a wearable non-invasive computerized miniature system for mechanical chaotic perturbations of gait pattern in order to counteract and prevent tendencies to fall;
2. To develop an easy to use advanced version of the same system for easier exploitation by end-users;
3. To develop stimulation algorithms fitted to suit individual user's specific needs;
4. To implement a system for training to be spread in rehabilitation, health care and fitness centres for a reorganization of the rehabilitation process in ageing.

The SMILING project will develop a complete system that will stimulate, train and measure gait in a non-invasive manner aimed at improving walking and thus improve personal autonomy and participation.

This aim will be reached through a systemic solution that includes three sub-components:

1. A wearable mechatronic sub-system, referred to as the *SMILING intelligent shoe*. This shoe will be made of:
  - i- a mechanical motorized device to modify the environment during walking;
  - ii- miniaturized sensors embedded in the shoe to identify the walking phases, drive the mechanical actuators, monitor the non-linear gait recovery index in real-time and detect risky conditions to prevent any unsafe events;
  - iii- devoted electronics for the real time processing of signals from embedded sensors and, using them as feedback signals, drive the mechanical actuators;
  - iv- a wireless communication module to allow communication with a laptop or other control unit, for the remote use of the system, upload of personalized training protocols, and download of training session data.
2. A set of smart miniaturized sensors to be worn on the body, referred to as the SMILING body sensor network. These sensors will measure biomechanical parameters enabling gait monitoring and accurate evaluation of the walking recovery process.
3. A control and processing unit for personalization, tuning and control of training programs, referred as the *SMILING control unit*.

The project is divided into different work packages:

I. Project management:

The scientific co-ordination will include the monitoring and assurance of scientific progress and reporting, the Risk Management Plan implementation and the managing of IPR Issue.

The administrative-financial management will include the overall financial, administrative and contractual management of the Consortium and the managing of the Consortium Agreement among the partners.

II. Algorithms, requirements and specifications:

The objectives are to obtain detailed specifications for the entire system, its major components including user interfaces, testing and analysis procedures. Moreover, the acceptance by end users and professionals of proposed technological approaches will be ensured.

III. Smiling Prototype development

The objective is to develop a laboratory based device for implementation of the novel chaos theory approach for the improvement of mobility in elderly people. The shoe structure, the motorised mechanism, the shoe and body sensors, the wireless communication architecture, the power supplies, the control unit and algorithm implementation will be defined. Moreover, ergonomics and safety will be tested.

IV. Smiling HC development

The objective is to develop a portable device, assuring portability and safe use of the device. Moreover, an algorithms, a control system for automatic operation of the device and a database for signals and information storage will be develop.

V. Validation and tuning

The main objectives are the validation and tuning of SMILING system, as regards basic functionality, repeatability over time, safety and effectiveness. The user feedback will be collected and analysed. Then, the final adjustments and the necessary regulatory process will be completed. It will be recruited 15 fallers and 5 non-fallers for four validation site (Italy, Israel, Slovakia, Switzerland). The Ethical approvals will be required for the validation phase.

## VI. Dissemination and exploitation

The dissemination activities will be assured making the project results known to the scientific, commercial and general public communities, including health professionals and elderly. Moreover, the future exploitation of the results will be prepared, with an exploitation assessment strategy, a market analysis and Business Plan.

## **Conclusion**

SMILING exploits ICT high tech solutions to develop a complete system focused to support elderly people continuing their life independently exploiting their best capabilities. SMILING will not be an Assistive Technology (AT) device, but an ICT support approach to personal training and fitness. The focus on elderly capabilities rather than elderly limitations plays a key role in prolonging independent living and facilitating social participation.

Mobility is a key element to enhance independence and social participation through relevant daily activities, such as keeping up relationships with family and friends, leisure time activities, access to health care or reaching everyday facilities (i.e. food store, ...). Mobility contributes to life satisfaction and subjective well-being. Satisfaction with one's ability to walk is a significant predictor of satisfaction with life on ageing. Therefore it is a fundamental precondition in order to lead people's everyday life. Mobility limitation is both a cause and a consequence of falls: in fact mobility limitation is one of the most important risk factors and falls are the largest single cause of restricted activity days among older adults. An adaptation by the elderly toward a slower and safer gait is made in order to avoid falling. Fallers can be considered as suffering from a Mobility Disability – defined as a reduced ability to manage complex environmental demands on walking.

SMILING development will require novel approaches such as self-learning and adapting systems, because of the needed adaptation of the system to walking performance of the users. SMILING will strongly contribute to a new organization of training and rehabilitation programs, allowing the overcome of the limits of old traditional rehabilitation paradigms moving towards at the edge challenges in training and rehabilitation, keeping in account novel principles of neuro-rehabilitation and focusing on mobility enhancing.

Health centres, fitness clubs, geriatric centres, sheltered houses, rehabilitation centres and any institution involved in elderly assistance and care will be the main target market of SMILING solution. These institutions play an important role in improving mobility function of older people, with tailored physical exercises carried out in health centres, like day rehabilitation centres or fitness clubs with special programs for impaired and older people. Actually, most fitness clubs have special programs for elderly but they are working mainly at improving the muscular tone of the subjects and also may put some people at risk of falls with some high intensity activities. The new necessary components in an exercise program for prevention of falls are balance, postural stability, bone, endurance, gait and flexibility. SMILING solution will well fit well in such a frame supplying health and fitness centres with new training paradigms focused to more effective exercise for elderly population.

## ***References***

Web site: [www.smilingproject.eu](http://www.smilingproject.eu)