Grant Agreement n. 215493

SMILING PROJECT

"Self Mobility Improvement of eLderly by counteractING falls"

Information and Communication Technologies

Instrument: Collaborative Project

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"SMILING presentation"

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Co-ordinator: Dr. Fiorella Marcellini

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Project co-funded by the European Commission within the Seven Framework Programme (2007-2013)		
Dissemination Level		
PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services).	
CO	Confidential, only for members of the consortium (including the Commission Services)	

Executive Summary

The SMILING Project Presentation is a short description of SMILING objectives, goals, approach, expected outcomes and consortium. The purpose of this document is to support the dissemination of SMILING.
It is intended to publicise the project on its website and other media, such as project folders, leaflets and CD-ROM/DVD. As such, particular care has been taken to ensure its accessibility to a large audience predominantly composed of non-specialists, by avoiding technical language and using a plain language.

All the information included given here is also available on the project's web site www.smilingproject.eu.

Keyword list

SMILING, mobility, elderly, independent living, falling, chaos theory, motor learning, training, walking

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General information

The European Commission selected SMILING, Self Mobility Improvement of eLderly by counteractING falls, for funding within the 1st ICT call, Seventh Framework Programme, Theme 7, ICT for independent living and inclusion.

The total budget of the project is € 2.868.050 with a contribution from the EC of € 2.250.000.
The project has an expected duration of 30 months, starting at the 1st of January 2008 and ending at the 30th of June 2010.

Project Acronym	SMILING
Project Name	Self Mobility Improvement of eLderly by counteractING falls
Project Logo	
Grant Agreement Number	215493
FP7 Programme	
Theme	7, ICT for independent living and inclusion
Start Date	1st January 2008
End date	30th June 2010
Duration	30 months
Project website	www.smilingproject.eu
Total budget	€ 2.868.050
EC funding	€ 2.250.000

List of Participants

Beneficiary Number	**Beneficiary name**	**Beneficiary short name**	**Country**
1 (coordinator)	Italian National Research Centres on Aging	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 - University of Bologna - Department of Electronics, Computer Science and Systems	UNIBO	IT
6	Stichting Imec-NL	IMEC-NL	NL
7	Ab.Acus	ABCUS	IT
8	Swiss Federal Institute of Technology of Lausanne	EPFL	CH
9	Swiss University Hospital “Vaudois”	CHUV	CH
10	Mishan	MISHAN	IL
11	Geriatric Center of Kosice	GCKOSICE	SK

Project Objectives

Nowadays, **mobility means freedom, flexibility and autonomy for all citizens**, including older persons. On the other side, 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.** 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 with the use of 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.

Such an approach will be implemented through innovative ICT solutions, able to change tasks to the user within his/her usual living environment.
Existing training and rehabilitation methods are based on movement repetition and correction or balance training for standing and not on problem solving for active walking. By applying conventional training interventions to improve walking in elderly at risk of falling some important factors such as the dynamics of the walking motor behaviour and the motor learning processes in the elderly are neglected.

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 for daily tasks. **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.**

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.

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 design an advanced prototype of a wearable non-invasive computerized miniature system for mechanical chaotic perturbations of gait pattern and to evaluate the efficacy of this system 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

Key issues

The proposed low-cost systemic solution for independent living and active ageing will enhance mobility of elderly people and improve their personal autonomy in everyday living.

New opportunities offered by ICT will be exploited to implement a training solution to prolong independent living and promote active participation in society.

Chaos theory describes the systems that respond disproportionately (non-linearly) to initial conditions or perturbing stimuli. Dynamic systems theory describes the changes in complex systems composed of multiple interrelated sub-systems. The SMILING system will address the complex control of gait accordingly.
The approach is intended to challenge the elderly to solve new motor problems in real time by inducing variable environments that need active response and problem solving. **Variable environments induced by perturbations will weaken stiff motor behaviour(s), induce flexibility and thus enable effective training and improved mobility in real life environments.**

Chaotic perturbations will be adapted for the elderly population. Patterns of walking, flexibility and stability will be identified by the system and used to 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. These requirements will be identified analytically in a dedicated phase of the project, where elderly fallers groups will participate.

Technical approach

On the technological side, SMILING will develop a systemic solution that includes three sub-components:

1. A wearable biomechatronic 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 and drive the mechanical actuators in real-time, monitor the non-linear gait recovery index and detect risky conditions to prevent any unsafe events;
    - iii- dedicated 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. 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. They will provide extensive feedback on the recovery process and will support fine-tuning and personalization of the motor training protocol. All modules will be integrated within smart, low-power, miniaturized and wearable wireless sensor nodes, enabling unobtrusive monitoring.
3. A control and processing unit for personalization, tuning and control of training programs, referred as the SMILING control unit. In addition, the control unit will gather data coming from the SMILING body sensor network and will enable data processing and data storage. The control unit shall thus include:
    - i- processing power for embedded data analysis;
    - ii- memory for data storage;
    - iii- wireless communication modules for communication with the SMILING shoe and the SMILING body sensor network;
    - iv- user interface to allow interactive and pro-active motor training.

The system will perform chaotic changes of shoe sole and heel heights or inclination in different directions (for example, slope forward or left, or diagonally) to challenge the user with new ground configurations. During the training session the user will perform a series of tasks administered through visual or audio commands, e.g., “Walk five strides forward,” or, “Walk to the right side until I ask you to stop.” At the same time, the mobile platforms will change their positions in one, or in a combination of the following ways: forward or backward and left or right inclination in the range of +4.5 to -4.5 degrees, up or down.

These angle changes are small to safeguard the safety of the user yet significant for the training and analysis.

Potential Impact

SMILING exploits ICT high tech solutions to develop a complete system focused to support elderly people continue their life independently and to exploit 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 maintaining 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 in ageing. Therefore it is a fundamental precondition for people to participate in 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. 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. The epidemiology of falls shows that more than 50% of 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. Elderly people adopt a slower and safer gait 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 when walking.

The development of the SMILING system will require novel approaches such as adoption of self-learning (and adapting systems) schema because the system’s behaviour will adapt itself in response to the walking performance of the user; tracking technologies and sensors to capture and process motion information and activate actuators in a feedback loop; 3D based multi-media interaction systems and virtual community technologies to supply the user with appropriate training tasks. SMILING will contribute strongly to a new organization of training and rehabilitation programs to overcome the limitations of traditional rehabilitation paradigms. It will introduce novel principles of neuro-rehabilitation and focus on mobility enhancement.

Health centres, fitness clubs, geriatric centres, sheltered houses, rehabilitation centres and institutions involved in elderly assistance and care will be the target market of the SMILING system. These institutions play an important role in improving mobility in older people. Most fitness clubs already have special programs for elderly people but they work mainly at improving the muscular tone of the subjects and may put some people at risk of falling with some high intensity activities. The SMILING solution will fit well in health and fitness centres, providing new training paradigms for the elderly population.

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