REHABNET - NEUROSCIENCE BASED INTERACTIVE SYSTEMS FOR MOTOR REHABILITATION

GOOD PRACTICE - PROJECT

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Contents

Introduction to the Good Practice:

RehabNet project has been financed by the EC under the call FP7-PEOPLE-2011-CIG - Marie-Curie Action: "Career Integration Grants".

Problem:

Chronic diseases such as diabetes, cardiovascular and respiratory diseases account for nearly 40% of mortality cases and 75% of health care costs. Obesity alone accounts for an estimated 12 percent of the health spending growth in the U.S. So is the case in Portugal. Wearables and their activity trackers promise a new health care model that stresses patient-driven prevention. The chronic diseases trends make elderly people to stay in danger if not monitored, therefore the goal was to provide support and connectivity from elderly persons to their caregivers not only when they are at home, but especially when outside at streets.

Solution:

RehabNet is a highly interdisciplinary project that addressed several research areas including clinical research, robotics, Human Computer Interaction (HCI) and neurofeedback / neuroscience. RehabNet proposed to develop a novel rehabilitation paradigm, based on low cost technology that can deliver motor rehabilitation for all patients, anywhere they are. An ICT based novel upper-limb rehabilitation system allowed not only to effectively train motor function, but to monitor and collect extensive synchronized brain activity and behavioural data on patient performance during the recovery process. This unique system provided extremely valuable data that allowed to propose a generalization of it to a neurofeedback paradigm that can eventually be used by all stroke patients, either at home or in the clinic. Through different interaction interfaces, RehabNet is accessible to a wide range of patients. Via a user-centred design strategy, it created computational models for the automatic generation of cognitive rehabilitation content precisely adjusted to each patient. Finally, it combined Virtual Reality (VR) with a gaming approach to allow patients to be active agents in the rehabilitation process by providing a controlled and motivating intensive training targeted to their motor and cognitive deficits. The result of the RehabNet project is an integrative platform for neuroscientists, engineers and clinicians to further study stroke recovery and improve the impact of rehabilitation strategies. During the project, 4 novel rehabilitation scenarios were developed: (1) a bimanual motor training, (2) a dual motor cognitive-motor training for attention and memory, (3) a simulated city for the training of Activities of Daily Living in an ecologically valid context, and (4) a Motor Imagery based brain computer interface (BCI) system that combines VR with EEG based neurofeedback for motor rehabilitation. All scenarios are implemented with state of the art game engines, are platform independent and most of them are freely accessible through a web browser or as an app.

Impact:

In RehabNet we developed, in close collaboration with our clinical partner, the Hospital of Funchal (SESARAM), a combination of a Virtual Reality (VR) training task with an automatically adjustable robotic assistance level. Technology was put in place at the Hospital Dr. Nélio Mendonça and clinical trials made with real patients. The impact of using the system for Neuro rehabilitation with people who suffered strokes, was assessed, and results were positive. The Legislative Assembly of Madeira voted on 26/10/2016, unanimously, a congratulation vote to M-ITI researcher Mónica da Silva Cameirão, acknowledging her contribution to the Madeiran community through the development of technologies that improve the quality of life of those with special needs. She obtained an International Society for Virtual Rehabilitation's (ISVR) Early Career Investigator Award, officially announced at the International Conference on Disability Virtual Reality and Associated Technologies in Los Angeles, California in September this year.

The whole technology developed can be easily transferred, adapted and integrated in other geographies.

1. Relevancy of the Good Practise (GP) project

The “Relevancy of the GP project” section provides quick check and definition of its relevancy in regards to HoCare project objectives.

Good practice of quadruple-helix cooperation in R&I?	Yes, this GP project includes good practices of quadruple-helix cooperation in R&I
Good practice of delivery of Home Care R&I?	Yes, this GP project includes good practices of delivery of Home Care R&I.
If not in Home Care R&I, describtion and proof of its potential for transferability to delivery of Home Care R&I	
Generation of innovation in home care through answering unmet needs identified by formal or informal healthcare providers?	Yes, this GP project includes good practices of innovation through answering unmet needs.
Generation of innovation in home care through public driven innovation?	Yes, this GP project includes good practices of public driven innovation.
Generation of innovation in home care via quadruple-helix cooperation for quicker delivery to the market?	Yes, this GP project includes good practices of innovation via cooperation for quicker delivery to the market.

2. Quick overview of the GP project

The “Quick overview of the GP project” section provides initial overview of the good practice project (GP project) and enables readers to see if this GP project idea is relevant for possible transfer to their organization potential innovation activities.

Name of the GP project	REHABNET – NEUROSCIENCE BASED INTERACTIVE SYSTEMS FOR MOTOR REHABILITATION
Region of origin of GP project	Madeira, Portugal
5 keywords that best describe the content of the GP project	clinical research, ICT, rehabilitation, upper-limb rehabilitation, robotics, human computer interaction (HCI), neurofeedback and neuroscience
Relevant Programme name through which the GP project has been funded	RehabNet project has been financed by the EC under the call FP7-PEOPLE-2011-CIG - Marie-Curie Action: "Career Integration Grants".
Relevant support programme / intervention area name of the GP project through which it was funded	

Single or multiple recipients?	single recipient
Type of lead recipient and its role (SME, LME, research centre, innovation centre, network/association, university/school, municipality, other public body, other (specify)	research centre
Types of participating partners and their roles (list all participating partner types. E.g.: hospital, social house, senior house, patient association, networks, SMEs, LMEs, research actors, business supporting organizations, public institutions/regulators, other (specify)	Research institute of university, universities, centres of research in, collaboration with the regional health system (SESARAM)

3. Transferability

The "Transferability" section provides more detailed review of strengths and weaknesses of this GP project including description of necessary basic conditions for region and leading organization to potentially transfer it. At the end of the section, the key threats in the successful transfer open up possibility to focus on specific relevant issues important for the successful transfer.

Strengths and weaknesses of the project

What are the GP project strengths? Why it was funded?	Innovation driven highly advanced systems related with health networks, various partners from universities to research centres, possibility of being funded in various sectors from Marie Curie program, other h2020, national programs and others. Funded by FCT.
What are the key weaknesses of the GP project?	Not funded in an OP. Short linkage with investors. Not funded among H2020.

Basic conditions for successful transfer

Why is this GP project transferable? – innovation, impact, financial, legal, and timeframe aspects	It is an innovation applied to healthcare addressing a social issue and contributing towards strategies to make the public health systems more sustainable and effective. It has commercial potential.
What are the basic conditions the region needs to have to be successful in transferring this good practise?	The involvement of the health sector, and resources for the acquisition of the technology The costs of the implementation depend on the system. The basic one requires only a computer and a printer and can be used on a web browser. The typical one a computer with a 3D accelerator (~1000 eur), a webcam (20 eur) and a custom made handle interface (30 eur). The most complex one requires a computer with a 3D accelerator (~1000 eur), a Head Mounted Display (~1000 eur), a Brain Computer Interface (from 750 to 20000 eur) and a custom made haptic feedback system (~100 eur). All these costs have to be added to the installation and setup costs as well as any possible licenses or royalties that derive from the work that have to be negotiated with the institution owning the IP.
What are the basic conditions	space to install the technology, specific training with the rehabilitation

the leading recipient from the region needs to have to be successful in transferring this good practice?	professionals (physicians and therapists)

Key threats in GP project transfer

What are the key potential threats for the GP project transfer?	Inefficiency in addressing the needs of the region to the investor's investments list. Lack of competitiveness to address investors interests and get investors to intervene in other areas and geographies.

4. Description of the GP project

The "Description of the GP project" section provides more detailed information on the Good Practice project (GP project) and enables readers to get further detailed inspiration and easy ready-to-use information for possible innovation transfer to other project applications. This includes: tackled problem, time length of the GP project, objectives, phases, activities and deliverables of the GP project, its main innovation and target group.

Description of the tackled problem

What was the problem / challenge tackled by the project?	Development of a novel rehabilitation paradigm based on an ICT upper-limb rehabilitation system.
What were the reasons for the problem?	The chronic diseases trends make elderly people to stay in danger if not monitored, therefore the goal was to provide support and connectivity from elderly persons to their caregivers not only when they are at home, but especially when outside at streets.

Time length of the GP project

What was the time length of the GP project in months?	48

Objectives of the GP project

Describe the overall and specific objectives of the GP project	1) Accessibility: Since 85% of stroke survivors will present a motor deficit, the system was design so it can be used by the widest range of patients, and in particular by those with worse prognostic. Our partnership with Myomo Inc. (Boston, USA) in this project allowed us to take advantage of a unique wearable and portable robotic device that restores correct limb position with integrated EMG measurement capabilities (mpower1000). 2) Effectiveness: Our neurorehabilitation training paradigm takes into account concepts of occupational and physical therapy, motivational and engagement factors intrinsic to gaming, and robotics, and puts them at the service of a clear neuroscientific hypothesis on how to effectively mobilize brain plasticity for a functional recovery. In RehabNet we developed, a combination of a Virtual Reality (VR) training task with an automatically adjustable robotic assistance level. 3) Multimodal data: In order to understand the plastic changes that the brain undergoes during the upper-limb rehabilitation process, were able synchronously collect data on the patient behaviour (his/her physical movements and their

	quality), analyse how behaviour relates to task performance (successful vs. failed motor actions), and assess which are the particular brain activity patterns that relate behaviour with performance and successful functional recovery (EEG).

Phases, activities and deliverables

List all main phases of the GP project including their time length	- Pilot Testing and Evaluation
List and describe all **main activities that were implemented by the GP project**	The project is completed but more clinical trials will follow to assess the impact of all developed components. So far the Reh@City system has been tested and validated (training thorugh virtual reality simulations of activities of daily living), but clinical trials for the NeuRow system (use of brain computer interfaces and virtual reality for upper limb rehabilitation) are still taking place.
List all main deliverables of the GP project	

Main innovation of the GP project

What was the main innovation of the GP project?	In RehabNet we developed, in close collaboration with our clinical partner, the Hospital of Funchal (SESARAM), a combination of a Virtual Reality (VR) training task with an automatically adjustable robotic assistance level. Technology was put in place at the Hospital Dr. Nélio Mendonça and clinical trials made with real patients. The impact of using the system for Neuro rehabilitation with people who suffered strokes, was assessed, and results were positive.

Target group of the project

Who was the main target group of the GP project? (SME, LME, research organization, university, public institution, healthcare provider, business supporting organization, other (specify)	Health care organizations, end users, Hospitals, health centres.
Describe the main target group	

5. Impact

The “Impact” section provides more detailed information on the effect of the GP project implementation and dissemination of major outputs.

Impact

What was the level of geographical impact of the GP project? (village, city, county, country, international, other	Region

(specify)	
What were the final impact indicators including their quantification?	During the project, 4 novel rehabilitation scenarios were developed: (1) a bimanual motor training, (2) a dual motor cognitive-motor training for attention and memory, (3) a simulated city for the training of Activities of Daily Living in an ecologically valid context, and (4) a Motor Imagery based brain computer interface (BCI) system that combines VR with EEG based neurofeedback for motor rehabilitation. The project is completed but more clinical trials will follow to assess the impact of all developed components. So far the Reh@City system has been tested and validated (training through virtual reality simulations of activities of daily living), but clinical trials for the NeuRow system (use of brain computer interfaces and virtual reality for upper limb rehabilitation) are still taking place. - Pilot Testing and Evaluation - Clinical trials of all developed components
Describe the changes resulted from the project activities	While being a research based initiative, patients as representative of user/citizen helix actors were invited to participate in the design process of the RehabNet solution through their involvement in user-centered design (UCD) during cognitive rehabilitation content specification process.

Dissemination of outputs

Describe dissemination activities of the project outputs carried out during the GP project	Most of the products resulting of the RehabNet project have been made available freely online to facilitate technology transfer and adoption, in particular to the clinical community and final end users. The solution is ready to be deployed as AS A SERVICE based solution, based on web technologies. It has not been transferred but: - One of the project outcomes is the participation in the "Open Rehab Initiative", what we define as the "The go-to community for clinicians, scientists, engineers, game developers and end-users to interact with and share virtual rehabilitation tools". This is a user-friendly portal where the community who build and use software tools for virtual rehabilitation can easily communicate, interact and share with these tools. Here you will find software, drivers, and documentation of evidence and application, discussion boards, blogs. In this website we have made available 2 applications that came out of the RehabNet project. - There are 3 clinics of the "Centro Medico Murtosa" group where this technology has been deployed and tested. - The remaining knowhow and applications have not been transferred or licensed to any other institutions. SESARAM project of neurorehabilitation - http://neurorehabilitation.m-iti.org/lab/rehabnet-2/ Open Rehab Initiative: http://www.openrehab.org/ Brain computer Interface aplication: http://neurorehabilitation.m-iti.org/bci/ Task Generator: http://neurorehabilitation.m-iti.org/TaskGenerator/ Youtube channel: https://www.youtube.com/neurorehablab Facebook: https://www.facebook.com/NeuroRehabLab Blog: http://sergibermudez.blogspot.pt/ RTP coverage: • https://www.youtube.com/watch?v=DrtlG6yvBZM • https://www.youtube.com/watch?v=LTIc03DgfNc • https://www.youtube.com/watch?v=HcSjXC40SGQ • https://www.youtube.com/watch?v=-ThF4du5DaY

6. Risks

The “Risks” section provides more detailed review of potential risks of this GP project implementation including their defined mitigation strategies to eliminate them.

Describe risks involved in implementing this GP project including their mitigation strategies	Low acceptance by the clinical and patient community Mitigated through training and information

7. Budget

The “Budget” section provides more detailed review of costs regarding the project implementation as well as operational sustainability after its end. In addition, if relevant, public tenders within the project and additional generated incomes by the project are showed and explained.

Budget

What was the overall budget of the project in EUR?	100.000 EUR
List relevant budget lines of the project including their % share from total budget	Equipment and personnel

Additional income generated by the project

Did the project create any additional income?	no, the GP project did not generate additional income
If yes, specify which type of income and what amount in EUR?	

Public tender

Did the project include any public tender?	no, the project did not include a public tender
If yes, specify what kind of contract (specific contract, general contract, other)	
If yes, specify in what amount in EUR	
Describe the public tender subject	

Financial sustainability after GP project end

Was there an operational financial sustainability	no, the GP project did not include an operational financial sustainability plan

plan in the project after its end?	
If yes, specify where the operational funds after project end came from?	
If yes, specify the amount of operational funds in EUR	

8. Other information

In this section, specific additional information about the GP project could be revealed.

Please describe any other relevant information about this GP project (if relevant)	

9. Information gathered by …

The information about this good practise (GP) project has been gathered for the purpose of the HoCare project (Interreg Europe Programme) by the following organization:

Region	Madeira
Organization name(s)	Madeira Interactive Technologies Institute
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