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ADAPT

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ADAPT Project Publications Booklet



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Adapt Project

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INTRODUCTION

The ADAPT project (Assistive Devices for empowering disAbled People through robotic Technologies) ran from January 2017 to June 2022. It was co-financed by the European Regional Development Fund within the framework of the INTERREG VA France (Channel) England programme. It gathered 16 partners, 8 French and 8 English, around two major social and economic issues: the ageing population and those with disabilities.

The aging of the population and the increase in patients with chronic impairments are two challenges that the European Union must face. These are often accompanied by a loss of autonomy and social ties. In some cases, the use of an Electric Powered Wheelchair (EPW) makes it possible to regain this autonomy and a social life (62 per 10,000 people in France, 200 per 10,000 people in the UK). However, some EPW users suffer from confinement; have difficulty assessing the EPW; and some point to difficulties in choosing the most appropriate EPW for their needs.

In response to these difficulties, studies highlight the key role of Assistive Technologies (AT), Social Assistance Robotics (SAR) and intelligent EPWs in meeting the mobility and autonomy needs of vulnerable people to (re-)integrate them into society. However, obstacles remain to the use of these innovations (standardization, interoperability, low involvement of end users, lack of training for health professionals on AT / SAR themes, lack of funding model).

To overcome these obstacles, the ADAPT partnership was based on a global innovation strategy, working on developments from TRL 4 to 8 and training in AT / SAR. The issues of profitability and standardization of products was integrated upstream in order to facilitate

Le projet ADAPT (Dispositifs d'assistance à l'autonomisation de personnes handicapées grâce à la robotique), cofinancé par le Fonds Européen de Développement Régional dans le cadre du programme INTERREG VA France (Manche) Angleterre, a déroulé en janvier 2017 jusqu'à juin 2022. Il a réuni 16 partenaires, 8 français et 8 anglais, autour de deux enjeux socio-économiques majeurs : le vieillissement de la population et l'augmentation du nombre de personnes fragilisées.

Le vieillissement de la population et l'augmentation des patients atteints de déficiences chroniques sont 2 défis auxquels l'Union Européen doit faire face. Ceux-ci s'accompagnent souvent d'une perte d'autonomie et de liens sociaux. Dans certains cas, l'utilisation d'un Fauteuil Roulant Electrique (FRE) permet de retrouver cette autonomie et une vie sociale (62/10000 personne en FR - 200/10000 au RU). Néanmoins, certains utilisateurs de FRE souffrent de confinement; éprouvent des difficultés à évaluer le FRE; et certains soulignent des difficultés pour choisir le FRE le plus approprié à leurs besoins.

En réponse à ces difficultés, des études soulignent le rôle clé des Technologies d'Assistance (AT), de la Robotique d'Assistance Sociale (SAR) et des FRE intelligents (JRRD 2008) pour répondre aux besoins de mobilité et d'autonomie des personnes fragilisées pour les ré-inclure dans la vie sociale. Cependant, des obstacles subsistent à l'utilisation de ces innovations (standardisation, interopérabilité, faible implication des utilisateurs finaux, manque de formations des professionnels de santé sur les thématiques des AT/SAR, déficit de modèle de financement).

Pour dépasser ces obstacles, le partenariat s'appuiera sur une stratégie globale d'innovation, basée sur des développements de TRL 4 à 8 et des formations en AT/SAR. Les enjeux de rentabilité et standardisation des produits seront intégrés en amont afin de

marketing. Pre / post questionnaires were proposed during the project to measure the added value of the results and include them in a process of continuous improvement.

The project was divided into 4 work packages:

- WPT1: Electric Powered Wheelchair (EPW) Simulator platform using virtual reality. This gives the user an immersive experience of the Smart and Connected EPW and facilitates training them to drive in everyday life.
- WPT2: Smart and connected Electric Powered Wheelchair (EPW) to compensate for user disabilities through driving assistance technologies and report users' health through connection with Internet.
- WPT3: Training of healthcare professionals in AT/SAR. This novel training provision addresses a gap in the current healthcare education.
- WPT4: Formalized agreements between research institutions and companies built through events, ranging from local to international meetings to create synergies and promote and disseminate ADAPT's results.

The project has resulted in 83 scientific publications to date. This booklet provides a brief overview of each of the three technical work packages (WPT1 – WPT3) and lists the corresponding resulting scientific publications within each work package section.

faciliter la mise sur le marché. Des pre/post questionnaires seront proposés durant le projet pour mesurer la valeur ajoutée des résultats et l'inscrire dans une démarche d'amélioration continue.

Le projet a été divisé en 4 modules de travail :

- *WPT1 : la réalisation d'un fauteuil roulant électrique (FRE) intelligent et connecté compensant les handicaps des utilisateurs grâce à des technologies d'assistance à la conduite.*
- *WPT2 : la réalisation d'un simulateur de conduite en réalité virtuelle pour une expérience immersive du FRE intelligent.*
- *WPT3 : la mise en place d'un package de formation destiné aux professionnels de santé sur les apports du Numérique pour les Technologies d'assistance.*
- *WPT4 : Les accords de partenariat entre instituts de recherche et entreprises intégrés grâce à des événements locaux et internationaux pour créer des synergies, promouvoir et diffuser les résultats du projet.*

Le projet a donné lieu à 83 publications scientifiques à ce jour. Cette brochure donne un bref aperçu de chacun des modules de travail techniques (WPT1 – WPT3) et répertorie les publications scientifiques correspondantes dans chaque section de module de travail.

WPT1 EPW SIMULATOR VIRTUAL REALITY PLATFORM

The objective of this work package (WPT1), led by INSA Rennes, was to design and evaluate an electric power wheelchair driving simulator in order to increase user autonomy and better understand and manage user rehabilitation.

The core activity of this work package was to establish bridges between “in silico” (definition of a power wheelchair simulator hardware and software system); “in virtuo” (interactive and real-time evaluation of the simulator in an immersive environment representing everyday life situations including indoor and outdoor navigation); and finally “in vivo” evaluation in a clinical environment through user feedback and the development of software for recording and analysing the user's driving patterns and response to the simulator.

This two-step work package focused first on the definition of the functional analysis of the system, to identify, characterize, and organize the functions and functionalities to be designed and integrated into the platforms. The second step consisted of the development of the software and hardware modules required to deliver the final technological platform. These developments were assessed through rigorous evaluation involving all stakeholders. Experiments were first carried out in laboratories and were then followed by clinical evaluations and user tests performed within clinical and living lab environments.

The key scientific outputs of this work package can be found next in the subsection **WPT1 Bibliography**, before we go on to present **WPT2 Smart and Connected Robotic EPW**.

Ce module de travail, piloté par INSA Rennes, vise à la conception et à l'évaluation d'un simulateur de conduite de fauteuil roulant électrique pour favoriser l'autonomie et la prise en charge du handicap.

Le principal objectif de ce MT est d'établir un pont entre le “in silico” (définition d'un simulateur de conduite de fauteuil paramétrable composé de matériels et de logiciels), le “in virtuo” (expérimentation fonctionnelle interactive et temps-réel du simulateur dans un environnement immersif représentant les situations écologiques de la vie quotidienne : navigation dans la ville, navigation dans un environnement intérieur) et enfin le “in vivo” (expérimentations cliniques en environnement hospitalier). Un logiciel de stockage et d'analyse de données complètera les retours d'expériences exprimés par les utilisateurs.

Ce MT se structure autour d'une part de l'analyse-système de ces aides techniques innovantes. Il s'agit de réaliser l'analyse fonctionnelle des systèmes afin d'identifier, caractériser, ordonnancer les fonctions ou fonctionnalités à concevoir et à intégrer aux plateformes technologiques. D'autre part, le développement de briques logicielles et matérielles pour la réalisation de ces plateformes technologiques fera l'objet d'évaluations minutieuses. Des campagnes de mesures seront tout d'abord menées en laboratoire et seront suivies d'évaluations cliniques et de tests d'usage réalisés au sein des structures hospitalières et des structures de type living labs.

*Les principaux résultats scientifiques de ce module de travail se trouvent ensuite dans la sous-section **WPT1 Bibliography**, et puis on présente le **WPT2 Smart and Connected Robotic EPW**.*

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WPT2 SMART AND CONNECTED ROBOTIC EPW

WPT2 aims to improve user quality of life by providing a multi-layer EPW driving assistance system, adapting to disabilities, to develop user access to and increase mobility. The core activities of WPT2 are hence to tackle and combine three layers of navigation assistance that are:

- i) the reactive and interactive layer
- ii) multi-sensor-based path following layer, exploiting 3D models of environments and cities,
- iii) the collaborative guidance layer : intra-collaboration, i.e. high-level collaboration between the user and his EPW ; and inter-collaboration, i.e. collaboration between EPWs in order to share their experience (paths) to ensure accessibility in real-time ("cloud" connected EPW to the Internet with urban Wifi or 4G).

The latter connected capability will be crosslinked with health sensing instrumentation of the wheelchair that offers several interests as:

- remote health monitoring of the user, with adapted user-machine interfaces
- auto-switch of driving assistance mode in order to adapt automatically the EPW system to varying disability state of the user

Work focuses first on the definition of the capabilities requirements (usage scenarios), and subsequent functional analysis of the system. Then, these innovations will be assessed rigorously with experiments in clinical and living lab facilities for indoor and outdoor use. Healthcare professionals will take part in developing the specifications and experiments to ensure relevant training (WPT3).

Le WPT2 vise à améliorer la qualité de vie de l'utilisateur grâce à un système multicouche d'assistance à la conduite de FRE, auto-adaptatif aux handicaps, pour développer et accroître l'accès à la mobilité. Le cœur d'activité du WPT2 est donc de traiter et associer 3 couches d'assistance à la conduite :

- i) couche réactive et interactive*
- ii) couche suivi de trajectoire basée multicapteurs, exploitant des modèles 3D d'environnements et de villes*
- iii) couche guidage collaboratif : intra-collaboration collaboration haut-niveau entre l'utilisateur et son FRE); inter- collaboration (collaboration entre plusieurs FRÉ afin de partager leurs expériences (trajectoires) pour assurer l'accessibilité en temps réel - FRE connecté via Internet par Wifi urbain ou 4G).*

Cette connexion internet permettra également d'instrumenter le FRE pour le suivi de la santé du patient pour :

- moniter les paramètres de santé de l'utilisateur, avec interfaces adaptées utilisateur-machine*
- commutation automatique du mode d'assistance à la conduite pour adapter automatiquement le FRE au handicap de l'utilisateur*

Les travaux porteront sur la définition des besoins (scénarios d'usage), l'analyse fonctionnelle du système et le développement. Ensuite, ces innovations seront évaluées en essai clinique et en living lab, pour utilisation en intérieur et en extérieur. Cette plateforme matérielle servira également dans le WPT3 pour former les professionnels de santé.

The key scientific outputs of this work package can be found next in the subsection **WPT2 Bibliography**, before we go on to present **WPT3 Training of Healthcare Professionals in Assistive Technologies**.

*Les principaux résultats scientifiques de ce module de travail se trouvent ensuite dans la sous-section **WPT2 Bibliography**, et puis on présente le **WPT3 Training of Healthcare Professionals in Assistive Technologies**.*

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WPT3 TRAINING OF HEALTHCARE PROFESSIONALS IN ASSISTIVE TECHNOLOGIES

WPT3, led by CCCU (co-leader BREIZH PC), has developed training for healthcare professionals to support Electric Powered Wheelchairs (EPW) users and to engage with Assistive Technology (AT) [e.g. Augmentative & Alternative Communication (AAC) and Socially Assistive Robotic (SAR) systems]. AT is increasingly embedded in the care of EPW users in the UK and France. A competence training framework has been developed for professionals to enable clients to make more effective use of this technology. This has been achieved by:

- 1) cross-border benchmarking of existing AT services, professional training and training evaluation evidence
- 2) cross-border assessment of training needs of professionals through online survey of AT knowledge, attitudes and experience (both 1 & 2 will provide the basis of training)
- 3) development of UK/FR training materials at pre/post-qualifying levels as well as Continuing Professional Development (CPD) by engaging with an advisory group of professional bodies, public/private agencies, family carers and services providers + development of training materials for the health-trainers. The training courses were built upon the work carried out in WPT1 and WPT2 and previous INTERREG projects (COALAS, SYSIASS, EDECT). Academics in charge of training health professionals and engineers have worked closely to develop common training materials
- 4) cross-border delivery of training of health professionals + trainers
- 5) evaluation of training efficiency for continuous improvement. This also made it possible to improve the platforms developed in WPT1 and WPT2 which are an integral part of the training protocols

Le WPT3 piloté par CCCU (co-responsable BREIZH PC), a développé les formations des professionnels de santé pour aider les utilisateurs de FRE à s'engager vers les AT. Ces technologies sont de + en + intégrées dans les soins aux patients de FRE au UK et en France. Pour définir ces modules de formation, plusieurs jalons ont été franchis:

- 1) *recensement transfrontalier des services AT existants et des formations professionnelles*
- 2) *évaluation transfrontière des besoins de formation des professionnels par une étude des savoirs, des attitudes et des expériences sur les AT*
- 3) *développement de supports de formation RU/FR au niveau pré/post-qualifiant ainsi que pour la formation continue supervisé par un groupe consultatif d'organisme professionnel, agences publiques/privées, aidants familiaux et prestataires de services. Développement des supports de formation pour les formateurs. Les formations ont été construites à partir des travaux menés en WPT1 et WPT2 et des précédents projets INTERREG (COALAS, SYSIASS, EDECT). Les universitaires en charge de la formation des professionnels de santé et les ingénieurs ont travaillé étroitement pour développer des supports de formation communs*
- 4) *session de formation des professionnels de santé + sessions pour les formateurs*
- 5) *évaluation de l'efficacité des formations dans une démarche d'amélioration continue. Ceci a permis également d'améliorer les plateformes développées en*

WPT1 et WPT2 qui sont parties intégrantes des protocoles de formation

The key scientific outputs of this final technical work package can be found next in the subsection **WPT3 Bibliography**.

*Les principaux résultats scientifiques de ce dernier module de travail technique se trouvent ensuite dans la sous-section **WPT3 Bibliography**.*

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