

Welcome to the fourth of the six monthly newsletters for the CuPiD project.

CuPiD Pilot

At the beginning of July 2013, the first pilots with the CuPiD system were performed. These pilots were the first occasion for Parkinson patients to get in contact with the actual CuPiD technology. The pilots were performed by the project's clinical partners Tel-Aviv Sourasky Medical Center, Israel and KU Leuven, Belgium. This work led to clear information for further development of the system by the consortium's technical partners. In general, people showed a positive attitude towards the first prototypes and were eager to test future versions of the CuPiD system.



Patient working with the exergame 'touch and explode'

The picture above shows a patient working with the exergame 'touch and explode'. The aim of the game is to make patients reach and use their trunks to stabilize themselves, while being challenged by the images. In later stages this game can be done from standing. Also, a cognitive challenge can be added to make the game more difficult. As the exercise is meant to be done at home, the CuPiD project is about offering interesting and motivating applications that are an invitation to extend the patient's physical boundaries.

Partners:

Università di Bologna (Italy)
Tel-Aviv Sourasky Medical
Center (Israel)
Eidgenössische Technische
Hochschule Zürich
(Switzerland)
KU Leuven (Belgium)
Oxford Computer Consultants
(UK)
ST Microelectronics (Italy)
EXEL (Italy)
Fundació Illes Balears
Innovació Tecnològica (Spain)

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Closed-loop system for personalized and at-home rehabilitation of people with Parkinson's disease

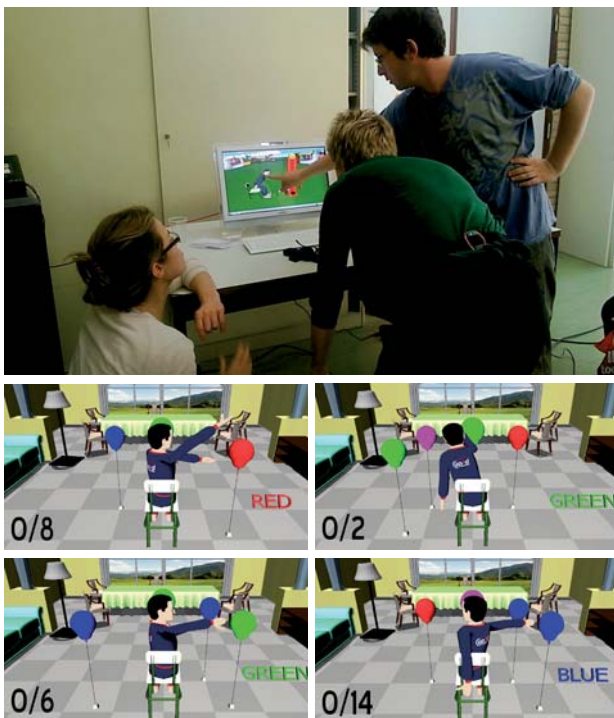
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Testing and receiving patients' feedback is crucial for the development of the system as well as ensuring the safety and appropriateness of the exercises.

KUL Meeting

Some of the consortium members gathered together in June, for a technical meeting to discuss the development of and assess cognitive rehabilitation using exergaming. Partners were able to see the progress that had been made and discussed upcoming developments.



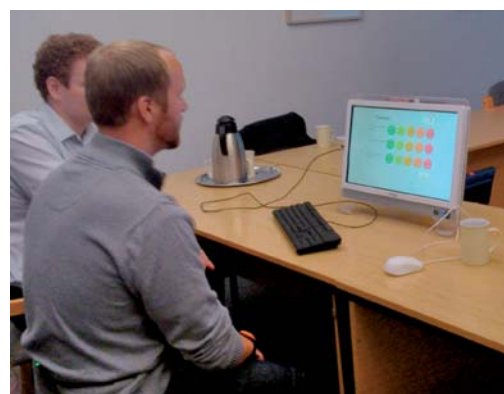
Exergaming Development

Oxford Brookes Demonstration Day

Recently, The Oxford Brookes University Movement Science Group (MSG) visited OCC for a demonstration of the CuPiD telemedicine system and exergaming.

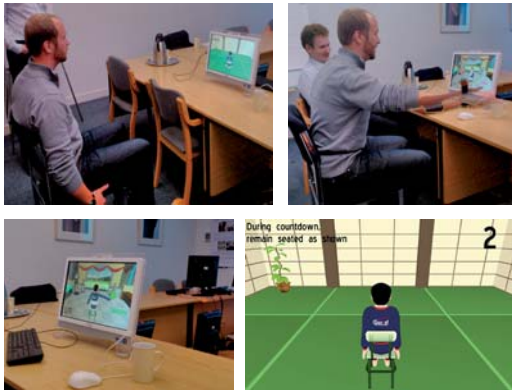
Professor Helen Dawes, Group Leader of MSG, and Dr Patrick Esser, Research Fellow, are experienced in many disciplines relevant to CuPiD, including research into Parkinson's disease (PD), analysing gait and using wearable sensors to measure movement.

OCC demonstrated CuPiD end-to-end, from the technician configuring the CuPiD home system for the patient, to the use of CuPiD Home through its touch screen to following up the results in the CuPiD clinical application.



Oxford Brookes trying the telemedicine system

OCC used IBIT's Exergaming as the example of a CuPiD service closest to Oxford Brookes' interests.



Oxford Brookes trying the exergaming

The telemedicine infrastructure will be available under open source licence at the end of the CuPiD project.

Wireless Body Area Networks

Casamassima Filippo, from CuPiD lead member, University of Bologna attended the Body Sensor Networks Conference 2013 (BSN2013) at MIT, Cambridge, USA, 6-9 May 2013. At BSN2013, Casamassima presented a paper on Wireless Body Area Networks (WBANs) which demonstrates possible synchronization methods for CuPiD Sensor nodes.

Wireless Body Area Networks can take advantage of many wireless protocols. Among them, Bluetooth is a good candidate since its widespread adoption guarantees compatibility with a number of devices and significantly reduces development time. In most cases data collected from different sensors on

different nodes needs to be synchronized. We present a synchronization protocol that makes use of Bluetooth piconet internal clock to achieve near-millisecond accuracy with minimal radio communication overhead. Experimental results show that Bluetooth low power mode does not negatively affect accuracy, but improves it, uses less power consumption and higher synchronization accuracy.

SIAMOC 2013

At the end of September, Alberto Ferrari attended SIAMOC 2013 in Pisa and gave an oral presentation on CuPiD. The work is entitled "Wearable system for auditory feedback based on real-time gait analysis: Application on patients with Parkinson's Disease".

Quantification of Motor Impairment in Parkinson's Disease

Lead consortium member, University of Bologna, has published an article, Quantification of Motor Impairment in Parkinson's Disease Using an Instrumented Timed Up and Go Test, in Neural Systems and Rehabilitation Engineering, IEEE Transactions (Volume:21 , Issue: 4).

The Timed Up and Go (TUG) test is a clinical test to assess mobility in Parkinson's disease. It consists of rising from a chair, walking, turning,



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and sitting. Its total duration is the traditional clinical outcome. In this study, an instrumented TUG (iTUG) was used to supplement the quantitative information about the TUG performance of PD subjects: a single accelerometer, worn on the lower back, was used to record the acceleration signals during the test and acceleration-derived measures were extracted from the recorded signals.

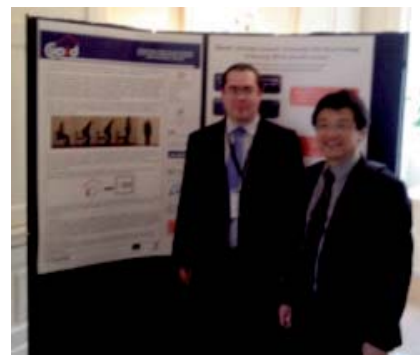
The aim was to select reliable measures to identify and quantify the differences between the motor patterns of healthy and PD subjects; in order to do so, besides comparing each measure individually to find significant group differences, feature selection and classification were used to identify the distinctive motor pattern of PD subjects. A subset of three features (two from Turning, one from the Sit-to-Walk component), combined with an easily-interpretable classifier (Linear Discriminant Analysis), was found to have the best accuracy in discriminating between healthy and early-mild PD subjects.

These results suggest that the proposed iTUG can characterize PD motor impairment and, hence, may be used for evaluation, and, prospectively, follow-up, and monitoring of disease progression.

King's Fund Annual International Congress on Telehealth and Telecare

OCC represented CuPID for the Third International Congress on Telehealth and Telecare at the King's Fund, London on 1-3 July 2013.

Andrew Muddiman presented the CuPID project at the Rapid fire poster session on day 2. Andrew was accompanied by Tim Palmer, who both spent the day answering questions and networking with delegates at the CuPID stand.



Tim explaining CuPID to Richard Chin (SoCal, USA)

CuPID discussed with O2 Health and Philips the possibility of using their respective telemedicine platforms to host services as well as how they realize their routes to the market.

There was interest and discussions around the acceptance of telemedicine into the wider community, the best funding model to employ and how telemedicine-based services will be

purchased by the public in the general market. The final panel session even questioned whether the terminology used (telemedicine, telehealth and telecare) was a barrier and concluded that next year's conference will have a different title.

Oxford Parkinson's Disease Centre Research Day

Andrew Muddiman and Laura Walton from OCC attended an insightful Research Day at the Oxford Parkinson's Disease Centre, on 10th September 2013. The day was made up of a series of talks looking at various aspects of Parkinson's disease and a poster abstract display.

The day included Keynote lectures on: The role of data integration in resolving the genetic basis of Parkinson's disease by Dr Andrew Singleton (Chief of Molecular Genetics Section and Laboratory of Neurogenetics, NIA, NIH) and Is Parkinson's disease a prion-like disorder? by Dr Patrik Brundin (Director of the Center for Neurodegenerative Science, Jay Van Andel Endowed Chair in Parkinson Research).

Other topics included: Phenotypic alterations in Parkinson's patient-derived neurons, loss of reward modulation of vigour in Parkinson's disease patients, Neuropathology: transitional potential in Parkinson's

disease research and Exome resequencing of the OPDC Cohort.



Andrew next to the CuPID poster

Andrew and Laura, spent the breakout sessions discussing CuPID and networking with delegates at the CuPID poster.

Artificial Intelligence in Medicine Conference 2013

Luca Palmerini and Lorenzo Chiari from lead consortium member, University of Bologna, attended the Artificial Intelligence in Medicine Conference 2013 in Spain, to present Classification of Early-Mild Subjects with Parkinson's Disease by Using Sensor-Based Measures of Posture, Gait, and Transitions.



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The presentation was then published in a book containing all the proceedings entitled Artificial Intelligence in Medicine, Lecture Notes in Computer Science Volume 7885.

The presentation focuses on the evaluation of posture, gait, turning, and different kinds of transitions, which are key components in the clinical evaluation of Parkinson's disease (PD). The aim of this study is to assess the feasibility of using accelerometers to classify early PD subjects (two evaluations over a one-year follow-up) with respect to age-matched control subjects. Classifying PD subjects in an early stage would allow the use of a tool to follow the progression of the disease from the early phases to the final ones and to evaluate the efficacy of different treatments. Two functional tests were measured by one accelerometer (quiet standing, Timed Up and Go test); such tests carry quantitative information about impairments in posture, gait, and transitions (i.e. Sit-to-Walk, Walk-to-Sit and Turning). Results with satisfactory accuracies are obtained in the classification of PD subjects by using an ad hoc wrapper feature selection technique.

2013 International Joint Conference on Pervasive and Ubiquitous Computing

In September, Alberto Ferrari and

Filippo Casamassima from University of Bologna attended the 2013 International Joint Conference on Pervasive and Ubiquitous Computing (UbiComp 2013). They presented a poster and a gave a demonstration on Wearable audio-feedback system for gait rehabilitation in subjects with Parkinson's disease.

Abstract
Parkinson's disease (PD) is classified as a chronic movement disorder. We have developed a new platform to support gait rehabilitation in PD patients. By using a smartphone and inertial wearable sensors it is possible to analyze and evaluate the patient's gait in real time. The system returns an appropriate audio bio-feedback (ABF) message, tuning user's gait performance. Main advantages of our approach are mobility and unobtrusiveness: the system can be easily used by patients with no gait restrictions.

Usage scenario
Once the system is calibrated in the clinic, it can be autonomously used at home by the patients. The training session of three weeks (sessions or intervals) with sessions of 30 minutes. The ABF system measures the gait parameters selected by the clinician and compares them with respect to reference values (over a number of sessions) (e.g. every 6 weeks). Positive visual information is returned to ease the patient in walking close to his/her specific reference values. Audio messages are given every time the patient is below or above the target zone.

System architecture
The ABF system, designed and developed in the context of the CuPiD project, is essentially composed by three elements: a smart sensor node, an Android mobile phone and the ABF application.

Wearability
Mobile phone with ABF application
Headphones for audio feedback
Inertial sensors

Usability
The software assembles an event-driven finite state machine with 3 available states: disconnected, connected and calibrated. Once the system is calibrated, it allows the patients to enable the ABF training by simply pressing one single button at the beginning of the session, with no need to handle sensors and other ABF settings.

Conclusion
By embracing a fully portable and wearable solution, the proposed system supports the patient's gait rehabilitation via real-time audio feedback restoration. The system is now being used for pilot trials with PD patients, whose feedback and comments will be employed to refine the application for a more extensive clinical usage.

CuPiD display at UbiComp 2013

Parkinson's Disease Café, Oxford Town Hall, 3 July 2013

Laura Walton, Daniel Huggins and Janine Smith from Oxford Computer Consultants attended a very interesting morning about new clinical treatments for Parkinson's disease.

There were three presentations with Q&As and Breakout sessions. Professor Ray Chaudhuri, Medical Director of the NPF Centre of Excellence, Kings College Hospital, London, gave an update on invasive therapies and

interventions which may be available in the future, and Alex Green from the Department of Neurosurgery, The John Radcliffe Hospital, Oxford, discussed drug development. His main research interest is in Deep Brain Stimulation. The patient perspective of clinical trial involvement was given by Richard Windle, patient group representative. All in all, it was a very illuminating morning. You can watch a video of the presentations via EPDA's twitter page or the EPDA YouTube channel (1 hour 16 mins).

AAL Forum 2013

Exel attended the AAL Forum 2013 in Norrköping (Sweden), 24-26 September 2013. The AAL Forum is the annual platform for the increasing European Ambient Assisted Living Community to meet and discuss several topics, relevant for improving the AAL Joint Programme as well as the adoption of AAL solutions in the market.



CuPID display at AAL

The four main themes for this year's forum were:

1. Autonomy, choice and control – AAL solutions impact on individuals – autonomy and ability to choose how to spend their days and live their lives.
2. The ageing society – end-user studies and inclusion – Older adults as a collective and integrated part of the society.
3. AAL and the economy – Economic aspects of AAL solutions – economic growth through new ideas, a new branch and new solutions
4. Programmes and policies in Europe – AAL on the European level – implementation and policy strategies.

Book Chapter Published

CuPID has a chapter in *Telehealthcare Computing and Engineering: Principles and Design* edited by Fei Hu and published in April 2013. The chapter is called *Tele-rehabilitation System Based on Augmented Feedback for People with Parkinson's Disease: Design Principles*. The book *Telehealthcare Computing and Engineering: Principles and Design* focuses on computing science and engineering design rather than the conventional medical and social aspects of design and explains in detail telehealthcare engineering system and individual hardware components.

<http://www.crcpress.com/product/isbn/9781578088027>

CuPID Audio Bio Feedback Video

CuPID lead consortium member, University of Bologna, produced an audio feedback video which demonstrates the Audio Bio Feedback CuPID service. The video shows the system being calibrated in the clinic. Once the sensors are attached to the patient's trunk and legs and have been calibrated the video focuses on the patient walking. The individual is given audio feedback on their gait and given messages to correct their action, for example "please may you increase your walking speed". The video also demonstrates how portable the system is by being used on a smartphone.



Audio feedback

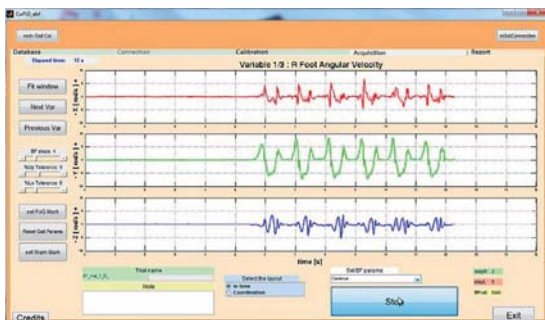
Upcoming:

- ST Microelectronics, UNIBO and EXEL will be presenting the work done by CuPID through videos, posters and demos at ST Technology Days 2013 (organized by ST Microelectronics). These will be held at the National Museum of Science and Technology "Leonardo Da Vinci", Milan, 24-25 October 2013.

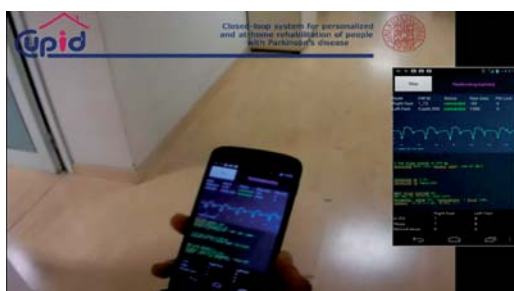
- EXEL and UNIBO will participate also at the Medica 2013 Trade Fair (<http://www.medica-tradefair.com/>) in the Wearable Technology area (http://www.medica-tradefair.com/cgi-bin/md_medica/custom/pub/show.cgi/Web-ExhDatashet/exh_datashet), Düsseldorf, 20-23 November 2013

For more information on the CuPID project visit our website at <http://www.cupid-project.eu>

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Clinic system calibration



Fully portable on smartphone