★ Major depression is now the fourth disorder with the highest disease burden worldwide, at an estimated cost of €177 million per million inhabitants.. Now a unique EU technology project, aims to ease that burden by delivering a flexible, interactive therapy system remotely through the patient's mobile phone and the Web. Project Managers **Dr Mark Hoogendoorn** and **Dr Michel Klein,** both Assistant Professors of Artificial Intelligence at the VU University in Amsterdam (VU), explain how ICT4Depression could ease this complex human condition

Calling time on the cost of treating depression

You might think that in our modern high-tech world health care would be well supported through the latest Information and Communications Technology (ICT). But while physical health care has seen several recent developments of this kind – not least devices to help the elderly or physically disabled in the home – mental health care has hardly seen any. Until now, ICT systems for depression consist mostly of web-based systems that merely act as an interface between a therapist and a patient, or online versions of self-help books.

Now Assistant Professors Hoogendoorn and Klein, together with an interdisciplinary team across other EU countries, are going one stage further. ICT4Depression is a project to develop a user-friendly ICT-based system for people suffering with depression, that automatically provides a patient with the support and self-help they need. Yet unlike any other system, this one involves the use of non-intrusive biosensors attached to the patient's body, developed by PLUX in Portugal, which provide information on heart rate and other vital physiological data, via blue-tooth technology on the patient's mobile, as the patient works through the automated module sent to them by mobile or the Web. "We hope to show that these measurements can be used to interpret the needs of a patient," says Klein.

The project requires a highly skilled consortium of ICT and clinical organisations. On the ICT side, the VU's Artificial Intelligence department has extensive experience of using human behavioural knowledge in ambient intelligence environments. The University of Limerick has expert knowledge of using and combining sensors with mobile phones for activity monitoring, while the Swiss AARDEX Group provides over 20 years of experience in monitoring and enhancing patient adherence to prescribed medications. In Portugal, PLUX, an innovative startup working on wireless biosignal acquisition is developing beyond-state-of-the-art sensors and signal processing techniques, while INESC PORTO provides expertise in the overall system integration.

On the clinical side, the project contains three of the front-running research groups on internet-based interventions for depression, with clinical psychologists from the VU (including Professor of Clinical Psychology Pim Cuijpers), GGZinGeest Institute of Mental Health (Dr Heleen Riper

Michel Klein (left) and Mark Hoogendoorn (right) in the Intertain lab of the VU. They are both holding equipment used and developed by the project.

and others), alongside a research team at Sweden's Linköping University (headed by Professor Gerhard Andersson).

"Like any therapy, it relies on the patient's co-operation and indeed there is a great deal of self-management, to empower them in their own treatment," says Hoogendoorn. "And it's very flexible too – apart from a wide range of self-help therapies on offer, the system is highly mobile for the patient – they can use it freely anywhere, anytime – they're not wired up to a bunch of machines in a treatment room. Moreover, they do not depend on the availability of a therapist, as the mobile phone is always available to the patient."

The mobile delivery allows the patient to interact with the automated system as if a real therapist was providing the feedback, with the patient feeling reassured that the system is aware of their problems and helping them in a very tailored, dedicated way. Yet even if, for some reason, the patient does not wish to insert information into the system, it can still gain invaluable information about their present condition from the wearable physiological sensors attached to the person's body – and a medicine intake monitor, also carried by the patient, which compiles drug dosing history data automatically by electronic time stamping of each patient entry into the medicine package.

The data collected from the discussion, the sensors and the medicine intake monitor is then processed by what Hoogendoorn calls the Intelligent Reasoning (IR) system, to determine the overall condition of the

patient during the session, whether they are following the therapy correctly (and understand how to do so) and their general interaction with the system.

The system then analyses the processed data to tailor future sessions or treatment accordingly.

"The idea is to ensure the patient stays in the system," explains Hoogendoorn, "because that's how they will continue to have the vital support of the system – and of course gain further motivation from the self-help aspects of the therapy, through being actively involved in the process, rather than just passively receiving treatment. The IR system processes the feedback from the self-help modules and allows us to see what the patient might require next. So if their enthusiasm to stay in the course is declining, for example, we can encourage them in the next session by reminding them of the benefits of persevering with it – or perhaps offer a different therapy entirely."
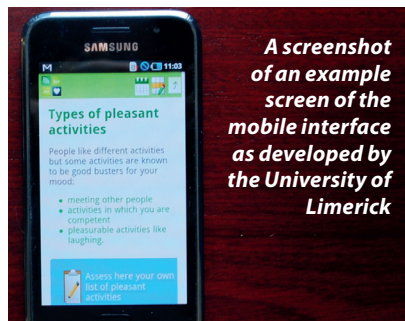
A year on from the start of the project, in January 2010, the team is now in the process of building the first prototypes of the system.

"This has never been done before so there are of course unique challenges to overcome," says Hoogendoorn. "Most importantly, we need a system that the patient will accept because without that it can't really function properly." This involves getting the technology, not least the biosignal acquisition sensors, small and comfortable enough to be unobtrusive and easy to wear.

"We're looking at chest straps for the sensors, for example, to see if that could be the best option," he says.

Integrating the technology with the information is also challenging, not least ensuring that the IR system accurately processes varied data from different sources into a coherent information stream.

"A lot of data has to be interpreted," says Klein. "And for some of the measurements, the precise interpretation of the information is still part of the psychological research." Indeed, it seems the psychologists that develop the self-help modules could be almost overwhelmed by the information they have available, to give the patient dedicated feedback and support via the automated system. Once the prototype has been built, a pilot study will commence at the end of 2011, consis0ting of 100 patients, recommended for the study by their GPs. In fact, this is very much how the system could work for real. "This is designed to be used in the primary care arena, with perhaps GPs recommending it to their patients," says Cuijpers. "Or perhaps patients could ask their GPs for this treatment, because it will allow them to access services in a very different

A screenshot of an example screen of the mobile interface as developed by the University of Limerick

way than the currently available services."

No matter how it is brought to market, Riper hopes the system will bring great advantages for patients and other stakeholders. "What we're doing with ICT4Depression is using technology to support people better and at an earlier stage," she says. "Our research shows that web-based interaction is at least as good as face-to face sessions, without the long wait to be seen. So if this mobile version proves equally successful, it could improve the quality of depression care and even cut the cost of treatment for depression and free up waiting lists at the same time. It's an ambitious goal, but we are striving for the best evidence based healthcare outcomes possible." ★

Mark Hoogendoorn

Mark Hoogendoorn is an assistant professor at the VU University Amsterdam, Department of Artificial Intelligence. Before starting as an assistant professor he has been a visiting researcher at the Department of Computer Science and Engineering of the University of Minnesota. He obtained his Ph.D. degree from the VU University Amsterdam in 2007. His current research interests include multi-agent systems, cognitive modelling, and ambient intelligence. Together with Michel Klein he is the project manager of the ICT4Depression project.

Michel Klein

Michel Klein works as an assistant professor at the VU University Amsterdam, in the section of Artificial Intelligence. He received his Ph.D. degree at the VU University Amsterdam in 2004. His current research theme is the application of Artificial Intelligence techniques to support human functioning.
Specifically, he focuses on technology that supports people in healthcare applications, such as intelligent self-management systems for chronic patients or support systems for people with mental disorders such as depression.
Together with Mark Hoogendoorn he is currently managing the ICT4Depression project.

Pim Cuijpers

Pim Cuijpers is Professor of Clinical Psychology at the VU University Amsterdam (The Netherlands), and Head of the Department of Clinical Psychology. He is also Vice Director of the EMGO Institute for Health and Care Research (www.emgo.nl). He received his PhD at the Radboud University in Nijmegen in 1993 for his thesis on support groups for caregivers of dementia patients. He also worked at the Trimbos Institute (Netherlands Institute of Mental Health and Addiction), as Head of the Prevention Department (1997-2004).

Heleen Riper

Heleen Riper is senior researcher and program leader eMental-Health at the Research Department of GGZinGeest, a large scale mental health service organisation in the Amsterdam region (The Netherlands). She is associated with the EMGO Institute for Health and Care Research (www.emgo.nl) and collaborates with the Dept. of Clinical Psychology of the VU University Amsterdam. Heleen Riper is specialised in the development, evaluation, implementation and policy development of low intensity eHealth interventions for common mental health problems, including depression, anxiety and alcohol use disorders (both on a national and international level).