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ICT 2008 SPECIAL REPORT

Wearable computing pioneered by the wearIT@work project

As the largest project world-wide in 'wearable computing', which incorporates computer technology into clothing, wearIT@work is setting new standards of applicability and integration in this field – with a goal of improving productivity, efficiency and safety in the workplace. Professor **Otthein Herzog**, coordinator of the project, explains some of the applications to date

Set-up by the European Commission under the Sixth Framework Programme and consisting of forty-two partners with a project volume of €23 mn and EU funding of €14.6 mn, the wearIT@work campaign is making strides towards its goal of computer system integration in wearables. In addition, its applications of these new technologies are diverse and, while developing for the industrial workplace, are also pushing the technology into innovative new areas.

The main goal of the wearIT@work project is to 'investigate the user acceptance of wearables'. This is being achieved, as well as methods for user interaction and the identification of successful wearable processes, through the project's four industrial pilot applications and three take-up schemes. The basis for the pilot schemes is focused on four areas: variant production, clinical pathway, maintenance and emergency. The take-up schemes on the other hand, focus on fire prevention in rural areas, cultural heritage and e-Inclusion.

However, despite the high level of research activity and practical application through trials, the apparent benefits of wearable computing, at first, remain unclear. This is something the wearIT@work project wishes to address. The benefits of wearable computing are two-fold: firstly, the technology leads to an increase in productivity, thus allowing simplified access to enterprise information and therefore to faster group decisions, and secondly, increased safety at work and decreased pressure towards automation. In addition to this, it is important to note that the world-wide market for wearable computers generated over $600 mn in 2006, a figure that will increase to over $1.7 bn by 2011.

Wearable computing is not overly intrusive and very effective for information

So how has the project progressed since initialisation? Run in 18-month cycles, the project has developed from early 'Show Cases', through 'System Prototypes' and finally into 'Industrial Pilots' in all four dedicated scenarios and the three take-up applications. Indeed, as the project stands now – underway in all Industrial Pilots and take-up applications – the integration of wearable computing seems inevitable.

Industrial Pilots

By wearing computer-integrated clothing many industries and enterprises, not necessarily office based, can reap the benefits of the wearIT@work project. The wearIT@work: Ward Round Support is a good example as one of the projects' Industrial Pilots, and demonstrates the benefits to healthcare that wearable computing can offer. By equipping physicians and nurses with wearable devices and software systems, wearable computing allows them to access all available patient information at any time and any place in the hospital. This provides them usable, ubiquitous access to information through connections to the clinical server and audio and visual functions, greater data retrieval, an improved quality of information and prevention of patient mix-up through context awareness.

Another Industrial Pilot, Emergency Response: a wearIT@work application field, further demonstrates the benefits wearable computing has to offer. Created to 'push wearable computing to its limits', here the wearIT@work project has worked in co-operation with the Paris Fire Brigade (BSPP) to provide – through wearable computing – Localisation and Navigational Support, Context-Sensitive Information Services and Enhanced Communication systems. These developments have in turn led to improvements in safety, communication and rescue rates.

devices – with the former reporting from the field to the latter at a 'situation room' in direct contact with local fire brigades.

The wearIT@work concept

The wearIT@work wearable computing concept differs from that of conventional mobile systems. Instead of basing interaction on a modified version of a desktop human computer interface (HCI), the wearIT@work concept focuses on the interaction between the user, the system and the environment. Instead of forcing the user to choose between interacting with either the device on one hand, or the environment on the other (but never

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Take-up projects

Of course it's not just in the health and emergency domains where wearable computing has a future, nor indeed merely in the Industrial Pilots. WearIT@work has seen significant developments in all three of its take-up projects too, particularly in rural fire prevention. 'Farmers Rangers' in Lunigiana: a wearIT@work take-up action, aims to counteract the effects of climate change and arson by protecting fire-prone ecosystems. The project works by creating a 'living-lab', constituting a collection of producers and officials who act as 'Farmers-Rangers', protecting a large area through integrated mobile

both), the wearable system pioneered by the wearIT@work project allows the user to interact with the system and the environment simultaneously. Further, 'there is direct interaction between the system and the environment as well as the possibility of the system mediating the interaction between the user and the environment.'

This synergy of user, device and environment underpins the entire wearIT@work project. The 'always-on' nature of the wearables accompanied by this focus, provide a fluid cross-pollination of enterprise, user and computer system – in turn allowing greater productivity, communication, safety and efficiency. es

Industrial applications and emergency service applications are currently in use

Otthein Herzog is the head of the Artificial Intelligence Research Group at the Computer Science Department of the University of Bremen since 1993. Before he joined academia, he worked in industrial software development and research with IBM for 16 years, working in many international software product development and research projects.

The AI Research Group is fully integrated in the "TZI – Center for Computing Technologies" of the University of Bremen, which was founded by him in 1995 devoted to the technology development and transfer in the areas of Mobile Computing, Intelligent Systems, and Digital Media.

For further information on the project, including a full list of 42 partners and an overview of the Technology Repository, the collection of available wearable technologies:

W: www.wearitatwork.com

WearIT@Work: Wearing your computer on your sleeve

An interview with Professor **Michael Lawo**, Technical Manager, about his work on the wearIT@ work project that is integrating computing needs into work clothing. This technology has the potential to improve the way professionals conduct their daily communications and access to information

eStrategies: Can we just start by getting an understanding of the founding principles, aims and objectives of the wearIT@work project? What exactly is wearable computing?

Michael Lawo: Imagine your typical work day. Now imagine it without all the stress and hassle, without the challenges of trying to complete many time-consuming tasks at once. Imagine that you have an intelligent assistant who is able to find any information you need at the drop of a hat, no matter where the information is located. Imagine your personal assistant is by your side and at your service every minute of the day, but never disturbs you or interferes with your work. Imagine your assistant never asks for anything in return: you can use this assistant whenever you want and you can forget about him when you don't need help.

The wearIT@work project made this dream a reality. In wearIT@work a set of new solutions was developed supporting the workers and businesses of the future. These solutions are based on wearable computing technology that can drastically improve your business and your work life.

eS: What in the world is a wearable computer?

ML: It is a computer system that is integrated into one's clothing. These computers are either integrated into the outfits of their users, or attached to them in the form of a belt, wristband, vest, etc. A wearable computer serves as an ideal personal assistant to workers: it provides useful information regarding work tasks without distracting or interrupting the users, and without the user lifting a finger.

The systems have sensors that are aware of the users' work progress, and enable the user to engage in ambient interaction with the system. Based on this context awareness, and ambient user interaction, the wearable device gives the worker information about how to proceed with the work.

eS: Do you think that the academic sector is increasingly informed by the demands of commercial applications? With this in mind, how crucial is it for the wearIT@work project to forge close links with public sector institutions and the business community?

ML: Throughout the last decade, the field of technology has advanced tremendously, and what was once technology restricted to the few has become commonplace. For example, computers have become increasingly

portable as they have progressed from desktop PCs, to laptops, to handheld computers. The introduction of wearable computing marks the next generation in computing. Although PCs are being used daily by white-collar workers, this is not the case for blue-collar workers. PCs are not accessible to offer immediate, on-the-spot support to this population in their work tasks. To involve everyone: developers, integrators, users, policy makers, associations, etc. and to make sure that they are all on the same page when it comes to the various aspects

of wearable computing, wearIT@ work formed the Open Wearable Computing Group (www.OWCG. org). It is a standardisation effort necessary in order to create on-the-spot collaboration and maximum synergy. The OWCG will continue beyond the scope of the wearIT@work project and will continue to be facilitated by the make-up of its strong industrial consortium in the future.

eS: What are the social implications of developing wearable computing in the workplace? Are there any particular difficulties in terms of the provision of wearables that you need to overcome? How does the focus on UCD (User Centred Design) help to meet these challenges?

ML: The process of introducing wearable computers into the workplace is enhanced by a number of different

factors: clear and transparent communication both for clarifying the process ahead and involving the workers. In addition, communication helps build and create trust which is also essential to the adoption process. Involving the workers and utilising their knowledge and experience enriches the system itself and enhances its reliability, while involving the workers in the process. General staff training on wearable computers has been found to be hugely beneficial for workers at an organisation introducing wearable computers into the workplace.

> **In wearIT@work a set of new solutions was developed supporting the workers and businesses of the future. These solutions are based on wearable computing technology that can drastically improve your business**

Michael Lawo is with the Centre for Computing Technology (TZI) at the Universität Bremen where he is professor for applied computer science

With the ongoing shift toward more highly skilled workers, not only will the training help workers feel more secure in their jobs, it will enable them to progress along with the technological developments.

eS: The potential benefits of implementing wearable computing in the workplace are huge, ranging across the medical and manufacturing sectors in particular. How difficult is it to maximise performance while simultaneously minimising cost, ensuring these developments are viable internationally?

ML: From a technological point of view, the systems might be not too challenging. The performance improvements are just achieved by avoiding any kind of unnecessary paper bound work, similar to the office where the email drastically speeded processes up. The achievements lie in the seamless integration into complex, well-established workflows involving elaborate cooperation among multiple participants and existing information systems.

The technology showed in all our field tests that it has certainly been accepted. However, this requires the involvement of all stakeholders to assure a win-win situation for all.

eS: The four main applications of the wearIT@work project are in the fields of maintenance, production, healthcare and emergency response. Could you outline the particular benefits, methods, problems and solutions in terms of research in these areas?

ML: The project emphasises context and sensing as enabling technologies. For example, we aim to use unobtrusive body-worn sensors to track the individual activities of the maintenance and production workers. This helped us create customised information (such as manuals for each step performed), verify that the workers are correctly performing each procedure, and assess the progress of trainees. We were also facilitating professional, industrial development environments for wearable applications rather than producing only isolated technologies and solutions. To this

end, we developed the Open Wearable Computing Framework, which supports easy, hardware-independent development of wearable applications. Several low-level software toolboxes supplement it: the Wearable User Interface Toolbox, the Communication Service Module for seamless communication access, and the Context Recognition Network for simple implementation of a distributed context-recognition application all well documented with the respective maturity levels in the Technology Repository of the project homepage.

eS: Do you anticipate that wearable computing can revolutionise productivity and success in the workplace? Where do you see the wearIT@work initiative moving in the coming years?

ML: Issues of frustration and dissatisfaction in the workplace have been the subjects of much research, understanding organisational aspects, social interaction and human aspects as having an influence of the way employees view their work and their situation within this context. The issue of unsatisfied workers not only affects the workers' personal feelings but also has been found to correlate with many operational and quality goals, and achievements through lowered motivation. A close connection has been found between the workers' satisfaction level and the organisation's turnover. Such seemingly personal issues affect the performance and profitability of the whole organisation. Creating a dialogue has been found to be an important factor in preventing and addressing the issue of burnout. This can help workers understand their place within a more complex organisation, make sense of things, express their concerns and can create a sense of community, empowerment, reduce the sense of powerlessness and encourage ongoing communication between co-workers and management. Empowering the workers is an important factor in reducing burnout and frustration, and cooperation can reduce the sense of helplessness. Wearable computers are a useful tool for facilitating such ongoing communication. However, there are still steps in research and development to take to gain the full benefit for the European industry. eS