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Preface

Ubiquitous Computing and Pervasive Health Care

More than 10 years ago, Mark Weiser in his visionary papers, e.g. [1] established a new direction in computer science for which he coined the name Ubiquitous Computing. Meanwhile this area is well established and is generally considered as the next quantum leap in information technology that will lead to radical changes in our everyday life. Friedemann Mattern gives the following definition [2] (translated and shortened form German):

"*With Pervasive Computing, or equivalently Ubiquitous Computing, we mean the omnipresent, universal processing of information and along these lines the access to information from anywhere and at any time... This is enabled by the continuous progress in information technology – Moore's law with its doubling of the power of processors and of the capacity of storage elements every 1.5 years seems to be valid for more years to come. But also developments in material science, e.g. sensor technology, and progress in communication technology, especially in the wireless area, form the engineering basis of a new world where huge amounts of tiny computers communicate with each other without us being aware of them because we do not see them anymore. They are embedded into all objects of our daily life; they are merged with the environment around us.*"

The interconnectedness of many common daily objects is already reality e.g. in intelligent buildings where things like simple switches have an IP address and we are able to program them [2]. Also for the embedding of computing power in textiles we see already prototypes e.g. in the intelligent carpet project [4]. Wearable Computing [5] is another good example of pervasive computing with the following vision (from [5]): "*Wearable Computing is that a mobile computer should not just be a machine that we put into our pocket when we plan on doing some office work while on the road. Instead it will be an integral part of our every day outfit (hence wearable), always operational and equipped to assist us in dealing with a wide range of situations.*" Special attention is devoted to the human-computer interaction where exciting technologies can be detected such as the projection of screen contents into the human eye [6].

Some years ago we saw much research and development devoted to the construction of virtual realities. Now we are back to real because pervasive computing often is considered as the opposite to virtual reality: In

a virtual reality users enter a world created by computers. In pervasive computing world computers enter the physical world and are inherent part of it. With this "brave new world" in mind it is urgent to ask for socially relevant applications of ubiquitous computing and there seems to be general agreement that the most important application is e-health and e-inclusion, i.e. modern IT for healthcare, disease management and support for independent living of the ageing society. We see more and more initiatives under the title of "pervasive healthcare" that consequently may be defined in two different ways (taken from [7]): *"First, it is application of pervasive computing (or ubiquitous/proactive computing, ambient intelligence) technologies for healthcare, health and wellness management. Second, it is making health care available everywhere, anytime – pervasively… Developments in sensor and more generally measurement technology make it possible to obtain health related information from wearable or embedded sensors also in out-hospital conditions, in our daily life. Ubiquitous communication based on mobile telephone networks, (wireless) local area networks, and/or some other wireless technologies makes possible anywhere, anytime transfer and access of all kinds of information – like measurement data, person-to-person communications or health information. Mobile communication gadgets provide ubiquitous user interfaces for the users - from health care professionals to citizens..."*

Considering this technological progress and important application opportunities many computer scientists worldwide are concerned about the grand challenges for the next decade and beyond. A trans-disciplinary theme is the computing and information infrastructure that enables an individual to benefit form the progress made in IT and in pervasive computing, to use it for his welfare and to let the individual be part of this interconnected world in a harmonious manner. Pervasive computing enables to receive information regardless were we are and anytime. We talk about ubiquitous information. We are in an information space and we ourselves are part of this space as objects carrying information. In spite of these promising perspectives we know already about shortcomings: we are flooded with information. We are not sure how relevant information is at this time or whether it has been relevant in the past. Furthermore we suffer from the unreliability of our infrastructure; we can not count on it.

A first example of a strategic directions and vision paper for future research is the NSF "Cyberinfrastructure" paper [8]. It envisions a new infrastructure, called cyberinfrastructure, with the objective to move our today's middleware up to a much higher level of abstraction. A second important vision paper, the "Grand Research Challenges in Information Systems" has been put together by the CRA [9]. They have identified 5 challenges out of which the following 3 are of outmost importance for pervasive health:

Build a Team of Your Own. Building cognitive partnerships of human beings with software agents and robots will enhance individual productivity and effectiveness.

Build Systems You Can Count On. Assuring reliable and secure systems—from the regional electric grid to an individual's heart monitor—will allow us to rely on information technology with confidence.

Conquer System Complexity. Building predictable and robust systems with billions of parts will enable broader and more powerful applications of information technology.

These challenges must be seriously considered and investigated in broad and fundamental research activities. They connect immediately to the areas mentioned above. The first one, dealing with cognitive partnerships contains the aspect of context dependant relevance of information; the second one contains the dependability issue, most crucial for applications in e-health and e-inclusion.

Also in Medical Informatics visions have been identified, e.g. [10]. There the authors have developed a prognosis for the time beyond 2013 and describe how health care will probably look like in the future. More and more research and development institutions are being created. A good example is the Centre for Pervasive Health Care with the following mission (taken from [11]): "*The healthcare systems of the Western world are facing some core challenges. The demographic development entails an increasing number of elderly people, who will live longer, and there is a strong demand for better services in a typical public funded healthcare sector. At the same time, there is a growing consumer request for more control and better means of managing their own health – at home or hospitalized. Furthermore, there is a growing potential for making better use of clinical systems for healthcare professionals, in e.g. hospitals. Hence, the potential demand for new easy-to-use healthcare technology is growing rapidly."*

Other remarkable initiatives are the TAHI project [12], or the Caremedia project [13]. Many EU projects have been and are being established devoted to e-health and e-inclusion [14]. Also the IT industry is well aware of the importance of these subjects. Examples include HP [15], IBM [16], and Intel [17]. Attached to the international UbiComp Conference we see the UbiHealth Workshop [18]. All this

is extremely encouraging and shows an increasing awareness of the potential and opportunities for healthcare.

We at UMIT have established several activities devoted to this subject and have put together a strategy paper [19]. Out of the many activities there I would like to mention three directions, namely finding and measuring relevant information including information provided by sensor data streams, ensuring reliability in order to build systems one can count on, and wearable computing including biosensors. The interested reader may inspect the websites and the publications there [20, 21, 22]. Finally and last but not least, this volume contains a special section with interesting papers devoted to our subject. I am sure that these will stimulate further research and certainly will lead to a beneficial application of ubiquitous information processing to pervasive health.

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