

Ambient Intelligence in Working Environments

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Abstract. The concept of ambient intelligence (AmI) has recently been adopted related to living scenarios and denoted as ambient assisted living (AAL). It has received high attention related to the demographic shift and the positive options of care and support for elderly people at home and on the move. However, there exists an equally important field of application related to work. In the context of labour high mobility and flexibility of people is requested. The demand to work up to higher ages complements the situation. People in the workforce develop growing expertise and different abilities over time. They need tailored support systems at work keeping the efficiency and effectiveness and elements of prevention or adjustment to changing abilities. Indeed, environments in industry and at work provide already a high degree of networking and computing infrastructure, much more than in the private sector and can provide a basis for an advanced AmI infrastructure. The idea is discussed within the framework of creating accessible workplaces for people with disabilities. Here, so far a reactive strategy has been followed based on the individual case. Only in case a concrete person with a disability is included in the work force and only in that very moment a workplace adaptation is considered. However, now this reactive strategy is outdated, because today the complete infrastructure needs to be considered to make a workplace accessible. Following an AmI strategy –ambient assisted working (AAW) provides a flexible approach towards workplace adaptation for all, including people with disabilities and older people in the workforce. In order to use AAW, the process has to start much earlier in a more inclusive way. Without knowing the exact demands of a future worker, the system needs to be designed. The flexible networking character of AmI provides the required flexibility.

Keywords: Ambient Intelligence, Work, Ambient Assisted Working, Universal Design, Accessibility, Information technologies, Higher Age.

1 Introduction

In the past 10 years the greying of the society has attracted the focus of policy and society. It is considered as very positive to live longer in good health and to enjoy retirement. This approach is based on the traditional assumption that there is an overall lack of job offers and enough younger workforce in society. Early pension programmes by companies and governments have been installed in order to combat

unemployment and often people have already left the labour market into retirement between the age of 50 and 65.

In the area of technology, there has been a lot of emphasis on the support of people at home through modern technology like smart homes, support of living, and the support of health care and nursing. However, there exists an equally important field of application related to work. Meanwhile the ratio of people in gainful employment and of all other people is considered critically. Consequently, it is intended to let people stay longer in employment. In the context of labour high mobility and flexibility of people is expected and requested. The demand for life long learning and the wish and need to work up to higher ages complement the situation: people in the workforce develop growing expertise and different abilities over time. They need tailored support systems at work keeping the efficiency and effectiveness and elements of prevention or adjustment to changing abilities. This leads to the question, if modern technology can be used to support older people or people with functional restrictions at work.

In the past changes of workflow and workplace adaptation have been motivated mostly for increase of productivity and quality. Safety at work and ergonomic considerations have also been aspects. Individual workplace adaptation has been installed in the framework of vocational rehabilitation of people with disabilities. This individual adaptation has been done case by case considering the concrete workplace and the special requirements of the worker. Very often it has been related to access to buildings and workshops, special furniture, devices and equipment. Accessibility and compensation of disability have been the main elements [7]. Although high technology has played an important role here, the general e-accessibility of company infrastructures has not much been at the scope of such measures [3]. The challenge to support older people at work connects closely to all these approaches.

In the first part of the paper the traditional strategy of creating accessible workplaces and the limitations of the concept in a modern infrastructure are described. It relates back to examples of current legislation which supports this old approach. The second part deals with options for Aml at work and presents examples of current options.

2 Approach of Traditional Workplace Adaptation

In many highly developed countries, ergonomics and safety have developed as important aspects in the design of workplaces besides the overall need to create workplaces for efficient and effective work processes. It is considered essential to support workers in a way to enabling them to perform their tasks during a whole working day and for many years with high efficiency and a quality output. This implies preventive measures for health and avoidance of repetitive strain injury syndrome (RSI) and other work related health problems. In this perspective workers are considered as human potential and the investment in their education, training and experience needs to be secured over time. This brings automatically along the need to consider human factors at work and to protect the workers. Of course these issues are also very much requested and supported by the policy of the unions and the work related health and rehabilitation systems in many countries, but also the solidarity systems in health and

pension systems. In this context the adaptation of a workplace to individual needs of a worker becomes a complementing option to general ergonomic, safety and accessibility considerations. Particularly in the case of highly qualified workers with changing functional capacities due to RSI, disease and accidents, which often also occur in the labour context or even are caused by work, schemes have been developed to provide individual workplace adaptations. Reactive options comprise among others the reorganisation of the work process and the tasks to be performed, the adaptation of the workplace and the work environment or the complete change of the work itself.

An example for a support system in this respect is given by the German Social Book IX [11]. This legislation constitutes a framework of support for a worker with a disability and the respective employer. Besides the clarification of rights and obligations, it builds the baseline for advice and support services. In particular it is possible to receive financial support for individual workplace adaptations out of a special fund. The adaptation is undertaken as a consequence of the concrete changes of the worker's abilities. It considers the individual case of personal requirements in the respective given work situation. The adaptation can thus be tailored and optimised individually, which is very positive. Examples of workplace adaptations are collected and provided as information for other cases [9]. On the other hand, a reactive strategy has to be followed. Only in case a concrete person is included in the work force - either a newly employed person with a disability or a current worker achieving problems due a disability - and only in that very moment a workplace adaptation is considered. This can have negative consequences, because the process starts only after the case has been made. If no concrete case exists at the time of general planning of infrastructures it might be done without any consideration of accessibility. Under worst circumstances, it can happen, that a complete infrastructure is designed inaccessible at least until a later adaptation has been planned and implemented. This can also be very costly. And it may be a hindrance to hire a new person needing accessible infrastructures. Today, this pure reactive strategy is outdated: Instead a careful planning of the infrastructures can provide very important complements to this reactive strategy.

3 Changing Infrastructures

3.1 AmI, AAL

In the last years the industrial societies have very much developed into information and knowledge societies. The modern infrastructures of private, public and industrial properties have taken up very much electronic communication, networking, smart sensors and actuators.

Wired telephony, cable networks (LAN and WAN), wireless connections (infrared, Bluetooth, WiFi), automatic door openers, motion sensors for illumination and safety, window openers, air condition, access control systems, GPS based services, acoustic sensors, video control, pattern recognition, biometrics, etc. are among the applications inbuilt in the infrastructures. Often the devices are operated locally and not yet in an integrated way linked to other appliances although the connection would easily be possible. In a new perspective and with the progress of technology, the option of connecting the distributed smart devices has created the vision of ambient intelligence [2].

In such an AmI infrastructure intelligent agents, interconnected through fixed and mobile networks, support the nearby persons in a responsive way: it eases interpersonal communication, access and delivery of information and the control of the environment.

People will interact through individualised mobile devices, but also infrastructure based I/O and they will be able to make use of the computational power of the surrounding networks (ubiquitous computing, nomadic computing, cloud computing). Already today, mobile phones can be interpreted as such personalised multimodal interaction devices. They offer wireless connectivity (GSM, UMTS, GPS, Wifi, Bluetooth) and access to computational power in the network, a variety of input options (reduced keyboard with T9 prediction, full keyboards, softkeys, pointing devices, touchscreen, voice) and outputs (display, tactile vibration, visual signalling, synthetic voice, sound) and inbuilt computational power and flexibility. These devices are perceived as everyday appliance in this case as telephones rather than as computers, which will be typical for AmI devices.

The concept of ambient intelligence has recently been adopted and transferred related to living scenarios and denoted as ambient assisted living (AAL). It has received high attention related to the demographic shift and the positive options of care and support for elderly people at home and on the move. The focus is here on private use rather than working environments.

3.2 Work Environments

Indeed, environments in industry and at work provide already a high degree of networking and computing infrastructure, usually much higher than in private surroundings. Systems for access control, time keeping, process control, automation technology, tracking of goods, work planning and monitoring and computer assisted work in trade, maintenance etc. combined with company intranets can provide a basis for an advanced AmI infrastructure. This is connected to the potential of creating a very flexible and supportive work environment for all. It is taking up the ideas of Design for all and accessibility, now applied to the work environment with an advanced modern information and communication infrastructure.

4 AmI at Work

During their work life and career people and companies benefit from tailored support systems at work keeping the efficiency and effectiveness and elements of prevention or adjustment to changing abilities. Following an AmI strategy –ambient assisted working (AAW) provides a flexible approach towards workplace adaptation for all, including people with disabilities and older people in the workforce. In order to make use of AAW, the planning process has to start much earlier in a more inclusive way compared to traditional workplace adaptation. The overall system needs to be designed without knowing the exact demands of a future worker. Basically three levels need to be considered: 1. the network(s) as computing resource and connection with all agents, 2. the agents (machines, devices, appliances in the infrastructure) and 3. the personal mobile interface. In particular the flexible networking character of AmI

provides the required flexibility in level 1. Level 2 can integrate the large variety of agents, like CNC-Machines, conveyor belts, robots, but also appliances like building automation, guiding systems [4, 6, 8] workflow control systems or work support devices (e.g. handling support [1], lifting aids [10] – body weight system [5]). These are less generic and depend very much on the work subject. New agents can be added to the system whenever needed. Level 3 deals very much with the individual requirements matched to the working tasks of an individual person. The assumption of AmI is that all the systems are connected and smart sensors and actuators are able to exchange information in order to create a flexible and intelligent environment. The interaction with the worker can be done in several ways: direct sensing and interaction with agents and/ or operation through the personal mobile interface.

4.1 Case Examples

In the following two virtual cases shall illustrate the use of AmI in a work environment for very different people. In both cases, it is intentionally left open which particular ability or disability the workers may have or which specific tasks they perform. The first example refers to a concrete specialist mainly working in an office like environment. The second case refers to maintenance tasks in a workshop environment. Both examples build upon existing options, but the full benefit is achieved through the AmI like system integration. From the examples it becomes obvious, that in this kind of business environments AmI is in closer reach compared to private environments. And looking more deeply in the organisation of work environments one will detect a lot more already existing options for AAW.

4.1.1 Case 1: Flexible Office Environment

Mrs. Adapt is employee of the multinational company Access International. She works part time from her home office in alternating telework. Keeping contact with colleagues and customers worldwide requires much coordination, communication and the use of new media.

Due to a car accident during a business trip Mrs. Adapt acquired a disability. Access International has put effort to keep her qualified work performance, because she is an experienced expert in her business field. Her work environment has been adapted in a way allowing her to perform all necessary tasks despite her disability. Fortunately Access International was well prepared for such requirements due to their modern infrastructure.

All subsidiaries and premises of the company are connected via a modern intranet. Secure gateways allow access by the employees to data from all over the world. When reaching a subsidiary Mrs. Adapt gains access to the premises through a RFID and biometric controlled electronic access control system. At arrival a workplace for the day is automatically assigned according to her daily work plan. The workplace is accessible and she is dynamically guided on accessible path to find it.

Her individualised software environment is loaded on the respective workplace by the system. She only needs to carry along her personalised mobile I/O device, which is configured according to her individual operation requirements. This device communicates wireless in the respective working environment. It allows her to operate and use all devices and machines of the company, which belong to her work or her nearby environment.

Due to the accident sometimes Mrs. Adapt faces temporary memory loss. The system is able to detect the condition automatically through the interaction pattern. In this case she is supported by the memory function of the intranet, which provides information on the daily tasks and a logging of the development of ongoing work. In case of a serious memory loss, she can reach (or can be reached by) her personal coach via the communication system, who helps her to resume work.

Regarding her health status Mrs. Adapt is secured via a health telemonitoring link. In case of potential irregularities or contingency it provides warning, alarm and quick emergency support. This option provides the safety needed and enables Mrs. Adapt to perform her work without anxiousness.

Once in a while Mrs. Adapt is confronted with problems, which she can not solve easily ad hoc. In this case, she can forward the issue to peers through the intranet (sometimes also Internet). At the same time a database with solutions of the past and relevant legal background are available in a database.

Mrs. Adapt makes available her experiences and adapted information in a Wiki shared with other people with the same disability. In this way adaptations and solutions once being made can support many other people.

4.1.2 Case 2: Maintenance of Machines

Following a basic instruction course on the construction, function and frequent service tasks of the machines technicians are supported in daily work by a PDA-based maintenance support system. The PDA (personal digital assistance) transmits information on the next service task, the material and tools needed and the location of the machine which needs the service. It guides the service staff dynamically to the machine. Upon arrival a connection between the machine and the PDA is established (could be local, could also go through the overall network). The PDA receives the information about the service condition and the tasks to be performed. Automatically, all necessary safety measures and environment settings are taken and approved by the service person, so that no one will critically interfere during service. It calls the service routine, which is presented to the service person step by step in an appropriate format (sequence of pictures/ drawings, sequence of tasks, voice output and hands free interaction by voice etc.). The PDA and the machine exchange information in a way that the respective next step is only presented after successful completion of the previous one. In case of problems the service centre can log in to the process and can provide assistance. It is an option to use video in both directions (recorded or live-stream) to deal with specific problems by the support of a remote expert. Logging of the work process will be fed into the instruction programme of the service personnel or may lead to a change of service routines. Such a support system can be used for complex and very technical tasks, but also for simple service tasks, performed by less technical staff. Even people with learning disabilities could be enabled by such an interactive support for example servicing printers and copy machines.

5 Summary

Although today AmI is very much discussed for public and private environments, it seems more closely ahead in industry and business environments. The high degree of

automation, facility management, work related control, safety in highly networked computational environments as present in industry creates a very good backbone for AmI applications. The high flexibility of such solutions offers options to tailor for very different workers and also tasks. Accessibility issues and workplace adaptation can be considered from a different angle than traditional approaches. Already during the planning status, without having a concrete case of a worker with special needs in mind, the basis for AAW can and needs to be implemented in the AmI infrastructure. With this understanding AmI in a work environment can support very different user needs and can help to create working environments for all.

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