Inclusive Network Services: Priorities for Research

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Introduction

Assistive devices have helped many people with activity limitations – these devices vary from inexpensive low technology aids for daily living to sophisticated special computer terminals. However the trends in technological development mean that it is increasingly important for all users to be able to use mainstream systems and services. All too often these systems have been designed for what has been perceived as a 'typical' user, and little allowance has been made for people with activity limitations.

Prioritising research for social inclusion in the emerging information society is not just about determining what new technological developments to fund, but how to influence mainstream design teams to take into account the needs of people with activity limitations when designing new products or services. It is essential that their needs are considered from the outset in the design process.

In the longer term the full integration of various technologies offers exciting possibilities to provide a wide range of services that are inclusive and able to support people when necessary. Whether this will be fully achieved is subject to debate, but ethical and privacy considerations will be significant factors in the uptake of new services.

The key to delivering full integration to users is being able to provide what is wanted, when, where and how it is wanted. All these aspects are important so that the user receives the right information and is given the possibility of interpersonal communication, at the right time and in the right way. However user control is paramount so they can decide what information they want and whom they want to contact and whether or not they want to interact with information and people at any given point.

Users should not need to understand the technology to use it, and most will have no desire to think about it. Information should be delivered to the users on their own existing devices, and the interfaces must be straightforward and meaningful without, for example, the user being overwhelmed by options and menus.

The involvement of users throughout the design and development of services and products cannot be over emphasised. It is vital that ideas and concepts are tested as well as prototypes and the final product. User testing and evaluation centered on real life implementation rather than conceptual technology are the key to achieving products and services that meet real user needs.

It is necessary to prioritise what research needs to be undertaken since there are finite resources, of both funds and skilled staff, to undertake these activities. This document has been produced to stimulate discussion on what should be the priorities.

Trends in Network Services

Historically the World Wide Web has been mainly a repository for indexed information. However it is now evolving in a number of directions to provide a range of new types of service including virtual interactive spaces for social interaction, semantic services and interconnected intelligent objects such as sensors. In the longer term ambient intelligent systems may fully integrate environmental control systems, navigation systems, and alarm systems using broadband communication networks. Such intelligence in the environment leads to many exciting possibilities for making life easier for people with activity limitations.

Web 2.0

> Web 2.0 is a concept that takes the network as a platform for information sharing, interoperability, user-centred design, and collaboration on the Internet or World Wide Web.
>
> Wikipedia, 2013

Recently, the web has added the facility for a virtual interaction space (Web 2.0, online collaborative systems, social networks) giving people the possibility of social interaction. Users of the web have become producers of information to be made available to others. Discussion about and modification of this information is possible. From the perspective of people with activity limitations, this can be very important since it allows interactions where lack of abilities can be hidden, but there can be a negative impact if the information is not in an accessible format and suitable discussion channels are not made available.

Web 2.0 is also emerging as a web of services. The services may be made available by service providers (such as cloud computing), but they can be also created by end-users, with the facilities made available by the Web 2.0 architecture and tools. These services can have features able to permit adaptation, customisation and control according to the needs of the users. Moreover, they can be composed by the users, for example by mixing existing services and data to implement services which are truly useful for them, matching their needs at that time and in the current context of use.

Semantic Web

> The Semantic Web provides a common framework that allows data to be shared and reused across application, enterprise, and community boundaries.
>
> W3C, 2011

The term ‘semantic web’ describes the evolution from a web containing mainly documents for humans to read to one that includes data and information for computers to manipulate. This can be very important since accessibility is frequently enhanced by the transduction of information from one medium to another which is made easier by the availability of a description of the information available.

Internet of Things

> The Internet of Things refers to uniquely identifiable objects (things) and their virtual representations in an Internet-like structure.
>
> Wikipedia, 2012

Up to now the internet of things has largely been conceived as only having interconnected sensors or just putting radio frequency identification tags on unintelligent objects. However, it is also about embedding intelligence so things become smarter and do more, for example by supporting people. The internet of things means the fusion of the physical and digital worlds such that physical entities have a digital counterpart, objects become context-aware so they can sense, communicate and interact, immediate responses can be given to physical phenomena, and instant information can be collected about physical entities.

Intelligent real-time decision making becomes possible, thus opening up new opportunities to handle incidents, meet business requirements, create new services based on real-time physical world data, gain insights into complex processes and relationships, address environmental degradation, monitor human activities, improve infrastructure integrity, and so on.

Ambient Intelligent Services

Life of people in an ambient intelligent (AmI) environment is supposed be facilitated by the availability of different services offering useful functionalities. So far, the inclusion of people with activity limitations has been based on a number of complementary approaches including adaptation of systems addressing the needs of individual user groups (eg by adapting their human computer interfaces), adaptation of services of general use (eg alarm services), and creation of special services (eg relay services). According to the current development scenarios, it seems that the ambient intelligence environment will be made available for all services which up to now were specifically used to support people with activity limitations.

> Ambient intelligence is where people are surrounded by intelligent intuitive interfaces that are embedded in all kinds of objects and an environment that is capable of recognising and responding to the presence of different individuals in a seamless, unobtrusive and often invisible way.
>
> Ducatel K, et al ScenarioS for Ambient Intelligence, 2010

Environmental control systems

Environmental control systems, introduced for the independent living of persons with limitations in motor abilities, will become an integral part of the environment. In principle they can be designed in such a way as to be extendable to incorporate additional facilities which are either for general

purposes (eg robotic systems) or for specialised support (eg assistive technologies).

Relay services

Relay services, of interest for people who cannot hear and/or speak, are in principle available by default in the ambient intelligent environment, where voice recognition and synthesis, automatic translation, gesture recognition (essential for sign language recognition and lip reading) and animation (synthetic sign language and lip movements) are available. Transduction of information between media (eg text to voice, voice to text, etc) and automatic subtitling will be the norm.

Navigation services

Navigation systems and services will be present or can be used in many scenarios for different purposes. They are supposed to acquire positioning information and to have the possibility of monitoring the presence of unpredictable obstacles (people, baggage, etc). If the user has cognitive limitations, the navigation system may tune the level of support to the known abilities or to the perceived present difficulties.

Alarm and support/control services

The entire AmI is a pervasive and very sophisticated alarm and support/control system. This may be very important for people with cognitive problems. AmI can continuously guide a user's behaviour in the various environments according to known habits and intervene if necessary, by reminding of tasks and helping to perform them. When necessary, AmI can also contact the family or a carer for advice and help.

AmI is able to describe its layout and functionalities, as well as the functionalities of its devices (eg the remote control in a hotel room). Moreover, AmI is able to organize sequentially the flow of information and the performance of the necessary tasks, allocating the necessary time.

Broadband communication facilities

There are additional opportunities offered by AmI which are related to the availability of broadband communication facilities. The possible scenario of a lady travelling abroad offers examples of advanced telecommunication facilities, in the car, in the hotel room and in the presentation room. When driving, the lady is tracked by the navigation system and people know (if she wants) that she can be contacted. In the hotel room there is an audio/video system, the video scenes of which are described if she cannot see, and automatically captioned, if she cannot hear. The audio/video system can also be used for communication with her daughter, with whom she can not only communicate, but also go through the news as they watch them at the same time from different places.

Audio/video interpersonal communication services

Even if support by technology can be invaluable in some circumstances, support by other people can be more efficient and acceptable in other situations and activities. It can introduce a personal dimension, which increases acceptability and efficiency in the intervention. AmI, with its emphasis on cooperative activities whereby people can remotely carry out common activities with audio and visual contact, can increase the feasibility of this approach.

Intelligence in the Environment

As already mentioned, the key factor is the intelligence in the environment. Intelligent agents could potentially offer focused services to people. However, they normally address a single 'intelligent' task and try to mimic the behaviour of the owner. The problem is much more difficult when the entire environment or complex parts of it must be controlled in a way to show behaviour that people can consider 'intelligent'.

At the level of interaction, a smart environment may provide an extremely large number of complex choices. An interface that directly offers all the possibilities to the user may result in being cumbersome and complex. Ideally, the user interface should act as an intelligent intermediary between the system and the user. This is the reason why artificial intelligence methods and techniques are starting to be used for the development of adaptive intelligent interfaces. Intelligent interfaces are supposed to be able to adapt to the user's physical, sensorial and cognitive capabilities, some of which may be restricted due to aging or impairments and/or may change through the day. An important characteristic of the human interfaces for smart environments is their spatial dependency. Many features and possible effects of interaction depend on the position of the user. For instance, a simple command as 'switch on the lights' must be differently interpreted according to the place where it has been given. Provided that the user is located with enough precision, the interface needs a spatial model to be able to decide which lights are to be switched on. To avoid potential dangers, the interface must be able to decide which services can be offered to the user in the current location.

The AmI environment must take care of the contexts of use. In AmI, the situation is very complex, because in the ubiquitous interaction with information and telecommunication systems the context of use may change continuously or abruptly and the same systems or services may need to behave differently in different contexts. It is not sufficient for a system or service to behave correctly at a given instant, but it must continue to behave correctly for the entire process. This requirement is compatible with the idea that AmI intelligence must be essentially in the environment and not in the individual objects. Functionalities will be more readily available if they can migrate through the network, instead of being entrapped in objects.

Another important issue is avoiding the risk of a possible mismatch between the model of interaction of the system and the user's mental model of it. In current systems, designers have pre-programmed solutions for the design space of the systems, while in AmI the interaction space is not defined and unpredictable. Three levels of abstraction exist: the sensing level, the perception level, and the level of the identification of situation and context. This is the level where the conditions for moving between situations are identified and the needs of the user and of the system are anticipated. This requires replacing explicitly coded responses to situations and contexts, with a higher-level, more knowledge-intensive use of strategies coupled with reasoning and learning.

In AmI the emphasis is on abstract goals of the users that the environment must infer and structure in a set of tasks adapted to the users themselves and the context of use (for example without interfering with the goals of other persons in the same environment). The acceptability and uptake of the new paradigm will be essentially dependent on how smart the system is in inferring the goals (desires) of

the users in the varying contexts of use and in organising the available resources (intelligent objects and services in the environment) in order to help users to fulfil them. This means that an 'intelligent' control must be available. So far most of the available control systems are deterministic. This is not compatible with the emerging situation for two main reasons. The first is that AmI is not only concerned with measurements from sensors, but with goals of people to be fulfilled and interaction in a social context. Moreover, it must take into account that the emerging model may be a social group interacting in order to cooperate in carrying out activities connected with independent living and interactions within a social environment.

Finally, ambient intelligence needs to inspire trust and confidence and to be controllable by ordinary people. The requirement about trust and confidence is very challenging, because these can be obtained only if the user has a complete knowledge at the conceptual level of the running principles of the systems and services and is given the possibility of controlling all the steps necessary to obtain the required results. For what concerns control by ordinary people, sometimes, a simple and naïve concept is assumed (ie that the user is given the possibility of switching off the system or service). But the problem is not so simple. For example, switching off the telephone can be a problem if a user is connected through it to an alarm system or a health care monitoring system. Therefore, it is necessary that the AmI environment is able to cooperate with the users, according to their profile (eg culture, technical knowledge, and possible impairments), the context of use, and the emotional situation in order to find a compromise between privacy, individual control, and possible security aspects.

Key Developments Required

Category		Short term	Longer term
Specification	Requirement elicitation	Explore how users interact and cooperate with intelligent environments in terms of both the system's mental model and the user model	Prediction of new end user needs created by new environments Analysis of the optimum methodology for the automatic assessment of end-user needs and preferences
	Educational aspects	Develop materials about the needs of people with activity limitations and technological solutions for education at university level Develop training modules for system designers in industry Develop information about technological developments and training for their use for end users	Start education on inclusive technology in European universities (eg at master's level)
	Social objectives	Analysis of the possible impact of new technological systems on social interaction, family relationships, personal care, social dominance and leadership Studies of the use of social media to reduce isolation for people with activity limitations	Investigate if and how cloud approaches can facilitate the emergence of services that can support independent living Explore how the living conditions of older people can be improved by ambient intelligent systems which automatically adapt to the user's needs
	Ethical aspects	Investigation of ethical and legal requirements and consequences to include the privacy of the data, security and reliability, and the independence of the user	Ethical and security issues arising from the storage or sharing of end-users profiles Development of secure systems to enable people with activity limitations to participate in social

		Study of the privacy and security controls in pervasive sensing technologies Analysis of the consequences of system failure for users with activity limitations, and methods for automatically handling such situations	activities (eg vote remotely in elections)
	Side effects	Prediction of the positive and negative impact on users' lifestyles created by the new environments including any misuse of the technology	Personal and collective health issues related to the use and misuse of technology
Usability	Usability	Emphasise usability of systems and services in addition to accessibility	Research on changing attitudes towards new technological developments including the effect of cultural diversity
	Socialisation	Development of mechanisms for technology-mediated collective intelligence to help people with activity limitations Studies of the user relationship with public and private e-services	Development of social cooperation models to support inclusion Adaptation of an ambient intelligent environment to accommodate the needs of several persons at the same time
	Adaptability	User-centred research on adaptable and adaptive systems including personalisation of content and user interface	Intelligent interfaces that allow for persons with progressive limitations
	Multimodality	Research on multi-modal interaction methods and alternative input-output technologies to ensure that they are seamlessly integrated within emerging systems for the benefit of users with activity limitations	

Tools	Testing accessibility	Formal methods to validate accessibility of potential services which may include both automatic and semi-automatic techniques	Design and authoring tools supporting and automating accessibility
	Methodologies	Development of robust criteria for measuring success and failure of inclusion using new network services	Virtual reality testing of potential new services for accessibility by a wide range of people with activity limitations
Implementation	Standardisation	Educating standards committees on inclusion issues so that they fully comprehend the implications of the content of proposed standards on people with activity limitations	Development of knowledge infrastructures that includes scientific knowledge about inclusion Development of systems for the automatic content control of Web 2.0 to ensure that the systems are fully accessible
	Data structures	Systematic analysis of the balance of intellectual property rights and the right of access to knowledge	Research on the optimum structure and content of data storage to accommodate the needs of people with activity limitations
	Interoperability	Seamless integration of a range of assistive technologies into the ambient intelligent environment	Research on how to integrate different technologies and infrastructures (eg web 2.0 with the internet of things) to give augmented interaction with objects
	Value creation	Statistically valid data concerning the business benefits and business models for building accessibility into new network services Development of marketing and branding of ambient intelligent systems which are appropriate and relevant for people with activity limitations	Integration of assistive technology and mainstream industries Mainstreaming of inclusion

Conclusions

Some interesting activity lines are emerging from several investigations about needed developments in the inclusion environment.

New network applications are unlikely to be fully accessible and supportive unless positive action is taken to ensure this happens. At present much of mainstream industry is unaware of how to make their new services accessible and supportive or has a very simplistic view of what is involved.

Currently little is known about how users with activity limitations interact and cooperate with intelligent systems. What is needed is a scientific study in this area using a statistically valid cross-section of potential users in realistic settings. Whilst this would be a time consuming activity, it is essential that the outcomes are based on sound scientific data.

The design teams in mainstream industry need to develop an understanding of the needs of users with activity limitations, and how to reflect these needs in the specification of new products or services. Similar education is needed for the other stakeholders such as standards committees.

Users with activity limitations need to understand and be able to use the full potential of ambient intelligent systems. This will require resource to be allocated to developing and implementing appropriate training systems for a wide range of activity limitations.

Research is also needed on an automated system for analysing an individual's needs, and then modifying appropriately the features of services (eg their adaptable or adaptive user interface). This becomes significantly more complex when there is more than one person using a system at the same time.

The attitudes of users with activity limitations to pervasive technology will be affected by how information dissemination has been implemented. For systems on which users with activity limitations rely, it is important to incorporate facilities to cope with the effects of system failure or any misuse of the technology.

The business case for industry to take into account the needs of people with activity limitations needs to be made based on reliable data. Without such information, the attitude of mainstream companies is unlikely to significantly change, with the effect that people with activity limitations will lose out on the benefits this technology could bring to their lives.

The Cardiac Project

The aim of the project is to create a platform that can bring together the various stakeholders in the area of accessible and assistive information and communication technology with a view to identifying research and development gaps, emerging trends, and generate a research agenda roadmap.

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