Technology for Inclusion and Participation – Technology Based Accessibility (TBA)

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Abstract. The UN Convention on the rights of persons with disabilities (UNCRPD) [1] puts a focus on accessibility and technology. Both are considered as a precondition and means to support full participation of people. Today, new technologies provide new options for the support of all people including people with disabilities. The concepts assistive technology and accessibility begin to merge into "Technology Based Accessibility (TBA)". TBA has the potential to make a significant change in the lives of people with disabilities.

Keywords: Technology · Accessibility · Ambient intelligence · Universal design

1 Introduction

The UN Convention on the rights of persons with disabilities (UNCRPD) [1] requests the use of technology as a basic precondition for the full and equal participation and inclusion of people with disabilities. Accessibility is one of the general principles of the convention [1, Art. 3f] and is outlined in article 9. Universal Design is defined in article 2 and is referred to in the general obligations [1, Art. 4f]. Different technologies are mentioned in several articles and the provision of technology at affordable cost is requested. All the available options need to be made available complementing each other [1, Art. 4g, h].

New combinations and implementations of technology based support for all people including people with disabilities open up through new technologies, mobile devices, and the options of a connected environment with ambient intelligence. There is no longer a clear distinction between individual assistive technology and accessible infrastructures: accessibility becomes a result of general installations in the environment, mainstream mobile devices, and cloud based services – "Technology Based Accessibility (TBA)". This TBA approach has the potential to make a significant change in the lives of people with disabilities and for many of us. This paper describes the technology baseline and gives examples for options of TBA.

2 Traditional Approach

People with disabilities are supported by individual assistive technology to provide them with restauration, enhancement, or compensation of functions [2]. This support enables

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to carry out activities and reach participation levels [3]. For example, for moving around walking is replaced by driving (in wheelchairs and scooters), for interpersonal communication natural speech is replaced by electronic talkers or gestures (sign language), for using books visual reading by audiobooks, and for orientation visual orientation by tactile white canes, etc. In all those approaches a complementation in the infrastructure is more or less needed to make it work: a wheelchair needs an environment without steps and arrangements for vertical access like ramps and elevators; users of white canes need tactile guidance systems on the floor and acoustic traffic lights; users of audio need content in appropriate audio books; users who talk in sign language need partners able to communicate by signing. If both parts, assistive technology and complementing accessibility, are present the activities can be carried out and participation is possible. In the past many recommendations on how to provide accessibility have been formulated and many standards have been developed [4]. However, what happens in an environment which does not provide the accessibility features? Or if the content of interest is not available in appropriate format, or communication partners do not understand signing? Unfortunately, under such circumstances many people face significant barriers towards their activities, participation, and inclusion. Therefore, traditionally the aim was to create more accessible environments and to cover as much of the infrastructure as possible. In practice this decent approach fails frequently due to various reasons. The persons responsible are often simply not aware of the need and the available options for accessibility. Unfortunately, even new infrastructures are set up inaccessible. Redesign and reconstruction of already existing inaccessible infrastructures is often considered as too expensive or conflicting with other requirements. In many countries legislation on accessibility of the built environment, accessible transportation, and accessible information and communication has given strength to the process. The UNCRPD [1] has led to increased awareness and further activities by the ratifying countries. Nevertheless, accessibility is not always and not everywhere implemented.

3 Technology Basis for the New TBA Approach

The technological basis for the new TBA approach builds mainly upon ubiquitous powerful cloud services, ambient intelligence, and mobile devices as individual user interfaces. Today we can already observe that mobile devices like smart phones, smart watches, and navigation systems etc. are in widespread use and are considered as helpful gadgets by many people (for example, many people still read maps but use car navigation on a daily basis). These kinds of systems provide local computing power, versatile operating options, inbuilt sensors, and connections to external sensors, communication between people, local and global data communication, and connection to powerful external services.

Many mobile devices can be considered as personal and individual interfaces to local functions of the device and functionality in the cloud. Small mobile devices need new paradigms of human machine interfacing. For example speech input, signalling, and sound output may be used with a very small device compared to text input and output which requires a display. Modern smart phones provide many interface options which

can be set individually: operation without vision (Voice Over ®, Talkback ®), use of gestures, voice input, vibration, options for colour schemes, font size, placement of functions, use of hardkeys and softkeys, visual or audio signalling, etc. With these interfacing options, the devices have the potential to provide individually adapted interfaces for a great variety of user needs including people with different disabilities.

Most important is, however, the range of functionality which can be used via the adapted personal interface. First, access to information and knowledge in the cloud and also humans is provided (via GSM, LTE, WLAN, and Internet). In case of requests encyclopaedias, data bases, search engines, and special services can be addressed to find the information. Second, interactive services allow for reservations, bookings, purchases, bank transfers, updates, maintenance, etc. The use of local sensors and local communications (WLAN, Bluetooth, RFID, etc.) enable e.g. measurements of body functions, activity levels, and exchange and interaction with local appliances like ATMs, ticketing, buses, and smart environments. Third, global sensors like GPS or similar services permit localisation. The combination of these options and the use of local and global computing power open up the potential of the new approach for technology based accessibility. Preconditions are, however, the availability and affordability of devices and network services. This is very much connected with an economy of scale, which means in turn availability and use of mainstream features.

4 Exemplary Solutions of the New TBA Approach

Accessibility needs can be divided in four main areas with some overlapping user requirements: hearing, vision, movement and understanding. This division follows the abilities of people and the connected required support functions. In comparison the four principles of WCAG 2.0 [5] support the structure of a guideline which tells developers what to do. The WCAG principle “Perceivable” corresponds to Hearing and Vision and the principle “Understandable” to understanding, whereas the principle “Operable” and “Robust” and Movement have no direct correspondence, but relations. As the application domain of accessibility is much broader than e.g. web access [6] or access to digital technology [7], the meaning of the terms is much broader. The movement abilities to operate a device correspond to the principle “Operable” but the movement abilities to move around in a physical setting belong to a different category. It needs to be said that for direct movement restauration assistive technologies like crutches, walkers, wheelchairs, etc. will still be needed.

The mobile device is considered as the individual interface. It can be adapted to the individual user needs, maybe by creation of a user profile, using presents from a selection but also by learning systems and dynamic adaptation. This is closely connected to access to digital technology, the domain of the initiative “Raising the floor” [7] and GPII [8].

For many people understanding how an environment is organised and how it can be used is a significant access problem. Physical and also digital environments but also the communication and interaction with people can be very complicated and an accessibility barrier for many people. Cognitive challenges can arise from a health condition, but are

often connected also to the level of education and (digital) literacy or simply situation related e.g. concentration under stress or fatigue.

Mobile devices provide a very good basis for supporting memory function, cognition, and understanding. Calendar, daytime schedules, and timed, situation based, or sensory based reminders help to structure daily routines or guide through unknown situations. Again, mainstream software tends to provide many options and a complexity that is not understood by many people. Therefore, the level of complexity needs to be decreased. The functionality needs to be restricted for simplicity and the presentation to and interaction with the user simplified. Here Easy2Read is an important concept, which needs to be further developed by means for content moderation [9–11].

Another support need arises if people move outside their homes, in public spaces, and public transportation. Unfortunately, not all locations are fitted with traditional accessibility features at all or only certain parts of an environment are accessible. Therefore, the first step is to provide information about the situation in buildings [12], public spaces [13], and public transportation [14]. Further, private companies and crowd sourcing initiatives have proven that it is possible to collect data about environments and provide it via the Internet to the general public. Using this information it is possible to carry out an analysis of an environment prior or during the visit of a certain location. It enables e.g. to plan door to door visits with public transportation using the best accessible travel chain and path depending on individual needs [15]. Other options allow finding e.g. accessible restaurants, restrooms, taxis etc. This kind of service can be helpful to support needs of *understanding, hearing, vision, and mobility*. Further, direct interaction with smart buildings is possible, e.g. operation mode of doors (opening time/closing speed), automatic selection of level according to target, internal routing, etc. In the context of mobility car adaptations and driving support systems make car driving accessible for many people. Navigation, lane assistance, automatic parking, collision avoidance, and fully automated driving are options, which are already available or about to leave the labs [16].

Similar navigation technology can be used for pedestrians, including blind people. Instead of tactile elements in the floor the correct moving direction can be taken from the navigation system and the user be informed via acoustic or tactile means [17]. For people with reduced sight details can be enlarged, textually described, or analysed and outspoken. It can be used to recognise landmarks, identify persons, analyse traffic situations, transfer visual information from screens into text, etc.

This is close to concepts of enhanced reality, where scenes are enriched by elements of information and explanation about the immediate surroundings or other aspects of concern in the vicinity or even far away. Mostly, people think of heads up displays and electronic glasses, but the information can also be transferred e.g. as audio. With respect to complexity the services again need to be adaptable to different user needs.

Today pictures and movies are made accessible people with restricted sight via alternative texts which are provided by the producers or providers of the information. In the new TBA approach audio information about pictures and videos will be automatically provided on demand. As a step towards fully automated systems assistance on demand or peer support via internet and social networks will partly fill the gap. The automatic production of subtitles is already available e.g. with YouTube but needs a lot

of quality improvement. The apps Greta & Starks [18] can also be seen as a step towards the new TBA approach; the information for subtitles and audio description are still produced in the traditional way but not provided by the movie theatre but through a smartphone. A further step for information and communication access for people who cannot hear is the automatic conversion from speech and written information into sign language provided by avatars. An intermediate step is the provision of sign language interpretation via relay services. For people who cannot see and hear technologies like the LORM-hand [19] can increase access. It is important to realise that only the fully automated conversion of information formats and modes will be able to reach out to all information, without the need for the information provider to follow any accessibility rules. The underlying vision is that by using computing power in the cloud all information and communication can be adapted to the respective individual user needs of each single user in real time.

It needs to be stated that the new approach does not completely supersede the traditional approach. The different concepts will coexist and probably the new approach will gradually take over particular domains whereas assistive technology and traditional accessibility will be needed in others.

5 Conclusions

Accessibility in combination with assistive technology and universal design builds an important precondition for participation and inclusion. New technology, especially ICT, provides innovative solutions for technology based accessibility (TBA), where the borders between accessibility, universal design, and assistive technology become blurred and floating. Powerful services are at hand to provide individual solutions based on user profiles, automatic adaptations, conversions, and translations. As these kinds of services are of general interest for the customers it is very close to Universal Design: optimal solutions to all users based on the respective individual needs. Big threads in this context are design thinking for heterogeneous needs and the usability of the solutions in terms of complexity. Finally, it will not completely supersede the need for traditional accessibility solutions and assistive technology.

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