Flinders University, Adelaide

ACCESSIBLE MOBILE COMMUNICATION FOR PEOPLE WITH DISABILITIES

A Thesis submitted to Flinders University in fulfilment of the requirements for the degree of

MASTER OF ENGINEERING

by

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Summary

Accessible Mobile Communication for People with Disabilities

People with disabilities are both functionally and socially disadvantaged and the lack of access to mobile communication technology adds to their disadvantage. Changes and benefits we have seen in our society with the advent of mobile phones and associated electronic communication for people without disabilities have not migrated to people with disabilities. The comprehensive communication capability of a mobile phone can enable users anywhere to independently access a very wide range of communication, information and control systems and services. This research has addressed the key accessibility issues faced by people with disabilities who need or want to use the mobile phone for voice and data communication.

The research revealed that:

- there exist accessible features on mobile phones that can better assist people with disabilities in using the phone;
- through education and training, people with disabilities can develop or be provided with effective and efficient ways to access and use the phone;
- current, off-the-shelf telecommunications equipment such as car kits, speakerphone, voice recognition technology, wireless connectivity capability on mobile phones can enable people with disabilities, even severe physical disabilities, to access the telecommunications network and services; and
- with a suitable interfacing system in place, Augmentative and Alternative Communication (AAC) device users can operate the phone for voice and data communication, which previously had not been possible.

Trials established that people with a range of physical disabilities can use and should have equal access to telecommunications equipment and services. This research has shown that, with the right policies, processes and support through equipment matching, education, training and delivery, current off-the-shelf solutions can help people with disabilities to effectively communicate with other members of our society and to access the same range of information systems and services enjoyed by able-bodied members of the community.

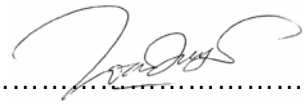
An interfacing system has been developed to provide users of AAC technology with the ability to use a mobile phone for voice calls and text messaging (SMS). It is confidently predicted that other features and services on the phone such as speakerphone, digital camera and FM radio, email and internet-based applications, and local or remote appliances and devices, can be controlled via the AAC device.

Outcomes and findings have confirmed the main hypothesis of the thesis that, despite very limited mobility, speed, accuracy and vocal communication ability, users will be able to successfully operate the mobile phone itself, and use it for various modes of bidirectional communication with systems to which they choose to connect.

The overall outcomes of the research have established that the benefits and usefulness of the mobile phone are so significant that they should become a necessity for people with a disability. It has been successfully demonstrated that, with the proper mechanisms and educational programs in place, the provision of accessible mobile phones for people with disabilities can significantly improve their quality of life through increased range of accessible activities, and will improve their independence, engagement with their peers, safety, security and self-esteem.

Declaration

I certify that this thesis does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any university; and that to the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is made in the text.

Signature  ……..

Toan H. Nguyen

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Chapter 1

ACCESSIBLE MOBILE COMMUNICATION FOR PEOPLE WITH DISABILITIES

1.1 Introduction

The provision of Assistive Technology to enhance the lives of people with disabilities is now an established applied science. While modern technology has provided many new options which have made a significant impact on the lifestyle of people with disabilities, particularly in their home, work and school environments, there has been very little application of modern technology to the needs of a person with a disability who is mobile. Changes we have seen in our society with the advent of mobile phones and associated electronic communication for people without disabilities have not migrated to people with disabilities. This project seeks to overcome this barrier.

The comprehensive communication capability of a mobile phone could enable users anywhere to independently access a very wide range of communication, information and control systems and services. The number of mobile phones currently utilised in Australia is clear evidence of their significance and potential. Jolley (2003) indicated that following the introduction of digital mobile (cellular) telephony around 1993, by June 2002 there were 12.67 million mobile telephone subscribers – 11.7 million GSM and 900 thousand CDMA subscribers.

The Short Message Service (SMS) for text messaging has also grown in popularity, spreading from the original take-up by young people to become popular across most significant market segments. There are more companies using SMS as a business medium to advertise their businesses or carry out daily business activities. For example, in the Banking sector, the Commonwealth Securities arm of the Commonwealth Bank of Australia uses SMS to update clients with share prices (Commonwealth Bank, 2001).

Messages of up to 160 characters can be exchanged between mobile phones for a cost equivalent to a local call. Similar to an email service, messages are stored and forwarded at an SMS centre. “Currently 300 million SMS messages are sent each month in Australia, approaching almost one message per cell phone subscriber per day, and generating around one billion dollars of revenue annually” (Jolley, 2003).

The integration of Wireless Application Protocol (WAP) for Internet connection, FM radio for entertainment, digital camera for capturing those ‘unforgettable moments’, Bluetooth technology for wireless connection with other Bluetooth-enabled devices and many more interesting features have made the mobile phone an even more popular and powerful tool for communication. This is further enhanced with the rollout of Third Generation (3G) mobile phone technology, which permits the transmission of voice, data, and video at up to 2 megabits per second across the network carrier.

This chapter gives an overview of the communication difficulties and barriers people with disabilities faced when accessing mainstream telecommunications technology. A brief outline of the telecommunications industry and what disability organisations are doing in providing accessible telecommunications for people with disabilities is also highlighted. The project’s context, scope and the main hypothesis are also defined with clear approaches, methodologies and intended outcomes for the thesis. An overview of succeeding work of the thesis is also given.

1.2 Communication difficulties and barriers faced by people with disabilities

People with disabilities are both functionally and socially disadvantaged and the lack of access to mobile communication technology adds to their disadvantage.

The small size and portability of the mobile phone are contributing factors that have made it a successful communication device for the general population. However, for people with disabilities, some disadvantages stem from the small size of the mobile phone. The small keypads, buttons and screens are obstacles for many people with disabilities and not very attractive for visually or mobility impaired users.

A person with restricted mobility and confined to a powered wheelchair may well have to depend on limited movement to just control the wheelchair. For people in this situation, it is rare that they would be able to pick up a mobile phone and then manipulate the small buttons that are commonplace on the phone keypad. These people may also lack the critical eye-hand coordination, fine motor control and timing required to navigate through the menus and to compose messages or text by selecting characters on the phone keypad.

For people with cerebral palsy, and others who have limited mobility and speech abilities, the tasks of communication and control are especially demanding. Many of these people have a personalised communication device or Augmentative and Alternative Communication (AAC[1]) technology, which they must have with them at all times, wherever they go. Even so, their communication capability is usually limited to direct one-on-one conversational situations. Increased functionality and direct or remote access to other technologies at home, work, or in the community would normally require the provision of additional interface devices. These systems are very expensive, due to the low production volumes and the high degree of customisation and training, and are often beyond the financial means of the users.

For people who use an AAC technology, the lack of a suitable interface system between their AAC device and the mobile phone, which would allow them to access and/or operate the phone, is the largest impediment. This is a need and an opportunity that has been addressed in this thesis.

With the current rapid market trend geared toward smaller phone models with an ever-increasing number of features, the telecommunications technology gap between people with and without disabilities has grown. At present, there are no standards in the mobile telecommunication industry that stipulate how a phone should be developed and what features should be incorporated on phones to support access by all people. Different manufacturers are implementing their own set design standards, as well as proprietary communication protocols, making it difficult to develop uniform standards. Any standards developed by the mobile telecommunications industry are more likely to be voluntary, and do not become mandatory unless national regulators adopt them. Given that telecommunications technology is changing rapidly; driven by competitive pressures, the development and adoption of national and international standards may be a long and challenging process.

The present disability standards for telecommunications equipment for customer with disabilities in Australia are very limited. Section 380 of the Telecommunications Act 1997 (Disability standards) lists just two features: an induction loop to assist people using hearing

[1] This is any system a person uses to communicate in addition to or instead of speech, including pointing to pictures and symbols, using gestures, eye gaze, or electronic devices.

aids, and a raised dot on the number 5 on the telephone keypad to help blind people. They have not kept pace with the rapid developments in communications technology.

Jolley (2003) indicated that experts differ on the preferred scope, list of features and legal/regulatory basis of any future standard. However, in order to achieve full compliance in accessible telecommunications access for people with disabilities, national and international standards need to be developed and implemented by the telecommunications industry and parties involved The inclusion of standardised mobile phone features suitable people with disabilities would allow better access to telecommunications equipment by people with disabilities as well as meet universal design principles.

The research carried out in this project endeavours to explore and make recommendations on the features to be incorporated on mobile phone technologies that will be of benefit for people with disabilities.

Legislative acts and regulatory bodies within Australia are gradually ensuring equitable and accessible telecommunications services and equipment for people with disabilities. In addition, peak consumer disability organisations encourage universal access for all by setting out principles and best practice guidelines in telecommunications access for people with a disability in Australia.

Recently, further effort has also been made to promote the implementation of the Principles of Universal Design by developers and manufacturers of mobile phone technologies, rendering them accessible by people with disabilities as well as by the wider community. The Center for Universal Design (1997) stated that “Universal design is the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design." One example of universal design in relation to deaf and hard of hearing people is the inclusion of closed-caption decoder circuitry in all television sets. Another example is the work from the Trace Research and Development Center of the College of Engineering, University of Wisconsin-Madison that endeavours to standardise a mobile phone design for all people to access. The Trace Center has released the first of a series of "Reference Designs" to illustrate how a single phone can be designed so that it would be cross-disability accessible as well as usable and attractive to mass market consumers (Trace Center, 2002).

1.3 Project’s context and scope

To provide the most effective communication possible for people with disabilities using telecommunications technology such as the mobile phone, the preferred approach is to utilise the person’s existing method(s) of operating their current systems. For many people with severe speech and/or physical disability, the provision of Augmentative and Alternative Communication (AAC) through speech output assistive technology offers powerful and appropriate solutions. An estimated one to two million Americans with severe speech disability can benefit from the application of AAC technology (Williams, 2002). At Novita Children Services Inc. (formerly The Crippled Children’s Association (CCA) Inc. of South Australia), it is estimated that 20% of its 1,300 clients use AAC technology.

A survey carried out in the US by the United Cerebral Palsy Association (UCPA) found that users of AAC technology (augmented communicators) have a critical need to have full access to voice communication technology such as cordless phones, cell phones, and pagers. It also established that, despite difficulties of access and use, telephones are still the preferred method of communication because they are readily available (UCPA, 1999).

People who rely on AAC technology have typically identified a successful method of operating their systems, and the same method may be useful for controlling the mobile phone as well. The development of a configurable interface to the mobile phone that works in conjunction with existing AAC technology such as the Pathfinder[2] from the Prentke Romich Company, could provide *multiple* accessing opportunities. It would also enable persons with severe disabilities to effectively communicate with other members of our society and to access the same range of information systems and services enjoyed by able-bodied members of the community. This was an opportunity that has been identified and undertaken in this thesis.

While this project addressed the specific needs of people with impaired communication and mobility (physical ability), the outcomes of the overall program could also lead to benefits for all people with disabilities. Potential beneficiaries of this research are people of *all* ages who:

- have adequate speech but poor mobility (eg people with a spinal cord injury or muscular dystrophy). The major innovation area would be the need for control of the phone while in a powered wheelchair; or
- are ambulant and who have difficulty accessing the phone keypad due to reduced strength and dexterity (eg people with arthritis); or
- are not able to speak, who often have limited mobility, and who use personal voice output communication aids (eg people with cerebral palsy). In addition to the features catering for the needs of this group, there is the requirement to interface their personal communication device to the mobile phone communication system for message input and output.

The main hypothesis of this research is *that, despite very limited mobility, speed, accuracy or vocal communication ability, users will be able to successfully operate the mobile phone itself, and use it for various modes of bi-directional communication with systems to which they choose to connect*.

1.4 Project's approaches, methodologies and intended outcomes

The provision of accessible mobile phones for people with disabilities can significantly improve their quality of life through an increased range of accessible activities, and will improve their independence, safety, security and self-esteem.

This research seeks to overcome the obstacles faced by people with disabilities, who need or want to use a mobile phone and its services (eg SMS), by identifying features that are accessible by people with disabilities and investigating/developing new solutions through the integration of existing mobile phone technologies. In addition, the researcher has initiated and evaluated the development of an interfacing system to a mobile phone for people who use an AAC device to communicate.

The work carried out to achieve this objective involved:

- A review of the literature and other available information on the telecommunications industry, technologies, services and current solutions suitable for people with disabilities (Chapter 2);

[2] A communication device featuring a static keyboard and built-in dynamic display touch screen, the Pathfinder comes with a choice of vocabulary programmes for spelling or symbol users. Direct access is via the keyboard and touch screen display, infrared head pointing or switch activated scanning (single, double or joystick options).

- A Focus Group session and survey questionnaire to identify difficulties or barriers faced by people with disabilities and their needs while accessing the mobile phone (Chapters 3 and 4);
- A trial of new mobile telecommunications technologies that could potentially alleviate the problems or barriers faced by people with disabilities when accessing the mobile phone (Chapter 5) as identified in Chapters 3 and 4, as well as the literature review of Chapter 2; and
- The development and validation of a suitable interfacing system between a mobile phone and an AAC device for people who use an AAC device to communicate or to access telecommunications technology and services. (Chapter 6).

This project is the first phase of a long-term collaboration between Flinders University and Novita Children's Services Inc. (industry partner for this project) to develop communication technologies and systems that promote the principles of Universal Design to ensure that future products and services take into account the needs and abilities of all people. This project was supported through the Strategic Partnerships with Industry Research and Training (SPIRT) Scheme, funded by the Australian Research Council / Department of Education, Training and Youth Affairs (DETYA).

The project is also of significance to the Novita Children Services Inc., as it will be able to provide a wider range and quality of cost effective communication and control services to its clients, as well as exploit the commercial opportunity to market the technology to users of all ages, nationally and internationally. The researcher of this thesis is currently employed at Novita Children's Services as a Rehabilitation Engineer to explore and fulfil some of these extended objectives.

1.5 Overview of the succeeding chapters of the thesis

Review of the Literature on the Telecommunications industry, Technologies, Services and Current Solutions for People with Disabilities (Chapter 2)

This section involves a review of the literature and other relevant information sources on:

- People with disabilities and the telecommunications industry, technologies and services in Australia;
- The mobile phone – its present and future technology;
- Current telecommunications solutions and options for people with disabilities.

It also includes an investigation of features on current mobile phone models used by the wider community that are also suitable for people with disabilities. A list of currently available mobile phones with these features will also be presented as a result of this investigation. This list is not comprehensive due to the continuous and rapid change in telecommunications technology, driven by competitive pressures to reduce costs, and by market demand for new services.

Focus Group session and Survey on Accessible Mobile Communications for People with Disabilities (Chapter 3, 4)

These chapters will present the focus group discussion, and a mobile and home phone needs analysis survey questionnaire with people with disabilities, that was carried out at Novita to establish the characteristics or barriers that make it difficult for people with disabilities to use a mobile phone or prevent them from accessing a mobile phone efficiently and effectively. The purpose of the survey questionnaire is also to identify what mobile phone technology people are using and what still needs developing to meet their access

needs. This work is also carried out to verify and reinforce the main hypothesis of this research.

A Trial of New Technological Options for People With Disabilities Through the Use of Telecommunications Equipment (Chapter 5)

This chapter summarises the trials and evaluations that were conducted to determine the suitability for people with disabilities of currently available hardware mobile phone technologies. This was an outcome from the review of the literature, focus group session and survey questionnaire of accessible mobile communications for people with disabilities. The trials included various alternative solutions/options (such as mobile phone car kits, voice recognition and hands-free technology, and network features such as voice mail) to improve the awareness and the telecommunications experience of people with physical disabilities. The aims of this research are to trial and evaluate new technological options that can improve the lifestyle, independence, and social interaction and inclusion of people with physical disabilities through the use of telecommunications, and also to verify the main hypothesis of this thesis.

Mobile phone access for Augmentative and Alternative Communication device Users (Chapter 6)

The ability to carry out essential tasks on a mobile phone such as dialling a number, answering an incoming call, terminating a call, and text messaging on a mobile phone via the client's existing AAC device, presented an opportunity for the development of an interfacing system to make this possible. The interfacing system acts as a link for the exchanges between an AAC device and the mobile phone's built-in modem. The implementation of such an interfacing system required the identification and utilisation of a standard Global System for Mobile communication (GSM) AT[3] command set that is available on most mobile phone modems.

This chapter describes the work undertaken to develop, test and validate an interfacing system between an AAC device and a mobile phone for voice calls and text messaging for the first time.

Overall Conclusions and Recommendations (Chapter 7)

This chapter summarises the overall findings of the thesis that supported and verified the main hypothesis of the study. Recommendations to improve the gap or shortcomings that currently exist between people with disabilities and mobile telecommunications technology are also presented.

[3] AT stands for ATtention, and is the first word to attract the attention of devices during communication between the two devices.