Design issues encountered in the development of a mobile multimedia augmentative communication service

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Abstract. Augmentative and alternative communication (AAC) systems can be mounted on a range of different hardware platforms, from custom-designed units to desk-top or lap-top personal computers and hand-held and palm-top systems. Palm-top devices such as Personal Data Assistants (PDAs) offer great advantages of portability. The small display size and limited storage and processing capacity of a PDA compared to larger systems are likely to impose some limitations on the range of AAC applications which can be supported, however, particularly when multimedia-based applications are considered. This paper addresses issues involved in migrating a multimedia AAC application onto a palm-top PDA, and discusses the user involvement in the re-engineering of the system for that environment. Outcomes from an initial practical trial with a person who uses AAC are reported.

Keywords: Augmentative and alternative communication, conversation, communication impairment, story-telling, mobile interaction.

1 Communication and disability

Most people take for granted their ability to communicate, and while they are communicating they can concentrate solely on what they want to say without having to worry about the physical or mechanical aspects of making communication happen. For those who have physical or mental disabilities, however, communication can be a major problem, particularly in a conversational situation. The extent of the problem has been highlighted by a number of researchers, including Beukelman and Mirenda [6] who review published information concerning the prevalence of communication impairment. Among such work, Beukelman and Ansel [5] suggested that 0.8%-1.2% of the general population experience severe communication impairments that require AAC. In the United Kingdom, Enderby and Philipp [20] suggested that 1.4% of the population have severe communication disorders. More detailed analysis of a local population with speech communication impairments was undertaken by Brophy-Arnott et al [10], who considered a local region and found that 0.65% of the regional population had a significant communication disorder such that professional speech therapy agencies were involved in seeking to deal with the associated implications of that disorder. There is therefore a significant population of people requiring amelioration of the effects of communication disorders, and the field of Augmentative and Alternative Communication (AAC) exists to contribute towards this.

The work described in this paper addresses issues of portability and mobility in AAC in the particular context of migrating a desktop multimedia AAC application onto a palmtop Personal Data Assistant (PDA). The desktop platform provides a large display area and sufficient storage and processing power for multimedia applications, but current Personal Data Assistants are not well equipped in these respects. This paper discusses the re-design of a multimedia AAC system with a view to porting it to a PDA in order to enhance its portability, while retaining as much as possible of the multimedia capability of the system.

1.1 Augmentative and alternative communication

Augmentative and alternative communication systems are designed to assist people with disabilities to communicate and, in particular, to participate in conversation. AAC has been defined [4, 6] as "[the] area of clinical practice that attempts to compensate (either temporarily or permanently) for the impairment and disability patterns of individuals with severe expressive communication disorders". The AAC field therefore aims to develop techniques and systems to enhance the communication abilities of disabled and non-speaking people. The advent of low-cost computers expanded radically the scope for technical AAC solutions; in particular the creation of text-to-speech technology allowed non-speaking people the opportunity to engage in spoken conversation. If a person with communication impairment can enter the word, phrase or speech act they wish to use, then a speech synthesiser can vocalise it to produce speech output. Participation in conversation thus becomes feasible. An AAC system can also contain a large amount of pre-stored material (words, phrases and stories) which a user can select from and use during communication, as well as access and input techniques to improve the efficiency of use of the system.

An important aspect of an AAC system is that its use should not place an excessive cognitive load on its user. The system should perform as much of the communication process as possible, leaving the user free to concentrate on the most important aspect – deciding on what he or she wants or needs to say. The cognitive task of accessing and selecting from the content of an AAC system must therefore be minimised wherever possible, and good interface design is therefore important as well as the development of techniques and algorithms to enable the system to contribute effectively to the communication process.

1.2 Rate of communication

People who use AAC systems usually communicate at lower rates than others, and rate of communication is an important factor in determining the success of a communicative exchange. Day-to-day conversation usually proceeds at rates ranging from 150 to 250 words/minute, while people who use AAC communicate much more slowly than this, with equivalent word rates lower than 8 words/minute in many cases [6]. Speech impairment is often associated with other physical impairments which make the selection processes needed to operate an AAC system, or any form of computer system, very slow. Glennen [23] summarises a number of "acceleration techniques" which have been devised over the years to speed up the process of producing unique or spontaneous statements for use in communication. The task of entering or selecting a phrase is fraught with difficulty, however, even with special acceleration and selection techniques, and the basic difference in equivalent speaking rate between people who use AAC and people without disability remains large.

Symbol or coding structures can be used to try to reduce the amount of physical effort required of a user to make selections. Automatic abbreviation expansion [31], for example, and probability and prediction algorithms [29, 32] can be used to help the user to input text into an AAC system. Such methods usually cause an increase in cognitive load for the user, however, as prediction lists have to be viewed, or abbreviations recalled, as part of the input task. Any improvement in input rate resulting from the application of techniques such as these is unlikely to make a person who uses AAC a fast communicator, and there remains a continuing need for more efficient selection processes in the AAC interface.

2 Conversation and story-telling

The low communication rate is a major problem in a conversational setting, where speed of response and the ability to interject are important requirements for successful participation in conversation. Much research attention has been given to creating AAC techniques to assist in conversation [2, 3]. Some general models of the conversational process can be developed, despite the limitless range of topics and changes of direction that conversation can take. Most conversations contain an opening introduction phase, small-talk, and a closing phase where winding up and farewells happen. The main part of the conversation, where information exchange occurs, lies between these two phases. Some of the information and other material used in the main part is re-usable, as certain information, anecdotes and jokes may be discussed with different audiences on different occasions. Topics of particular interest to the user might be discussed frequently with different conversation partners. There are therefore some elements of conversation which are relatively predictable, and which can be exploited in an AAC system. As a result, AAC systems and techniques [1, 42-45] have been developed based on concepts of conversational modelling and pragmatics.

2.1 Conversation

One approach is to model the various stages of conversation, such as the opening and closing stages, and the small-talk and feedback which can occur throughout. The CHAT (Conversation Helped by Automatic Talk) schema [1] contains sets of phrases appropriate for different phases of conversation (Open, Respond, Small-talk, Main, Wrap-up and Close) including small-talk phrases and feedback comments, and a structure to manage the sequence of flow through these phases. CHAT was developed to assist a user to participate in "phatic communion" during conversation, i.e. those aspects of communication which establish the atmosphere or rapport in dialogue rather than simply effecting information transfer.

The TalksBack system [11] enabled users to store information about their regular conversation partners, favourite subjects of conversation and individual utterances. This information is used to predict utterances when the user identifies the conversation partner and specifies the topic under discussion and the type of phrases needed. This approach was developed further in TalksBac [49], a communication system for non-fluent aphasic adults. Topic shifting in conversation and the use of pragmatics are important in giving a person who uses AAC some control over the conversation and the path that it takes. The TALK system [42-45] presents the user with a set of possible phrases for use in conversation based on prevailing perspectives of person (me, you), time (past, present, future) and orientation (where, what, how, when, who, why). A shift of topic can be achieved by altering one of these perspective settings, so that if the conversation partner is the subject of discussion, for example, the topic could be shifted to the system user by changing the person perspective from "you" to "me". A set of phrases appropriate for this new phase of the conversation would then be presented to the user for selection.

In some situations (e.g. transactional dialogues) there are predictable sequences which can be followed. The ScripTalker AAC system [18] is based on the concept of pre-scripting the AAC user's part of a transactional dialogue so that the user can perform such tasks as requesting a meal in a restaurant, buying tickets for a concert, or consulting a doctor, in a relatively efficient manner. The script approach (derived from goal-plan-script theory [38]) requires the author of a script to anticipate the stages, and the key statements that a user will need to use at each of the stages, of a transactional conversation. Once such stages and statements are identified, they can be laid out as a script for an AAC user to use, and then programmed into an AAC system such as ScripTalker. Schema-based techniques [12, 46] have a similar conceptual basis to scripts, providing sequences of utterances to AAC users, while frame-based methods [25, 26] take a situational or context-based approach to creating a structure for utterance selection.

2.2 Story-telling in AAC

A large amount of conversation consists of the telling of stories. Dunbar [15] indicates that the majority of human interactions are social, centred on exchanging opinions, gossiping or telling stories. Emler [19] found that 74% of the content of conversation is concerned with discussing, principally as anecdotes and stories, events (past, present and future) and opinions about these events, with the main focus being on personally known people and places. These stories are often told to many people at different times and are an important part of conversation and of showing our personality. Schank [39] lists several reasons why we tell stories categorised according to whether they affect the storyteller (me-goals), the listeners (you-goals) or the conversation itself (conversation goals). Stories can earn a speaker approval and praise from others, cathartic benefits from recounting difficult episodes, or simply the attention of other people. Stories can be delivered purely for the entertainment of others or as a means of transferring knowledge and information. Read and Miller [34] make the point strongly that humans are social creatures. They learn from others and share what they have learnt, and they interact in ways which influence their status and roles in social communities. In reviewing the work of Schank and Abelson [40], Scott makes the point [41] that story-telling does not automatically imply the use of words; other forms of representation such as pictures and images, symbols, objects or even mathematical equations are possible.

It is therefore very desirable that AAC systems should be able to store stories and make them available for use during conversation, and storage and retrieval features have been developed [48] which can prompt the user with an appropriate story based on conversation topic and partner. When used in an AAC situation, a story can be selected and narrated, with the person using the AAC system being able to control the flow of the story, including whether constituent phrases are spoken or not. Further research on the use of stories in AAC [50] has revealed that young people with unintelligible speech gain positive benefit in terms of interactive communication from the experience of writing and telling stories. Story facilities are therefore important in AAC systems.

2.3 Images in story-telling

Csikszentmihalyi and Rochberg-Halton [13] reported that photographs are the third most treasured possessions in the home of a modern western family after furniture and visual arts. This varies greatly with age, however, with children and teenagers ranking them only sixteenth in order of importance, while grandparents ranked them first. Mäkelä *et al.* [30] found the personal value of images to be in socialising and social interactions and in recording memories. Their study showed that younger people tended to use images to record humorous situations or everyday objects that were of importance to them, while older people like to use them for illustrating memories and helping in recounting stories. Pictures and images are therefore important in social interaction. They can contribute strongly to conveying the essence of a story or rekindling a memory, and so contribute to making conversation vivid and enjoyable. It is therefore important that pictures and images should be available and accessible in an AAC system, so that they can be put to good effect in stimulating and inspiring augmented conversation.

2.4 Multimedia story-telling service

A multimedia communication service was therefore developed [27] to provide non-speaking people with a means to interact socially when living independently, based on the sharing of stories using pictures and other media. Discussions with people with disabilities resulted in a broad design concept where communications services such as telephony, video-telephony, text telephony and e-mail were identified as desirable elements in the service. Asynchronous interaction would be made available using electronic mail, taking advantage of the fact that multimedia elements can be added to e-mail messages as attachments or embedded items. The overall concept took into account different needs of face-to-face communication and communication using Internet services. Functional modules of the system could be distributed so that a relatively low-power portable device could be used for the user interface, while processing (e.g. prediction algorithms) and storage of the multimedia information could be performed by remote servers. This approach gave greater flexibility regarding the type of hardware device which the user would be required to carry and use; the size, weight and power requirements of the user device would not be conditioned by the storage or processing requirements for multimedia material.

The multimedia communication service enables pictures, video clips and audio clips to be collated and stored in a database. They can then be presented as sequences in narratives. Stories are organised according to a number of topics and sub-topics, which are presented as a set of choices. When a topic is selected, five stories associated with that topic are retrieved from the database and presented as choices on the interface. When one of the stories is selected, five media items associated with the story are retrieved from the database, and when the user selects one of these, it is presented on the interface with a text phrase stating the message of the media item. In practice, therefore, a single story required the user to collect and annotate five or six media items, and a complete topic in this prototype consisted of 25-30 annotated media items. The users for whom this system is being developed will often require some assistance to collate, annotate and embed the original stories in a database. Users who collaborated in the development of the prototype compiled their stories with assistance from family members and personal care helpers. The initial selection of media items to represent the topics and stories would take approximately half an hour, with the help of an assistant (e.g. family member). The assistant would then spend a further period of time (perhaps an evening) annotating the media items with textual content outlining the stories to which the media items relate. The media items and textual content would then be transferred into the system database, and this stage typically required one day's work by the system developer. It was noted that the existence of the media items (photographs in this case) made the overall composition process much easier than it would have been if stories had had to be composed without such supporting material. The photographs effectively outlined the story from the outset, and made it relatively easy for the assistant to produce associated annotations which became the textual content of each story. The resulting system has been found to be a valuable means of presenting stories in an AAC context [27], and therefore a useful tool for promoting social interaction for people with a speech or language impairment. An example view of the system interface can be seen in Figure 1.

Figure 1. Full screen multimedia interface

A distributed architecture was selected as the means of storing and delivering the stories. Calculations were performed to estimate the amount of storage required to hold sufficient stories and story items, and measurements were made of the impact of performing all the storage, retrieval and presentation processes on one machine. As a story could consist of 5 pictures, audio clips with associated picture and text labels or video clips with associated picture and text labels, the storage requirements for a single story could range from 200 kbytes to 10 Mbytes. An initial collection of 125 stories arranged as 5 stories per topic and 5 topics per user would require storage capacity of between 25 Mbytes and 1.25 Gbytes. This minimum set of stories is a demanding storage requirement for a portable device. Performance calculations were performed using a variety of network technologies (GSM, GPRS, wireless LAN and wired LAN) and computing platforms (PDAs, tablet PCs, notebook PCs and desktop PCs) also showed that the presentation of material was slowed considerably if the platform being used to present the material was also the platform on which the database of story material was being held, compared to the situation where the material to be presented was retrieved from a server via a wired or wireless LAN. Both findings led to the conclusion that the story material should be placed on a central server, with information being uploaded to the client device. The technology chosen was therefore delivery from a central database to a web browser on the client machine with selections of story material being made using dynamic web pages.

3 Mobile access to communication service

The initial multimedia communication service described above uses conventional desktop work-stations and lap-top computers, and makes full use of the display area of these systems to present the user-interface. In order to make the service as portable as possible, however, there is a strong need to be able to operate it using a much more compact and light-weight device such as a personal data assistant (PDA). This would allow a user to move around within and beyond the home and still be able to access and use the service, while being relatively unencumbered by additional devices. A PDA can be carried in a pocket or handbag while not in use, and so presents little extra burden to its owner. It has a small display screen, however, much smaller than that on a typical desk-top workstation or lap-top computer. This raises the key question of whether the communication service, with its multimedia interface featuring photographs and images, could be hosted on a device with such a small display. The small size of the display could make it difficult to present an array of photographs to the user, for example, in the way that is done on the desktop/laptop version. There is also the issue of whether the multimedia information could be stored on the PDA itself, or would have to be stored on a remote server, with the PDA retrieving the multimedia material from the server by network (e.g. wireless) connection. The work described here was therefore intended to explore whether a PDA could form a usable platform for the service, while still retaining key features and advantages of the original service.

Researchers outwith the AAC field have recognised the problem of small display space on portable devices such as PDAs and investigated ways of making the presentation of information more effective on portable platforms. Examples of such research [7-9, 14, 16, 17, 35, 36, 47] show a number of interesting strategies, including the use of sound in the interface to augment the visual component [7-9, 47], the application of the rapid serial visual presentation (RSVP) technique to web browsing on small devices [14], and transformations of graphic images [36]. Dunlop and Davidson [17], recognising that access to large amounts of data on small devices is likely to become an increasingly common requirement, created a Starfield display (which would normally be used on a large high-resolution display) on a palmtop device. Despite the use of a simplified Starfield and a monochrome display, the system was well received by users in an experiment on searching through a small collection of movies, giving encouraging results concerning the use of visualisation techniques on small portable displays. Experiments such as these engender optimism about the use of PDAs as multimedia interface devices, and this could have very good implications for AAC.

Some existing AAC systems are mounted on compact portable platforms such as PDAs or hand-held devices [22, 24], and several commercial examples of these exist [21, 37, 51]. They can contain a wide range of facilities, such as prediction, symbol access, speech synthesis and many other AAC techniques. While the graphical displays on the PDAs are used extensively for aspects such as symbol access and dynamic display, there has been little exploitation so far of multimedia information in the form of picture or video material. This may be partly due to reduced processing power and storage capacity of PDAs compared to desktop systems, but the small display size must also have been seen as a disincentive to the use of such multimedia material. Investigation of the possibilities of mounting the communication service on a PDA, with the inevitable use of small image size, was therefore necessary. The investigation explored the potential of a PDA in this role and the re-engineering of the communication service to operate in a PDA environment.

4 System design

The specific design implications arising from providing the service on the restricted platform of the PDA were explored. User requirements were gathered, and a number of usability aspects were tested, as paper designs, individual components of the system, and as an integrated service.

The first step in the design process was to consider the user and the specific requirements of the user in the context of interaction with the PDA-based service. The parts of the UserFit methodology [33] that explored the specific user characteristics and how they affected the interaction with the proposed system were used. This highlighted the specific attributes of the PDA system that needed particular attention as being:

- the composition of the user interface and the details of how the functionality of the system would be presented within the small display area;
- the size of artefacts on the display, particularly the size of the images being used to represent the multimedia story items and stories within the interface being used to navigate to the stories;
- the nature of the selection method used by the non-speaking user: given that many non-speaking people also have some degree of impaired manual dexterity, the nature of the physical selection method for the stories and story items would need to be explored.

These issues were dealt with in turn. The first issue concerned the degree to which a user with impaired dexterity could use the various user interface components found on the display of a Palm-size PDA. As the service would be delivered through the web browser on the PDA, tests were conducted with a number of users navigating web pages on the PDA. The primary issue that prevented successful use of web pages was found to be the requirement to scroll down the web page to view its entire contents. The user interface component providing the mechanism for scrolling down the page was too narrow and generally too sensitive to be used by people with poor manual dexterity. This generated a requirement to confine the active aspects of the user interface to single pages that could be presented in full on the display. Where more material was available than could be fitted onto a single page, multiple pages would be presented rather than a long scrollable page.

Given the restricted size of the display, one possible approach to providing the navigation interface through the stories and media items might be to reduce the size of picture and text labels in order to fit more onto a single browser page. Given that information was being selected on the basis of a picture label, it was vital that the user could clearly distinguish between different picture labels. A test was devised to measure the degree to which the users could do this. Sets of pictures were printed in different sizes and users were asked to select the pictures that represented specific stories or story items. The various sizes used were:

- 0.7 cm wide, corresponding to 7 photographs in a row across the PDA display
- cm wide, corresponding to 5 photographs in a row across the PDA display
- 1.4 cm wide, corresponding to 4 photographs in a row across the PDA display
- 1.7 cm wide, corresponding to 3 photographs in a row across the PDA display

It was found that, in general, PDA users could distinguish between detailed photographs when the photographs were 1.0 cm wide. This would allow five photographic labels to be used in a row across the display of the PDA. Most importantly, a typical non-speaking participant in the trial was able to comfortably discriminate between pictures at that size.

The third issue to be tackled was the nature of the physical interaction with the PDA that typical non-speaking users with poor manual dexterity were most comfortable with. In general, it was found that poor dexterity is often accompanied by unreliable grip and unreliable use of force when pointing to the active area on the touch-sensitive display of the PDA. These two factors suggested that the use of the hard-tipped stylus that was provided with the PDA to make selections on the display was not recommended. Whilst a soft-tipped stylus was available, users tended to prefer to use their finger and to concentrate on a pointing task rather than on a combined pointing and gripping task. Both a hard and a soft-tipped stylus tend to slip across the touch sensitive display of the PDA, whilst the user was able to dwell on the point of interest using their finger more reliably than when using a stylus.

Having established concrete requirements addressing these issues, a number of different interfaces were developed and tested. The primary concern was to determine if a single page could be used to navigate to stories and story items and to display the media item that had been selected, or if one page was required to navigate to the story items and another page for presentation of the selected items. When the various interfaces were tested, it was found that whilst the users could distinguish between picture labels that were 1.0 cm wide, they could not reliably select these items because they were too closely located on the display of the PDA. The solution was to reduce the number of items on each row to four, and to expand the picture slightly, thereby allowing several pixels to be left inactive between pictures. The rows of pictures were also spread vertically using the full height of the PDA display. This inevitably led to an arrangement where all the picture labels were arranged on one page, and the selected story item was presented as a single item on another page.

A detailed aspect of the layout that emerged from this initial prototyping phase was the provision of an inactive area to the left and right of the row of items being displayed. It was found that this reduced the problems of both left and right-handed users selecting the items close to the edges of the display. The final design is shown in Figures 2 and 3.

Figure 2. PDA based navigation interface

Figure 3. PDA based presentation interface

Once the system had been constructed it was tested using a variety of network technologies. The development and initial testing of the system was conducted by connecting the HP Jornada to the network using a CompactFlash Ethernet card running at 10 Mbps. Mobility was verified by replacing the 10 Mbps Ethernet card with a wireless LAN card running at 11 Mbps. In order to test the wide area mobility of the service, it was accessed using a Siemens XYZ PDA that was equipped with a GPRS wireless continuous Internet connection operating from 38.4 up to 114 kbps. In practice, the data rate achieved on the GPRS connection operating during the test ranged from 56-70 kbps. It was found that all stories could be accessed and the service operated as expected under all of these network conditions.

5 System testing

Having optimised the design of the service to the display of the PDA, a trial was constructed to explore the usability of the system by a non-speaking user. At this stage in the development cycle the trial was conducted with a single user as the trial depended on the user supplying sufficient multimedia items of their own material. The prototyping of the database with multimedia items and populating it with story material was a time-consuming task, so it was felt that the most appropriate approach was to build a system for one user in order to explore the validity of the method before extending the system further. The user therefore prepared story items for ten stories consisting of a story picture label and four story items. The user has cerebral palsy with consequent poor speech and reduced manual dexterity.

The test was a formal comparison of the PDA-delivered service and the desk-top version based on a previous trial reported in [28]. The trial consisted of the user being asked a series of fifteen questions such as:

Question: Find who you went to Niagara Falls with?

The time taken for the user to select the story item to answer the question was recorded by capturing the data packets passing over the network between the PDA and the server. In order to time the interactions made by the user, a test system was set up with the following computers. The database and the web server were running on a Windows 2000 server, and the client web browser was running on an HP Jornada 568 PDA. A third computer, a Toshiba Tecra 540 CDT running Windows 98 was used to log network traffic. The Toshiba was running EtherPeek 4 network traffic monitoring software. This software is able to capture all, or a filtered selection of, data packets passing on the local area network between the machines. The trigger for the start of an answer was the activation of the browser "Back" button to return to the navigation page. The close of the selection was the selection of the correct story item. An error was counted as a story item that was selected which was not the correct answer to the question.

When the test was performed and the data were compared with that from the desk-top system it showed that the user was quicker in finding stories with the PDA system and made fewer errors than with the desk-top system. In both circumstances the user was faster and more accurate on the PDA by 25-35%.

Figure 4. Selection times associated with the PDA and desk-top systems

Figure 5. Error rates associated with the PDA and desk-top systems

A t-test was performed on this data, which showed a significant result ($t(1.77)=2.17; p=0.02$) when comparing the use of the desktop system with that of the PDA. The t-test was performed on the error data, which showed a non-significant result ($t(1.77)=1.63; p=0.06$) when comparing the use of desktop and the PDA. This result showed that the time taken to retrieve information using the PDA was less than that using the desktop system across the full set of questions. The variance of the errors between the two systems was not however significantly different, as in both cases, whilst many questions were answered without any errors, some questions were answered following up to four erroneous selections. Observation of the use of the systems suggested that this error resulted from the user forgetting exactly where the story item was within the topic/story hierarchy rather than incorrect selection of adjacent story items. There was no significant difference in this phenomenon between using either system.

The data suggest, therefore, that the user was able to select items for display significantly more quickly on the display of the PDA than on the display of the desktop system. The primary reason for this seems to be that the user was able to select items directly from the PDA display rather than using a selection device such as a mouse or roller-ball. Another important factor was that the PDA was light and small, and could be held by the user in the most suitable position for making selections, rather than being fixed in a non-optimal position.

Following the trial, the user was consulted about subjective impressions of the usability and usefulness of the service. Detailed design aspects were discussed such as the use of a finger to point or the use of a soft-tipped pen. These aspects highlighted the individual nature of the deployment of such a service. In principle, the user was enthusiastic about the possibilities of PDA-based AAC. This user is typical of many people who use AAC who have tried and rejected a number of powerful but barely portable systems, and have retained either simple portable AAC devices or have rejected technology-based AAC in favour of basic paper-based communication charts.

6 Discussion

Many AAC systems are provided on hardware platforms which, whilst not designed to be statically located, are not in practice very portable. Many users who have impaired speech also have additional motor impairments that affect their mobility, their muscular strength and stamina, their manual dexterity, or a combination of all of these. For this reason, the need for highly portable AAC systems is important, and as reported above, PDAs have entered the AAC market-place as practical platforms. The work reported here has indicated the feasibility of providing some transactional communication facilities on lightweight PDA devices, with multimedia material contributing to the provision of a rich and flexible social interaction service. Limitations to the processing power and storage capacity of the PDA device were overcome through the use of networking (wired and wireless) to provide connectivity to a static server which could provide the required power and storage. In all cases, the performance of the overall service was such that the user enjoyed fast responsive access to a substantial quantity of multimedia material which it would not otherwise have been possible to provide on a PDA, while having a very portable interface and access device with which to conduct augmented conversation. It is notable that the participant in this initial trial was faster in finding stories with the PDA than with the desk-top system. The network connection to the remote server therefore demonstrated itself to be a highly effective way of extending the power of the PDA platform, and represents a valuable architecture for other AAC applications which are found to require performance specifications beyond the scope of a compact portable device.

6.1 Future Work

Following the initial usability trial reported in this paper, the system has been demonstrated to a number of other people who use AAC. Sufficient enthusiasm has been expressed about the service for the research to be extended to encompass a larger pool of users. Equipment has been installed in a rehabilitation day centre to enable large volumes of story material to be collected and embedded into databases and made available to mobile client devices. These stories will enable further trials to take place to further investigate the issues highlighted by the trial reported here, with a view to formalising the story compilation process. Once sufficient material has been compiled, a more formal evaluation will be undertaken to explore issues such as the accuracy of the story understood by the audience and the degree to which the audience is able to gain an impression of the personality of the user through the stories. Other issues which could be investigated further include empirical comparison with other small display techniques and visualisation methods, and consequent exploration of the functionality and features of the system within that context. For instance, the result reported here echoes the promising outcome of Dunlop and Davidson [17] in migrating a “large-screen” technique onto a small display, in their case by mounting a simplified Starfield display on a palmtop device. Other approaches such as using RSVP in web browsing on a small display [14] and graphic image transformation [36] also create interesting possibilities which may benefit AAC in some way. The use of sound in the interface [7] is another area for possible development in this type of AAC application; multi-modal interfaces could be of particular value in mobile PDA-based AAC systems where sound or vibration could augment or replace the visual output. With imaginative design and development, therefore, there are techniques which can make the small display of a PDA more accessible and usable, and the prospects for AAC are therefore encouraging.

7 Conclusion

The research reported here has demonstrated how a compact PDA-based interface can work effectively in a multimedia AAC service, with a distributed architecture applied to facilitate the storage and delivery of stories in multimedia form to the PDA. This architecture gave effective performance in experimental conditions, and indicated that a PDA could form a usable platform for this type of service, while offering good portability and mobility to the user. It is evident that this concept can be extended within the AAC context, and further research in this area is merited to evaluate the system with a larger number of people who use AAC, and further prove and develop the concept. The position established here gives significant promise for future developments in this field.

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Figure Legends

Fig. 1. Full screen multimedia interface

Fig. 2. PDA-based navigation interface

Fig. 3. PDA-based presentation interface

Fig. 4. Selection times associated with the PDA and Desk-top systems

Fig. 5. Error rates associated with the PDA and Desk-top systems

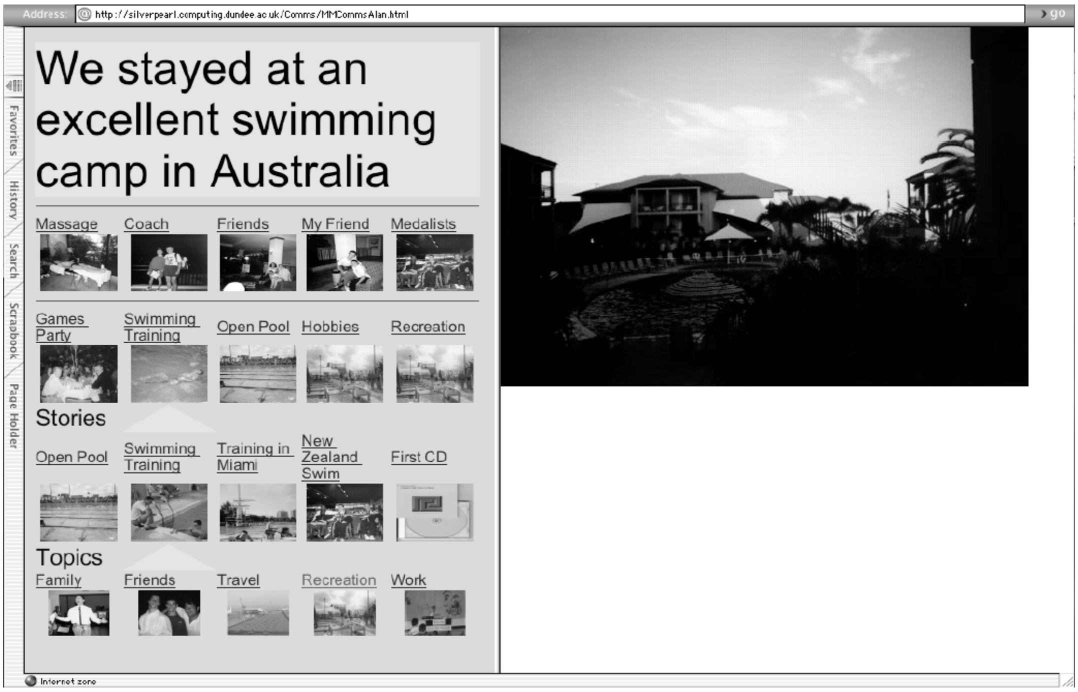

Figure 1: Full screen multimedia interface

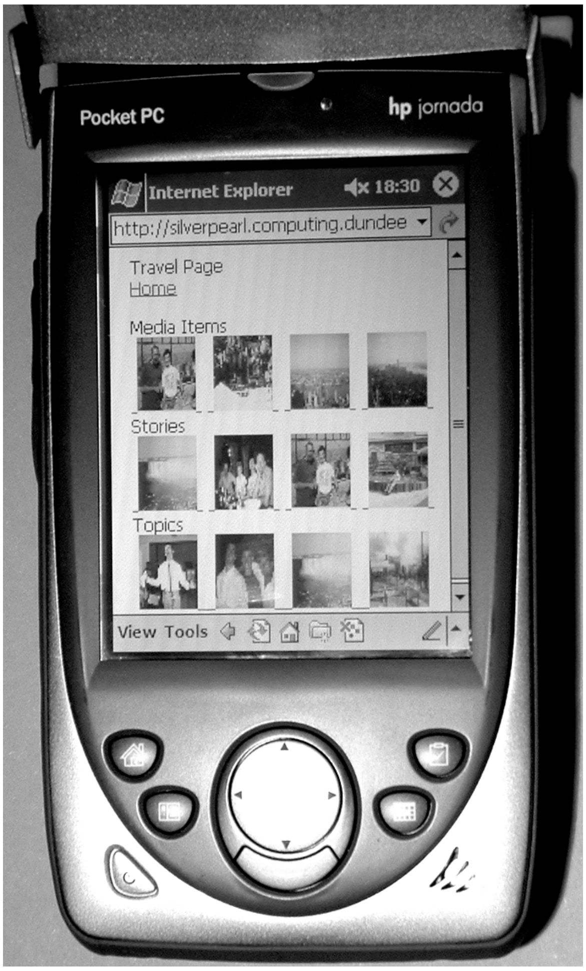

Figure 2: PDA based navigation interface

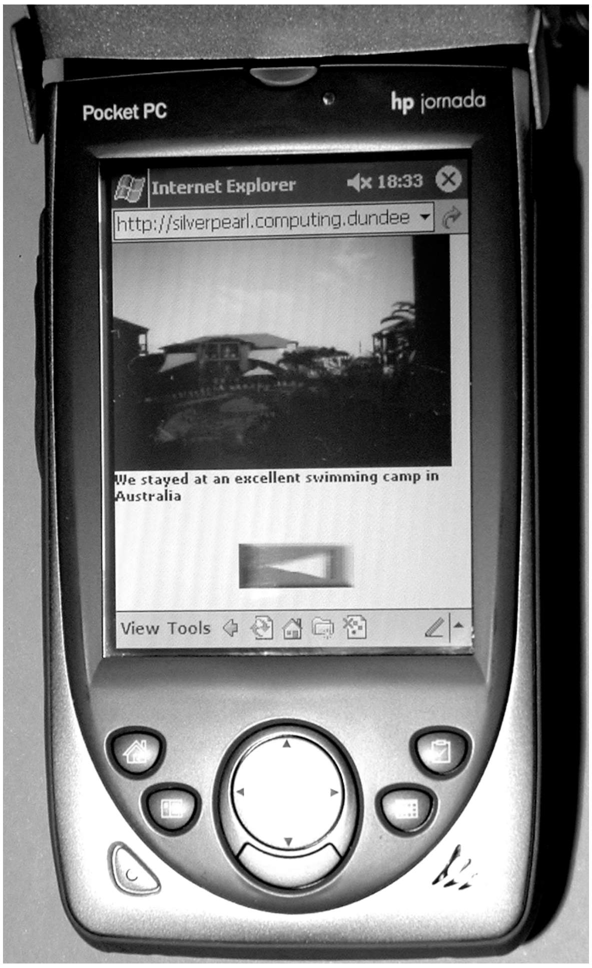

Figure 3: PDA based presentation interface

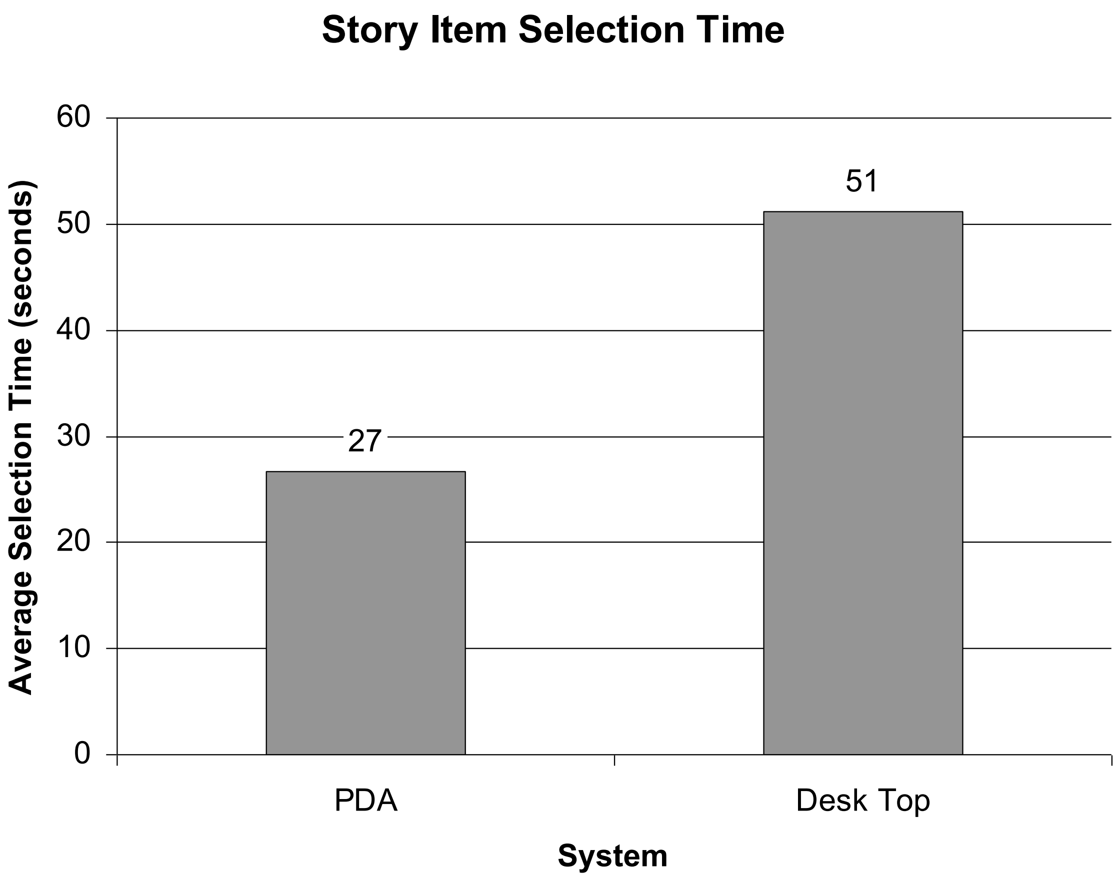

Figure 4: Selection times associated with the PDA and Desktop Systems

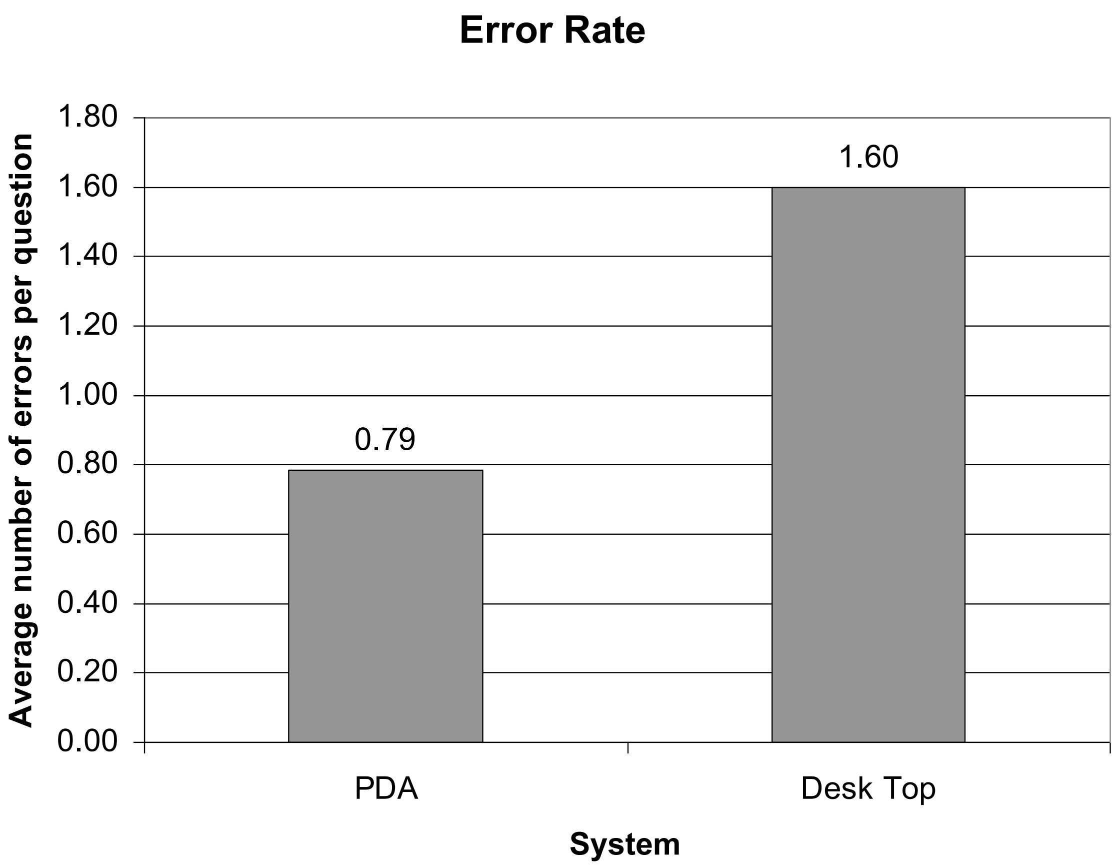

Figure 5: Error rates associated with the PDA and Desktop Systems