

A New Visual Communication System for Deaf-Blind Tertiary Education Students

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Abstract

With increasing influence of globalisation and the importance of accessibility legislation it is essential that the deaf-blind, especially deaf-blind tertiary students, can make effective use of computers for using the Web, word-processing and email for example. Conventional text to speech translation may not be effective if the student also has hearing difficulties. The authors have developed a system that can replace conventional textual characters with patterns that are matched to a visually disabled person's visual recognition capacity. A timed presentation of a sequence of such patterns can represent a word. Consecutive sequences of such patterns can represent a sentence or a paragraph. This paper includes results of experiments performed using this system via a specially developed program Dynamic Pattern System (DPS) that was designed as a test bed for such investigations. This paper also considers areas requiring further investigation.

I. Introduction

For most people vision is vital in their learning processes. Murray has noted that: "*Vision is the main sensory modality employed in learning*" and that "*One of the main deprivations caused by blindness is the access to information. Visualisation is an increasingly important method for people to understand complex information, and is presented using tables, graphs diagrams and images. Visual techniques are also used to navigate around structured information*"^[1].

However, there are still many problems for visually disabled students who wish to use computers or the Internet as is shown by the titles of the many research publications such as: "*Tension? What tension? – Website and accessibility and visual design*"^[2] or "*Web Blind Spots - The disabled community is potentially a big market. So why is it ignored?*"^[3]. Internet and email access for students is a vital tool for today's students.

It has been found that when people have one disability such as blindness they are more likely than the general population to have another disability^[4] and some students are both deaf and blind. Deaf-blind students may not be able to use the popular text to speech conversion programs

and as noted the problems can be difficult enough for blind people without the added disability of deafness. Such students need to be able to be able to access electronic text based information to be able to effectively participate in a modern learning environment.

2. The Dynamic Pattern System (DPS)

The American Foundation for the Blind note that out of the 1994-1995 population of 262 million in the USA the estimated number of blind or visually impaired people of all ages including institutionalised and homeless people was 7 to 10 million ^[5]. There are many people who are legally classified as blind but still have some residual vision. The Royal Blind Society of New South Wales notes that: *“The general community assumes that ‘blind’ people have no vision at all. This assumption is false. 92% of respondents to the survey have some useful residual vision, even though their functioning is affected by vision loss”* ^[4].

If such people could simultaneously discern a small number of different coloured areas on a computer screen then this could represent textual symbols. If for a particular user, 3 discernable coloured areas can be seen each of which could contain 5 discernable colours then the number of characters that could be represented is 5^3 or 125. This is more than the number of patterns required to represent the alphanumeric character set. However, the need to ensure that the patterns used are less likely to be misidentified meant that only a small range of the available patterns were used. Each pattern could represent a textual character. A word, sentence or book is can be represented by a dynamic sequence of such patterns presented on a computer screen in which each pattern is shown for a short set time one after another. The time that each pattern is presented and the time between each word could also be varied according to the requirements of the user. DPS was developed as an experimental aid to investigate such pattern presentation sequences representing text based information and uses a standard PC.

Text is entered using a standard keyboard or text file and can be displayed as both patterns and textual characters which can be saved and redisplayed later. Sets of available patterns can be adapted to an individual’s visual capacity and stored and modified for future use along with the pattern presentation rate, size, background colour and shape. Pattern presentation speeds known to induce photo sensitive epileptic fits in photo sensitive epileptics are filtered out by the DPS.

Figure 1 shows a typical DPS screen used to present patterns to the blind person undergoing testing is shown below. The need for the character based text and other details of the screen presentation are shown below. These are used to aid the investigator and can be turned off when required. It should be noted that there are a maximum of 5 coloured areas that can be used. This number was chosen because higher numbers of such areas could be used to represent alphanumeric characters. The coloured areas could either be squares or circles. The DPS program was written in Visual Basic. A fully implemented DPS system being used by a partially sight person need only show patterns on the screen and no text based characters.

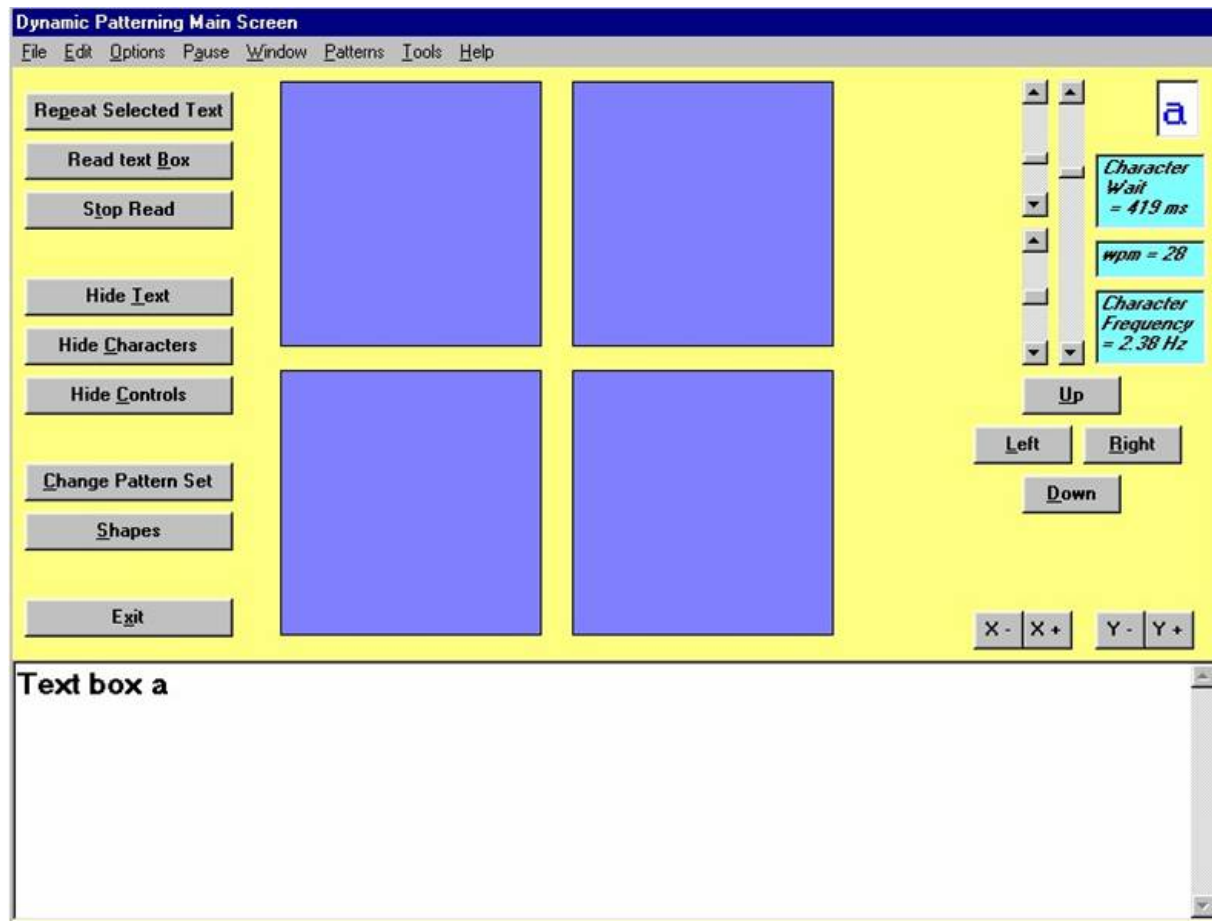


Figure 1. The DPS pattern presentation screen

Figure 2 shows a typical screen used to select the pattern representation of a textual character. Note that the shape number of areas and their distance apart can be selected. These were chosen with the help of the instigator by the volunteers to fit their own visual ability. It should be noted that from 1 to 5 coloured areas can be used but not all coloured areas need be used for every representation simply by making the colour of the pattern the same as the background colour can reduce the coloured areas in particular character representations whilst allowing more coloured areas in other character representations by choosing different colours. A large range of colours can be selected to fill the Palette.

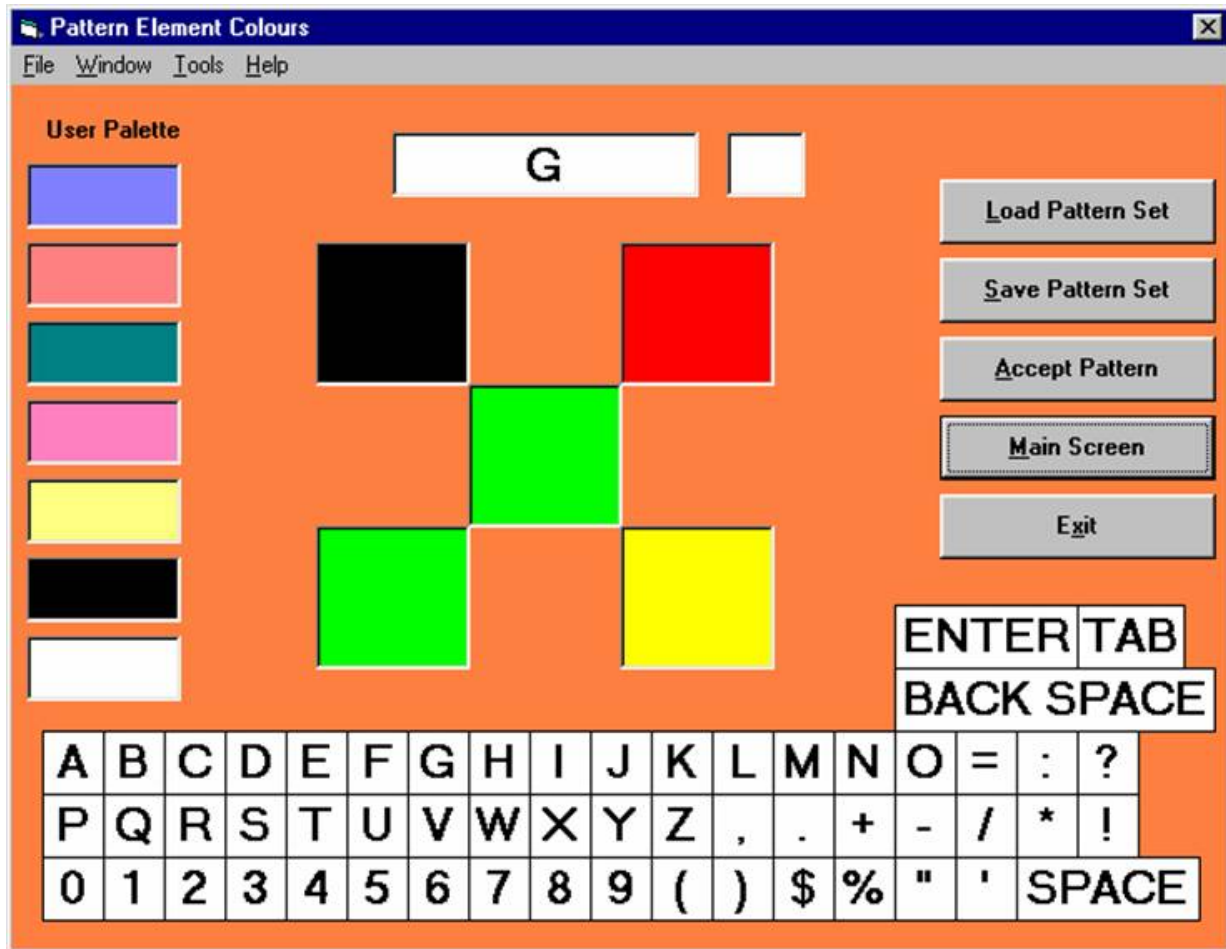


Figure 2. The DPS pattern production screen

3. The Experiments

Testing was first undertaken by the authors on themselves and once a few character representations were recognised spectacle frames covered with various layers of Sellotape were used by the authors in an attempt to simulate partial vision. The authors then sought the help of legally blind volunteers who were informed of the possible call on their time and the perceived risks involved. There were 12 volunteers attending either the Royal WA institute for the Blind or Edith Cowan University both in Perth WA. Of these one volunteer was deaf-blind and the others were blind in that all possessed less than 10% vision. The experiments were conducted over a maximum of three weeks, while some attended for three weeks, most only attended for two weeks. Potential volunteers other than the 12 mentioned were not included, as they either could see the computer or the screen or were epileptics and were not used due to the potential danger of a photo induced fit. Even though the known frequencies of pattern presentation speeds likely to induce epileptic fits had been filtered out it was necessary to make every effort to minimise potential risks. Each session took a maximum time of 20 minutes for each volunteer per week to attempt to limit any effects of fatigue.

The tests were undertaken using the same settings on the same PC. An optimal display rate was then set and the size and separation of the elements of the patterns were adjusted in an attempt to provide an optimal reading situation. The volunteers then chose their own patterns both in number shape, colour and separation of elements within the constraints of the DPS computer program. The volunteers then attempted to recognise patterns and to associate them with the characters that they represented. Sequences of such patterns were then displayed and the volunteers then attempted to recognise the words they represented. With practice sequences of patterns representing simple words could be recognised.

4. The Experimental Results

All of the volunteers were legally blind although they could all read highly enlarged text when tested, in some cases only a single letter covering most of the screen. However, useful data was obtained about the potential usefulness of this system and on the problems experienced by the blind volunteers in using it. The shape of the coloured areas did not influence the ability of volunteers to distinguish these patterns. However, the screen position of these areas with respect to each other varied as did the choice of background colour. One volunteer preferred to use only 2 squares with background of green and the room to be light whilst another preferred the room to be dark. With such a large range of requirements the DPS system was well tested and more modifications were needed such as the ability to change the background colour as part of the character representation. A further finding was that some volunteers found that their knowledge of Braille interfered with the pattern recall and one noted that they 'felt' the character representation patterns that matched Braille script via their fingers rather than seeing them. Another volunteer required 3 squares on screen whilst another needed the centre of the screen to

be clear and the patterns to be placed around that centre. Another volunteer required a special anti glare screen to be placed over the monitor. Yet another volunteer could not see a range of common colours. One volunteer said that they would prefer that the pattern presented to gradually increase in brightness. To ensure the conditions were matched the same lighting and distance from the screen and the same computers and monitors were used each time. The patternsets were individualized to the users and details stored that automatically reset the DPS system in terms of patterns used, delivery rate of patterns, size of coloured areas and background colour used. The background colour could also be reset.

The results of the experiments appeared to confirm that there was no one patternset that was suitable for all the participants. There was a necessity to fit the users to the patterns rather than the more common situation that forces people to use the set patterns representing conventional text. The results also indicated that sequences of patterns representing a single character were more recognisable than a single pattern per word representation but took longer to read. More results are needed and it is intended to widen the volunteer base via a more extensive investigation.

5. Proposed modifications to the DPS system

There are sets of coloured patterns that represent characters which have been in operation for centuries. This is the use of ships flags to represent strings of characters as described by Foley^[6]. In the modern international system each flag represents both a letter and a message. Therefore a DPS pattern could also be used as a message. The DPS could be considered as a dynamic representation of such a ship's flag signalling system but one that matches the patterns to the users. In cases where the users have a more limited visual capacity sequences of a single pattern can be displayed by being presented on screen for a long and a short time period to represent the dots and dashes used in Morse code.

A proposed modification is the use of a computer projector so that even if the volunteers cannot see the computer screen they might be able to see the patterns on a large projector screen. Another proposed modification resulting from the experiments is to use patterns that provide hints to aid recognition by their shape such as L F T or V as this was found to aid recognition in the experiments. Morse code is based upon the general principle that the shortest sequences of dots or dashes are used for the most commonly occurring letters used in English; likewise the more easily recognised patterns could be used for the more commonly occurring letters in the English language. However, Maguire in^[7] tabulates the coding methods using colour, lines, size, and shape, etc with associated comments. Word recognition is aided by the fact that there is not just an equal chance of finding any character following any other and Singh notes that: "*The English language in its choice of symbols to form a message is 42 percent as free as it could possibly be with the same alphabet. Unity minus the relative freedom, that is $1 - 0.42 = 0.58$ may approximately be adopted as a measure of redundancy; this fraction of each message is*

redundant in the sense that if it were missing, it could be readily guessed because of the accepted statistical regularities underlying our use of the alphabet”^[8].

At present the DPS program does not distinguish between upper and lower case letters. This is to reduce the number of patterns that users need to recognize. All that needs to be sent or received by the users' computers are standard text files as each pattern corresponds to an ASCII character. Any conversions to and from the pattern sets are made via the DPS program.

The patterns used to represent characters could also include multiple redundancies such that if an individual's visual capacity decreased over time then if one source of pattern to character matching failed then the other or others could enable such matching to take place. Research has also been undertaken into using the DPS system for diagram presentation^[9] and other research has investigated the use of a numerical distance between patterns used for pattern design^[10]. There is a need for further development to allow the users themselves to use menu systems in a fully developed DPS and also to investigate patterns with multiple redundancies to aid recognition process.

6. Conclusions

This system is potentially useful for the deaf-blind although more research and testing is required. Deaf-blind students are at a particular disadvantage when it comes to the need to access electronic based textual information. However, more results are needed and it is intended to widen the volunteer base via a more extensive investigation. Investigations using larger screens and a computer projector are also required. Further in-depth investigations using a larger number of volunteers on over a greater time period are also needed. The further development of a more fully developed DPS could allow the users themselves to use pattern based menu systems and also to investigate patterns with multiple redundancies for character representation.

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