THE CASE FOR EYE GAZE TRACKING FOR TELECOMMUNICATIONS SERVICE INTERACTION

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ABSTRACT
This paper discusses a pilot investigation of eye-gaze tracking based typing as an assistive input technique to be used by non-speaking people with additional motor impairments affecting their ability to type using a conventional keyboard. The context of the investigation is the use of broadband multimedia telecommunications systems in real time by these users, as part of a wider study within the EEC RACE IPSNI II project. The investigation followed an earlier pilot trial involving the use of an on-screen scanning array and a word predictor and showed that subjects can sustain an eye typing speed of over 6 words per minute (WPM) over a two hour period. Whilst this is not as fast as that achievable by untrained able-bodied typists, it is considerably faster than that reached by users employing an on-screen scanning array and a word predictor.

INTRODUCTION
Broadband telecommunications is predicted to reach business users in Europe by 1995 and domestic users shortly afterwards [1]. The CEC RACE IPSNI II project is investigating issues faced by users with handicaps as they seek to gain access to the services proposed to be available on the broadband system. Non-speaking people are one of the user groups being considered by the project, particularly when using applications such as those based on a videophone service.

One possible adaptation is to provide a text channel. Although this will not provide as complete a communication channel as the speech channel, it will allow some information exchange [2]. In practice, however, many non-speaking people have additional impairments that affect their ability to use a keyboard. One task of the IPSNI II project is to find a text input strategy that is useable as an addition to a videophone service.

An earlier study by the IPSNI II project [3] confirmed that a strategy employing a scanning selection system is problematic in a telecommunications based system because of the time taken to move to the item to be selected, and the large number of switch operations required to make one selection. For this reason, a method that allows a selection to be made directly from a matrix representing keyboard keys would seem to offer more possibilities for some users.

One of the devices built into a videophone is a camera. By using this camera, and the associated digital video signal processing hardware in the terminal, an eye gaze tracking system could be added to the terminal. The suitability of eye gaze tracking as a text input device is, therefore, being investigated in the context of the project. This paper describes the first steps of this investigation.

EYE-GAZE TRACKING AND TELECOMMUNICATIONS INTERACTION

STATEMENT OF THE PROBLEM

The initial questions to be answered about eye typing are:

- Is the data input rate fast enough to make it suitable for real time text exchange?
- Can the data rate be sustained for sufficient time to successfuly complete a conversation or a number of conversations?

An experiment was constructed to attempt to answer these questions, based on the following hypotheses:

- Eye typing will not reach a WPM (words per minute) value as high as that achievable by conventional typing, but it would achieve a higher WPM rate than that realised with a switch selected scanning keyboard system. When using a keyboard, it is possible to be moving to the next key to be typed whilst still selecting the current one. Eye typing is strictly serial. A switch selected scanning system, however, has a delay component associated with the scanning action, and the two or more switch selections required to trigger the scanning sequence.
- Eye typing rates will be sustainable over a reasonable time period and there will not be a significant degradation in the achievable eye typing rate with time. The hypothesis recognises the finding of other studies that suggest that the ocular motor system is capable of considerable sustained activity, and should therefore be able to maintain a working WPM value over a prolonged duration without a major change in its ability to move to gaze on objects in the field of view. [4]

EXPERIMENTAL METHOD

Two able bodied subjects took part in three experiments each. In each experiment the subjects emulated conversations for a two hour period. They completed as many conversations as they could fit in in the time allocated. A conversation was simulated by subjects typing their responses to a scripted dialogue. The typing method involved the subjects in gazing at an array of alphanumeric characters on the screen of a SUN Sparc 2 workstation. The array showed numbers 0-9, the lowercase alphabet, and some punctuation characters in an 8-by-5 array. The eye gaze was monitored by an ASL 4250 R+ eye movement measuring system. This recorded positional data every 50th of a second. The data rates achieved were compared with those realised by keyboard typists and users employing an alternative assistive strategy. The data for this comparison was gathered from the material published by the IPSNI II project [3].

RESULTS

The typing rate, expressed in Words Per Minute (WPM), were tabulated with results of the earlier study [3] and are shown in table 1 below. Comparison could be made because the same conversation script was used in both cases. These results quote the average rate sustained throughout the test period, including pauses and thinking time whilst typing.

In each of the different sessions, the data measured were the time when each character was selected. This was averaged over the conversations and converted to words per minute (WPM).

Typing Technique	Achieved WPM rate
Conventional Keyboard Typing	25.46
Foot typing on Keyboard	20.59
Text entry using a Scanning Array	0.58
Eye Typing	6.41

Table 1: Average Word per Minute (WPM) typing rate achieved using different text entry techniques

The average word per minute (WPM) typing rate for each conversation in sequence for the two subjects are shown in Figures 1 and 2 below.

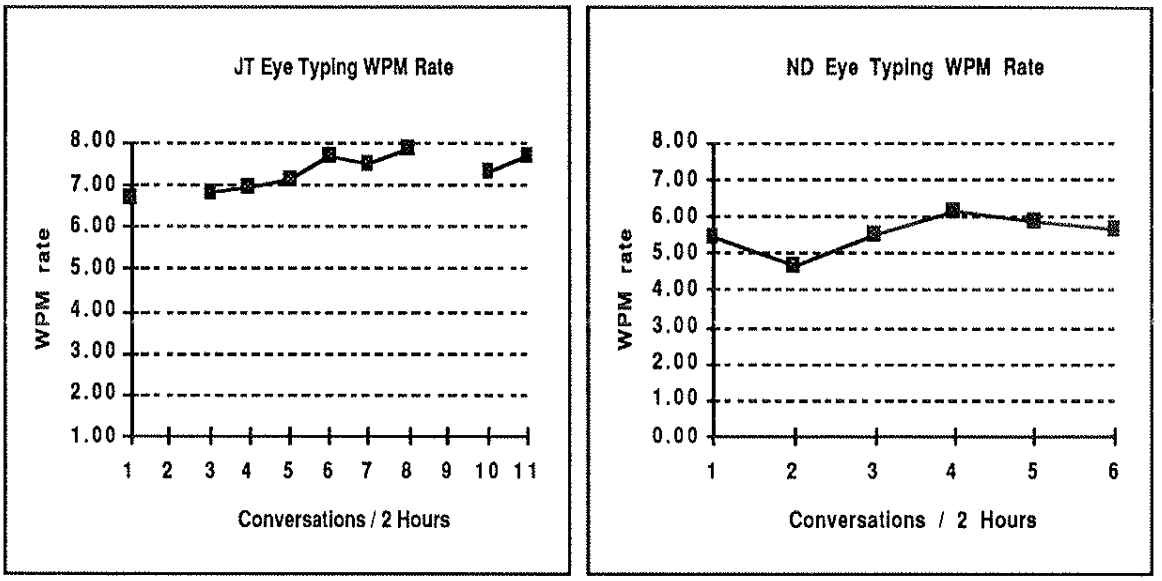

Figure 1 & 2: Average Word per Minute (WPM) eye typing rate plotted for each conversation over the two hour test period

CONCLUSIONS

This technique allows a user to sustain conversations over a two hour period at a consistent rate that is substantially faster than that achievable with a scanning keyboard system. The rate is still only 25% of that achievable by able bodied subjects using a conventional keyboard however. For this reason, additional steps will need to be taken to ensure that users of this technique will not incur excessively high telecommunications costs because of the increased call duration caused by the low data input rate. Possible solutions include providing additional assistive techniques such as word prediction, or negotiating realistic call charges with the telecommunications service providers for userS employing assistive techniques.

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