The Design and Evaluation of a Vibrotactile Progress Bar

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Abstract

We present an investigation into the use of Tactons to present progress information. Progress bars are common but must compete for screen space and visual attention with other visual tasks. We created a tactile progress indicator, encoding progress into a series of vibrotactile pulses. An experiment comparing the tactile progress indicator to a standard visual one showed a significant improvement in performance and an overall preference for the tactile display.

1. Introduction

Progress bars are a common feature of human-computer interfaces. They are used, for example, when files are copied, transferred or downloaded. They also occur on devices such as mobile telephones or MP3 players, where progress bars are used to indicate the download of web pages or the transfer of photographs or sound files.

A problem with visual progress bars is that they can become hidden behind other windows and often have to compete for visual attention with other tasks the user is trying to perform. For example, a visual progress indicator must compete with a primary task (e.g. typing a report) so the user ends up trying to concentrate on two visual tasks at once. We suggest that sharing tasks between two different senses may allow a better interaction; the user can look at the main task and feel the progress indicator. This paper presents an investigation of a vibrotactile progress indicator that does not require visual attention, communicating progress of a task via a series of tactile pulses.

Poupyrev *et al.* [1] discuss the use of a tactile display on a handheld computer. They describe a tactile progress bar where progress is mapped to the time between two clicks. They say it "… was easy to relate the tactile feedback to the current status of the process", but very little information is given about the design and no evaluation of its effectiveness is reported.

Summers [2] used temporal patterns along with frequency and amplitude to encode speech information in vibrations, and found that participants mainly used information obtained from the temporal patterns. For this reason we based the design of our progress indicator on simple rhythmic patterns.

Brewster and Brown proposed *Tactons*, or tactile icons, which are structured, abstract messages that can be used to communicate tactually [3]. Information is encoded into Tactons using the basic parameters of cutaneous perception, such as waveform and rhythmic patterns. Simple Tactons were used to indicate the state of our progress indicator.

2. Experiment

An experiment was conducted to investigate if progress information could be presented using simple Tactons, and if presenting it this way would be more effective than its standard visual form. The experiment used a two-condition within-subjects design. Participants experienced both interfaces (Visual and Tactile) in a counterbalanced order. The Visual condition used a standard Microsoft Windows style progress bar. The Tactile condition was identical, but without the visual progress bar. We measured time to respond to the end of a download, NASA TLX subjective workload and overall preference. Fourteen participants took part, all students from Glasgow University.

The basic design of our progress indicator mapped the amount remaining of a download to the time between two pulses; the closer together the pulses the closer to the end of the download. An Oboe timbre was used as the waveform for the Tactons and they were all played at 250Hz using a single AEC VBW32 TACTAID transducer. It was mounted on the top of the wrist of the non-dominant hand, under a sweat band to keep it tight against the skin. The design of the progress indicator used three simple Tactons:

- *Start:* indicated the start of a new download. A tone increased in amplitude from 0 to maximum

over a period of 1.5 seconds followed by 0.5 seconds at maximum amplitude.

- *Current:* marked the current position of the progress indicator and was a single pulse lasting 0.5 seconds.
- *Target:* represented the end of the task. As the download progressed the Current stimuli got closer in time to the Target. When they overlapped the download was finished. The Target cue was a series of 4 short pulses, each lasting 0.6 seconds with a total length of 2.5 seconds.

The experimental task simulated a typical interaction where the user had to type text and monitor file downloads at the same time. Participants typed in poetry which was given to them on paper by the side of the computer used in the study. Whilst typing they also had to monitor the download of a series of files and begin the download of the next as soon as the current one had finished. Five downloads took place in each condition. These were the same for both conditions and ranged in time from 12 seconds to 1 minute. Two sets of poems were used, taken from the same source.

2.2 Results

The response times to the downloads are shown in Figure 1. The results show that the participants performed significantly slower in the Visual condition with a mean time to respond of 13.54 seconds (SD 5.2) versus 8.7 seconds (SD 5.6) in the Tactile (T_{13}=3.23, p=0.007), showing participants noticed the end of a download significantly more quickly in the Tactile condition. In addition, the number of times the participants clicked to go on to the next download before the current download had finished was counted (this gives some idea of how well users understood the progress cues given). Participants clicked too early 4 out of 70 times in the Visual condition and 8 times in the Tactile.

There were no differences between conditions in terms of subjective workload. Overall preference did show an effect with the Tactile condition significantly preferred over the Visual (T_{13}=4.00, p=0.001).

3 Discussion and Conclusions

The results showed that a tactile display could be a successful progress indicator. Participants responded more quickly to the tactile progress indicator than to the visual one. We suggest that this is because the use of the tactile display allowed participants to concentrate visual attention on their primary typing task whilst monitoring the background task of downloading files with their sense of touch, facilitating a sharing of the tasks between senses.

The design we created was simple, using just one transducer. This is beneficial as the cost of adding our tactile display is low so that such a progress indicator could be used in many different situations. Many mobile phones and handheld computers already have a basic tactile transducer in them. We could use this to present progress information non-visually, saving valuable screen space.

References

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[3] S. A. Brewster and L. M. Brown, "Tactons: Structured Tactile Messages for Non-Visual Information Display," presented at the Australasian User Interface Conference 2004, Dunedin, New Zealand, 2004, pp. 15-23.

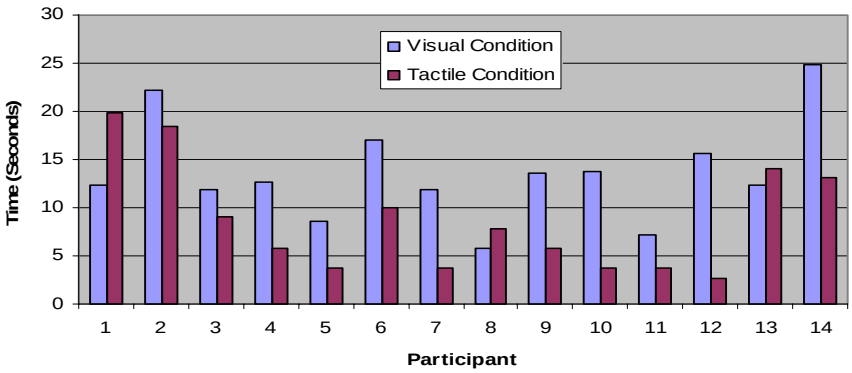

Fig. 1. Mean time to respond to the end of downloads.