Personal WebMelody: Customized Sonification of Web Servers

Maria Barra Tania Cillo Antonio De Santis
Umberto Ferraro Petrillo
Alberto Negro Vittorio Scarano

Dip. di Informatica ed Applicazioni
Università di Salerno
Baronissi (Salerno), 84081 Italy
{marbar,umbfer,alberto, vitsca}@unisa.it

Teenie Matlock

Paul P. Maglio

IBM Almaden Research Center
650 Harry Rd., NWE-B2
San Jose, CA 95120 USA
{tmatlock, pmaglio}@almaden.ibm.com

ABSTRACT
We present Personal WebMelody, a sonified Web server that allows customization and full integration of system-generated music with external music source (audio CD, MP3, etc). Results of an experiment on the usage of sonification for monitoring Web servers are also briefly reported.

1. INTRODUCTION
Size and complexity of World Wide Web servers are growing and it is important to be able to monitor their behavior. Monitoring by using log files is useful for an off-line precise analysis of accesses. But for Web servers used as a company asset, for instance, to showcase products and to support Web-based commerce, timely monitoring of server behavior and access patterns is critical, as it could very well mean the difference between making money and losing money. Thus, it is important to have an effective and efficient way to monitor in *real-time* the behavior of the server so that prompt action can be taken to fix a malfunctioning server or to fine-tune the system.

In this paper, we present Personal WebMelody, a sonified Web server that allows customization and full integration of system-generated music with external music sources (audio CD, MP3, etc.). As discussed, experiments conducted with the previous version of WebMelody [1] suggest that music can convey peripheral information [4] efficiently. Though it remains to be shown that such system-generated music can indeed be listened to for a long period without inducing mental fatigue in the listener, Personal WebMelody is meant to minimize such potential limitations by integrating system-generated music with personal musical selections. To convey server information, our system indicates server state by changing the volume of the personal music source and by mixing in additional sounds represented by MIDI tracks.

We believe Personal WebMelody offers an effective and efficient way for real-time monitoring of the server. By real-time monitoring, we mean that the system provides feedback to the webmaster of a Web server event within a short, fixed time interval, δ. Note that (ordinary) log analyzers do not provide such real-time monitoring because they rely on log files that are processed off-line in a variety of ways. Even using log-analyzers periodically (e.g., every hour) has the drawback that information must be explicitly requested by the webmaster. Our system solves this problem by pushing a constant flow of information to the administrator about the status of the Web server. Though, on the one hand, real-time monitoring ought to be useful and effective because it enables constant awareness of the server's state, on the other, it can only be effective if the user interface is not too intrusive by constantly interrupting the webmaster. Because Personal WebMelody relies on sounds --- music in particular --- to convey information to the webmaster, we believe it is critical to offer the user a choice of musical representations of server behavior. Thus, our system is fully configurable, using customizable sounds to represent server behavior and integrating personal external audio sources.

2. PERSONAL WEBMELODY
Personal WebMelody is based on the same three-level distributed architecture presented in [1], and is based on the following components: the sonification Apache module mod_musical_log (that intercepts HTTP request/response), the Collector server (for buffering and preprocessing), and the WebPlayer application, which produces audio output based on the tracks (WAV or MIDI) and allows to mix the output with an external audio source (see figure below).

Events that can be monitored include load, throughput, and almost any attribute of individual requests and responses. Our system is flexible because it can be configured to associate individual or group Web server events with specific musical tracks, allowing an administrator to customize and monitor the Web server's state.

The main new feature of Personal WebMelody is that the system can be easily personalized. This is a significant improvement on the impact of the techniques toward webmasters since it is well recognized that personal characteristics of users influence how they hear and feel about the information represented by sounds. To this end, the system also allows the mixing of the sounds generated by the sonification of the server with an external sound source chosen by the user (e.g. MP3 files, audio CD).

3. SONIFICATION STUDY
There are two potential problems with providing an administrator with sonic indicators of Web server status: (a)

sound, especially music, might be so distracting that the administrator's overall productivity drops; (b) specific sounds associated with specific Web server events might be difficult to pick out and attend to, especially if the administrator is engaged in other ongoing tasks. We set out to investigate whether either of these might in fact be problems in practice.

The goal of our study was to explore the effectiveness of our sonified Web server in a controlled setting. To determine whether the music played by the sonified server is distracting, whether it is informative, and whether there are tradeoffs between the two, we used a dual-task paradigm in which participants performed a primary text-editing task while at the same time monitoring music that simulated the sonified Web server (roughly following the method described in [4]. We measured the degree to which music distracted performance in an editing task, and we measured memorability of musical events in a post-experiment test.

3.1 Methods

Twenty-eight science undergraduate students at the University of Salerno volunteered to participate. All were native Italian speakers and only one was a trained musician.

We used a 3 (editing task/listening task/dual task) x 2 (presentation order) design. Presentation order varied between participants (divided in two groups), and task varied within participants. Each participant edited text (correcting simple errors) in two conditions, once with instructions to listen to the background music (Emphasis Music), and once with instructions not to listen to the music (Background Music). In addition, each participant also listened to music without editing (Music Only).

The materials consisted of three passages for text editing, three sound tracks (one for training, one for the Emphasis condition, and one for the Background condition), a music questionnaire (for testing the informativeness of sound tracks), and a final questionnaire (participants were asked to rate their reading and musical skills).

Soundtracks were designed as a compromise between providing information and being distracting, while at the same time creating pleasant background music. All three soundtracks used improvisational jazz styles to insure that in all cases no melodic sequence would be familiar to the participants. In addition, jazz style is largely unpredictable, lending itself to representing the spontaneous and unpredictable nature of Web server activity. Jazz-like chords have been used effectively to represent several coordinates to be monitored for parallel programs [3].

The music questionnaire consisted of eleven multiple-choice questions, followed by a table summarizing the associations of sounds with events.

3.2 Results

Data were analyzed as follows. First, we performed a 2 x 2 analysis of variance (ANOVA) on the editing data, with the within participants factor Background vs. Emphasis and the between participants factor presentation order. No effect was obtained for either factor on editing performance; for Background vs. Emphasis, $F(1, 16) < 1$, and for Group, $F(1, 16) = 1.35$, $p = 0.26$. Overall, the mean number of edits in ten minutes was 26.1.

Second, we performed a 2 x 2 ANOVA on the results of the music test, with the within participants factor Music Only vs. Emphasis and the between participants factor presentation order. There was no effect of order, $F(1, 16) = 2.09$, $p = 0.17$, but there was main effect of experimental condition, $F(1, 16) = 5.79$, $p < 0.05$. The mean number of correct answers in the Music Only condition was 6.56, and in the Emphasis condition, 4.72. There was no interaction effect, $F(1, 16) < 1$.

Finally, comparison of the information from the questionnaire and the results did not reveal any notable variation in terms of reading or musical skill. For instance, the one skilled musician appeared to perform equally as well as the other participants.

Overall, the results suggest that background music does not distract users from their primary task, and at the same time can effectively convey information. In particular, we found no decrease in amount of text editing (primary task) when participants were explicitly instructed to pay attention to the music compared to when participants were explicitly instructed not to pay attention to the music. Nevertheless, we also found a small (28%) decrease in the amount of information our participants extracted from the music in the dual-task as compared to the single-task conditions. Of course, it is not surprising to find that performance suffers when people performed two tasks compared to when they performed only one task. It is a little surprising, however, to find that the primary task (text editing) did not suffer at all, and that the secondary task (server event identification) suffered only a little.

Though we followed the same basic paradigm as [4], our results differ from theirs. Using text-editing along with a visual information monitoring task, Maglio and Campbell found a decrease in text-editing performance under dual-task as opposed to single-task conditions, and at the same time, found no effect on memorability (or informativeness) of visually monitored information. The present study obtained the opposite results: namely, no decrease in text-editing performance under dual-task as opposed to single-task conditions, but a decrease in memorability of auditorially monitored information.

ACKNOWLEDGMENTS

We thank our participants for their enthusiastic help in completing the study. We also thank Chris Campbell, Andreas Dieberger, and Shumin Zhai for helpful comments.

4. REFERENCES

[1] Barra, M, et al. (2000) WebMelody: Sonification of Web servers. In *Poster Proc. of the Ninth Annual World Wide Web Conference (WWW9).* Amsterdam (Holland).

[2] Barra, M, et al. (2000) MMM: Multi-Modal Monitoring of Web Servers. *Submitted for publication*

[3] Francioni, J.F., L.Albright, and J.A. Jackson. (1991) Debugging Parallel Programs using sound, in *Proc. of the ACM/ONR Workshop on Parallel and Distributed Debugging.* Reading, MA. ACM/Press Addison Wesley.

[4] Maglio, P.P. & Campbell, C. S. (2000) Tradeoffs in the display of peripheral information, in *Proc. of the Conf. on Human Factors in Computing Systems (CHI 2000).*