FreezeFramer: A Prototype Tool to Monitor Stress and Heart Rate Variability

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Abstract
This paper describes the design, architecture, and implementation of a software application, FreezeFramer, developed to help individuals manage stress. The application measures heart rate variability through a finger or earlobe clip-on sensor that reads pulse information. While a detailed subjective evaluation is ongoing, system performance analyses are reported here.

Introduction
Stress in humans is on the rise worldwide. Recent research has shown that though the brain controls most of our bodily functions; the heart also plays a critical role in stress.1 The Network Convergence Lab (NCL) developed a real-time biofeedback application to display heart rate, pulse data, and coherence ratios for the Institute of HeartMath (IHM). It is expected that the tool will help individuals cope with stress by performing real-time, stress reduction exercises that lead to higher coherence levels.1

Developed Solution
A distributed architecture (Figure 1) was utilized for this implementation using C++ for the FreezeFramer Engine code and a Flash-based Graphical User Interface (GUI) for the front end. The database uses JSP, java servlets, and MSSQL. The FreezeFramer architecture (Figure 1) includes six modules. The signal collection module collects the pulse wave analog signal from the sensor and converts it into a digital form. The signal processing module calculates PPG, heart rate, and coherence ratios from the digital pulse wave signal. The data distribution module converts this data into an XML format and streams it out to the data presentation module, which is a Flash-based, front-end, GUI, operated by the end-user. The data presentation module plots the data received in XML format. The GUI also allows the end-user to control the system and view various data displays. The data management module is a web-based application, which provides online data management functionality for all users of the system. The data storage module provides a central data repository and a database management system.

Conclusion
This application was developed to provide a flexible and easy to use interface for online stress management sessions. The distributed architecture allows the application to stream data to multiple front-end interfaces simultaneously. Consequently, an instructor can view an end-users data, at a remote location, in real-time. The application also records the entire stress reduction session into an XML file for an instructor to review at the end of training. The performance analysis indicates that the Flash-based GUI generates a high CPU load. However, total network traffic generated by the FreezeFramer Engine is less than 5Kbyte/s.

References
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