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Technology: Cognitive State Sensing

Two Critical Challenges – One Solution

Introduction

Information technology systems rapidly collect and deliver large volumes of data from diverse sources. For example: Tactical, combat situations or air-traffic-control displays can quickly exceed an individual's ability to prioritize and assimilate critical information and respond accurately.

Lockheed Martin Advanced Technology Laboratories' (ATL) Cognitive State Sensing (CSS) technology is a cognitively-aware computing architecture that dynamically assesses an operator's cognitive workload and performance on tasks. Software then uses that information to adaptively implement strategies to manage the individual's attention so that critical tasks are successfully completed. The result is an operator or controller who can maintain high levels of performance despite excessive information from multiple sources, frequent interruptions, and demands for attention.

CSS offers one solution to two challenges: (1) sustaining high levels of operator performance in volatile operational environments and (2) designing more effective human-computer interfaces (HCI).

Real-Time Performance

Using real-time biophysical sensor technology to assess an operator's cognitive state, CSS can detect, predict, and avoid cognitive overload and reduce operator error, maximize effectiveness, and improve critical situation understanding. Based on sensor feedback, the system can change the timing, modality, and format of information presented to the operator.

Cognitive State Sensing applies recent advances in cognitive neurosciences to assess an operator's cognitive state while managing human-computer interface displays in volatile, complex, stressful operating environments. CSS will change the timing and appearance on the display to maintain peak operator performance.

Applying recent advances in cognitive neurosciences, CSS uses electrocardiography, galvanic skin response, electroencephalography, pupil dilation, and eye movement to monitor cognitive activity in real time. These physiological markers typically depart from norms during periods of high stress, excessive workload, distraction or drowsiness.

In one instance, ATL is applying this technology to the Tactical Tomahawk Weapons Control System. ATL's system can detect an undesirable cognitive state and adjust task displays to help return an operator to an acceptable cognitive state within five seconds. Using this system, ATL recently demonstrated a 25.5 percent increase in the number of missiles that an operator could monitor at one time and showed a 14.4 percent improvement in accuracy for retargeting missiles.

Design Tool

In the second approach, CSS gauges are being used to guide the design of critical displays to develop more useable, less error-prone HCIs to achieve optimum operator performance. CSS gauges receive physiological data to provide a continuum of cognitive workload levels, from low to nominal to extremely high. The system uses these responses to determine the operator's cognitive state, which can then be used to revise technology designs to achieve higher performance levels of military personnel working in dynamic, complex environments.

CSS technology can be used in any application where an operator relies on HCIs and the constant flow of information to manage real-time operations, such as an air traffic controller, or to control multiple unmanned aerial vehicles.

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