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Real-Time Cognitive Model-Based Operator Assessment

Challenge

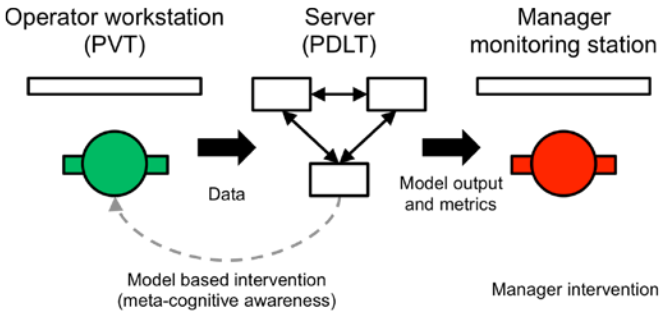
People get tired. Operator mental fatigue contributes to a large percentage of automobile accidents, medical errors, on-the-job mishaps, and numerous everyday mistakes. In a number of domains, there has been a surge in continual, 24/7 operations and extended missions. This increases the risk of fatigue-related operator errors. We are challenged to find a way to get ahead of fatigue—not to prevent it, but to minimize the negative impacts it has on operators, and minimize fatigue-related operator errors.

Approach

Current practice for fatigue mitigation emphasizes risk reduction through education, regulation-based scheduling, and countermeasures like coffee. These approaches do not provide personalized assessment and try to prevent fatigue rather than reducing the risk of errors through adaptable fatigue interventions.

We seek to stave off the negative effects of fatigue before mistakes and accidents happen by using cognitive models. Cognitive models provide

Real-time cognitive model-based operator assessment seeks forward-looking evaluations of risk in situ, creating a capability to make task-specific, individualized predictions to guide mitigation strategies.



Real-time fatigue monitoring supports direct intervention through operator feedback, manager intervention, or adaptive machine assistance.

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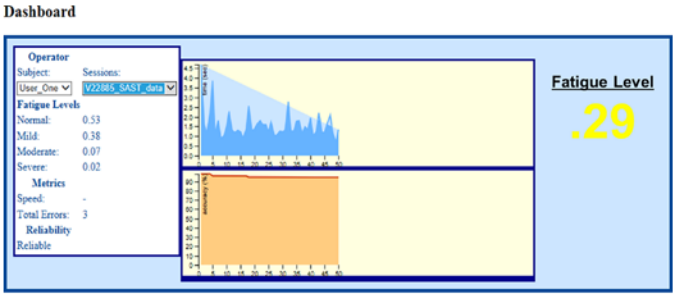

We leverage our novel technique for real-time cognitive model parameter estimation to infer operator fatigue risk level based on task performance in a portable, web-based system.

accounts of how moderating factors like fatigue impact different components of cognition. They enable us to predict how fatigue will influence behavior in specific task contexts. We deploy those models in real-time to monitor human performance for symptoms of fatigue before critical errors occur.

Methodology

We leverage mathematical models of performance dynamics to assess and predict how fatigue and other cognitive moderators influence human behavior in the task domain of interest. We identify critical tasks in the domain of interest that meet two criteria: (1) the task involves a measurable behavior that is repeatable over time, and (2) task performance changes as a person's fatigue increases. We develop a cognitive model of that task, capturing the perceptual and cognitive mechanisms that are involved in achieving high performance. We integrate biomathematical models of fatigue into the cognitive model to understand how each component mechanism is impacted by fatigue.

We can use the models to make specific predictions about the particular deficits and decrements likely in the given task under different levels of operator fatigue.

Real-time cognitive-model based fatigue assessment is achieved by interpreting a stream of task performance data according to the model-based predictions. We have developed a novel technique for real-time cognitive model parameter estimation. We use this to match model predictions with someone's current measured task performance. This enables inferences about a person's current fatigue level. And we can predict the person's near-term performance trajectory through additional model simulation.

We currently deploy a web-based fatigue assessment using two fatigue sensitive tasks which can be completed within a few minutes.

Impact

Cognitive model-based operator assessment creates an opportunity to unobtrusively monitor human behavior for signs of degraded functioning that are indicative of fatigue and other cognitive moderators (stress, task load, etc.). They provide us insights into the relationship between measurable behavior, performance changes, and the underlying state of an individual that enables more targeted interventions to mitigate risk and optimize mission performance. We can reduce the costs associated with mistakes and accidents by reducing the risk of those errors through adaptive interventions, individually tailored to each operator's cognitive state and level of performance.

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