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Psychophysiological Adaptive Automation Based on Fuzzy Controller

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Abstract : Psychophysiological adaptive automation is a concept that combines human physiological data and computer algorithms to create personalized interfaces and experiences for users. This approach aims to enhance human learning by adapting to individual needs and preferences and optimizing the interaction between humans and machines. According to neurosciences, the working memory demand during the student learning process is modified when the student is learning a new subject or topic, managing and/or fulfilling a specific task goal. A sudden increase in working memory demand modifies the level of students' attention, engagement, and cognitive load. The proposed psychophysiological adaptive automation system will adapt the task requirements to optimize cognitive load, the process output variable, by monitoring the student's brain activity. Cognitive load changes according to the student's previous knowledge, the type of task, the difficulty level of the task, and the overall psychophysiological state of the student. Scaling the measured cognitive load as low, medium, or high; the system will assign a task difficulty level to the next task according to the ratio between the previous-task difficulty level and student stress. For instance, if a student becomes stressed or overwhelmed during a particular task, the system detects this through signal measurements such as brain waves, heart rate variability, or any other psychophysiological variables analyzed to adjust the task difficulty level. The control of engagement and stress are considered internal variables for the hypermedia system which selects between three different types of instructional material. This work assesses the feasibility of a fuzzy controller to track a student's physiological responses and adjust the learning content and pace accordingly. Using an industrial automation approach, the proposed fuzzy logic controller is based on linguistic rules that complement the instrumentation of the system to monitor and control the delivery of instructional material to the students. From the test results, it can be proved that the implemented fuzzy controller can satisfactorily regulate the delivery of academic content based on the working memory demand without compromising students' health. This work has a potential application in the instructional design of virtual reality environments for training and education.

Keywords : fuzzy logic controller, hypermedia control system, personalized education, psychophysiological adaptive automation
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