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A GRANULAR MULTI-SENSOR DATA FUSION METHOD FOR LIFE SUPPORT SYSTEMS THAT ENHANCES SITUATION AWARENESS

Abstract

Slow-changing characteristics of controlled environmental systems and the increasing availability of data from sensors and measurements offer opportunities for the development of computational methods that enhance situation observability, decrease human work-load, and support real-time decision making. Some of these methods are known as multi-sensor data fusion; they combine measurements from multiple sources to produce a more concise representation of the information contained therein. Such information can be used to design better user-centered interfaces, allowing human operators to maintain situation awareness. Situation observability enables humans to perceive and comprehend the state the system at a given instant of time, and helps human operators in deciding what actions to take at any given time that may affect the projection of such state into the near future. This paper presents a multi-sensor data fusion method that makes use of a collection of discrete human-inputs and measurements to generate a granular perception function that supports situation awareness. These human-inputs are situation-rich, meaning that they combine measurements defining the operational condition of the system with a subjective assessment of its situation. As a result, the perception function produces situation-rich signals that may be used in ecological human-interfaces or as a switching mechanism in automation strategies and fail-safe/fail-op mechanisms. The granular perception function is a fuzzy associative memory composed of a number of granules equal to the number situations that may be detected by human observers; its development is based in the interaction of human operators with the system. The human-input data sets are transformed into a fuzzy associative memory by an adaptive method based on particle swarms. The paper describes the multi-sensor data fusion method proposed and its application to a ground-based aquatic habitat working as a small-scale environmental system. Results show how this approach helps to generate signals that enhance the situation observability of the aquatic habitat.