Part A—Plenary Lectures

Computational Intelligent Brain Computer Interaction and Its Applications on Driving Cognition

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Human cognitive functions such as perception, attention, memory and decision making are omnipresent in our daily life activities. For instance, driving is one of the most common attention-demanding tasks in our daily routine. Driver's fatigue, drowsiness, distraction or motion sickness is reported as the some of major causal factors in many traffic accidents. When drivers lost their attention, they had appreciably reduced (or diminished) the perception, recognition and vehicle control abilities. Based on these causalities, how to effectively prevent and enhance the human cognitive functions has become a very important issue. Recently, many investigators had developed novel algorithms based on computational intelligence (CI) technologies such as Fuzzy Logic and Fuzzy Neural Systems to monitor, maintain, or track the human operating performance. In this lecture, we briefly introduce the fundamental physiological changes of the human cognitive functions in driving first and then explain how to utilize these main findings to develop the monitoring and feedback systems based on Fuzzy logic and Fuzzy Neural technologies in the following two topics: (1) EEG-based cognitive state monitoring and prediction by using the self-constructing fuzzy neural systems; and (2) Spatial and temporal physiological changes and estimation of motion sickness. These research advancements can provide us new insights into the understanding of complex cognitive functions and lead to novel application enhancing our productivity and performance in face of real-world complications. thereby can account for subtle nonlinear interactions between sensors/features as well as the interaction between the tool used to solve the problem and sensors/features. Unlike conventional methods, our systems do not require to evaluate various subsets of features/sensors. The proposed schemes can deal with both function-approximation type and classifier-type systems. For any practical system, some redundancy in the set of features/sensors is desirable to account for measurement errors and other uncertainties. Thus a feature/sensor selection scheme should allow some redundancy in the selected set of features/sensors. For this we generalize our system so that can select useful sensors/features with controlled redundancy.

Neurodynamic Optimization Approaches to Model Predictive Control

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Abstract:

Model predictive control is an advanced control technology with wide application in many industries. In this talk, neurodynamic optimization approaches to linear and nonlinear model predictive control (MPC) will be presented. For linear and nonlinear affine MPC systems, the simplified dual network and general projection network are applied directly with guaranteed global convergence. For general nonlinear MPC, decomposition will be made first via Taylor expansion to make the system affine but with a higher-order residue to be learned iteratively. For unknown nonlinear systems, two recurrent neural networks .e.g., the echo state network and the simplified dual network) are adopted for system identification and dynamic optimization, respectively. Based on an echo state network, the original nonconvex optimization problem associated with nonlinear MPC is also reformulated as a convex one by using decomposition. Online and offline learning algorithms are developed or applied for solving the reformulated optimization problem. The neurodynamic optimization approaches have many desirable properties such as global convergence and low complexity. Due to the desirable features, the proposed scheme is efficient and suitable for real-time MPC implementation in industrial applications. Simulation results are provided to demonstrate the effectiveness and efficiency of the proposed approaches.

Sensor/Feature selection with controlled redundancy in a connectionist framework

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While designing many industrial systems, often we need to minimize the required number of sensors at least for three reasons: to reduce the cost of the system, to reduce the cost of decision making, and to honor physical constraints imposed by the specific application. For example, we may not be able to equip an "intelligent welding robot" with too many sensors because of the constraints on the welding environment and the limited available time for decision making. Hence, sensor selection, a generalization of feature selection, is a very important problem.

We shall discuss two connectionist schemes that can simultaneously select the useful sensors (and hence features too) and learn the relation between the input and output. The effectiveness of the systems is demonstrated with a few applications. Our results reveal that the proposed methods can detect the bad / derogatory sensors online and can eliminate their effect on the system's output. Such systems are also found to discover interesting, sometimes unexpected, relations. A unique characteristic of these schemes is that they look at all sensors/ features simultaneously and thereby can account for subtle nonlinear interactions between sensors/features as well as the interaction between the tool used to solve the problem and sensors/features. Unlike conventional methods, our systems do not require to evaluate various subsets of features/sensors. The proposed schemes can deal with both function-approximation type and classifier-type systems. For any practical system, some redundancy in the set of features/sensors is desirable to account for measurement errors and other uncertainties. Thus a feature/sensor selection scheme should allow some redundancy in the selected set of features/sensors. For this we generalize our system so that can select useful sensors/features with controlled redundancy.