J Math Imaging Vis (2012) 42:101–102
DOI 10.1007/s10851-011-0320-0

Special Issue on Hybrid Artificial Intelligent Systems

Manuel Graña · Emilio Corchado · Michal Wozniak

Published online: 13 September 2011

Hybridization has been always a source on innovation and a force pushing evolution. This observation applies when considering natural systems and the design of artificial systems. In natural systems, biological, social or whatever, the mixture of preexisting elements produces new social structures, cultures, genetic innovation and the like. When designing new products or systems, the engineer often needs to "jump out of the book" in order to find inspiration or tools that allow to build innovative solutions to new problems, or even to state the new challenges. In this framework of thinking, Artificial Intelligent Systems constitute a fertile paradigm for innovation through hybridization. Most often Hybrid Artificial Intelligent System design involves the combination of several of the current keystones for Artificial Intelligence, aka Computational Intelligence, namely: Evolutionary Computation and Monte Carlo Methods for sampling and optimization, Statistical and Bio-inspired approaches for Machine Learning, Fuzzy Systems techniques for modeling and reasoning. The present issue is devoted to gathering some such approaches for solving image processing or computer vision problems.

M. Graña (✉)
Facultad de Informática, University of the Basque Country, Paseo Manuel Lardizabal 1, San Sebastian, Spain
e-mail: manuel.grana@ehu.es

E. Corchado
Bisite Research Group, University of Salamanca, Plaza de la Merced S/N, 37008 Salamanca, Spain

M. Wozniak
Department of Systems and Computer Netwoks (W4/K2), Wroclaw University of Technology, Wybrzeze Wyspianskiego 27, 50-370 Wroclaw, Poland

The work of Cyganek on "One-Class Support Vector Ensembles for Image Segmentation and Classification" follows a classical hybridization pattern. It does combine one-class support vector machines with a kernel fuzzy c-means preprocessing. The application in classification based image region segmentation shows the power of the approach, which the author proposes for a wider variety of problems.

One of the most general computational frameworks, if not the most general, is Lattice Theory. In fact, Lattice Theory is underlying some of the success in Mathematical Morphology and Fuzzy Systems Modeling, among others. The field of Lattice Computing recognizes Lattice Theory as a fundamental framework for developing innovative, and often hybrid, approaches. In this special issue we have several examples of this approach.

The work by Kaburlasos et al. on "Binary Image 2D Shape Learning and Recognition Based on Lattice-Computing (LC) Techniques" introduces a hierarchy of lattices based on the Intervals' Numbers, defining a Fuzzy Lattice Reasoning based on the top of the hierarchy of models and representations, allowing learning and generalization. The power of such approach is demonstrated on the learning of 2D shapes in binary images with future extensions to grayscale and color images.

The work of Sussner et al. on "The Kosko Subsethood Fuzzy Associative Memory (KS-FAM)" uses the Kosko subsethood for the definition of Fuzzy Associative Memories, providing theorems for perfect recall and absolute storage capacity. The approach provides enhanced error correction in the reconstruction of grayscale images. KS-FAM can be used for classification, embedded in a nearest neighbor classifier schema, where the KS-FAM output is used to measure distance to the stored patterns. As such it is applied to a mobile robot visual self-localization task.

The work of Urcid et al. on “Lattice algebra approach to color image segmentation” deals with the application of Lattice Associative Memories to color image segmentation following a hybrid linear/lattice approach. The Lattice Associative Memories are constructed from the color image pixel representation in color space. They allow to find maximal tetrahedrons enclosing the pixels in the image. Then, a linear decomposition of the image pixels in the basis of the vertices of this tetrahedron, the so called linear unmixing, allowing to perform image segmentation. The approach is compared with state of the art algorithms on several color spaces.

The work of Plaza et al. “On Endmember Identification in Hyperspectral Images Without Pure Pixels: A Comparison of Algorithms” is related also to the linear unmixing problem. Specifically they deal with the problem of finding the endmembers of the image when the assumption that some pixels in the image are pure (hyperspectral) color representatives does not hold. Several approaches, with diverse degrees of technical hybrizations, found in the literature are presented, discussed and compared experimentally.

Another source of innovation and hybridization nowadays is the Multi-Agent paradigm, allowing to formulate distributed and heterogeneous (hybrid) systems able to solve a task as a collection of interacting heterogeneous tasks. Each independent agent can be based on a computational paradigm, thus the ease for hybrid artificial intelligent systems design. The work by Marti-Puig et al. on “Stereo Video Surveillance Multi-Agent System: New Solutions for Human Motion Analysis” formulates the task of video tracking and surveillance in this multi-agent framework. The process can be subdivided into human detection, human tracking, and human behavior understanding. The system reasoning is given by a case-based reasoning (CBR) model. Thus, specific agents carrying such processes are designed independently and integrated under the multi-agent paradigm. The system was tested under different conditions and environments.

In the work of Echegoyen et al. on “Visual Servoing of Legged Robots” the formal construction of a visual servoing framework for a many degrees of freedom legged robot is proposed. The system design follows from the decomposition of the global task into a collection of local inverse problems that are solved independently and concurrently, while ensuring some global stability conditions. The formal development is tested on real robot implementations, carrying most of the computations on the in-board robot computer.

The work of Mata et al. on “Isotropic Image Analysis for improving CBR forecasting” proposes an innovative hybrid of Case Based Reasoning with techniques developed for Geographic Information Systems. Specifically, the work shows the improvement in performance obtained with an isotropic buffer applied to data from an oil-slick formation following an oil-spill.

The work of Beristain et al. on “A Pruning Algorithm for Stable Voronoi Skeletons” combines several approaches for shape skeleton computation in order to obtain a real time implementation showing a high skeleton stability. Voronoi skeletons are efficiently pruned based on a theoretical result proved in the paper. A discrete curve evolution approach is further applied to obtain the final pruned skeleton. Shape recognition, based the computed skeletons, is performed by nearest neighbors approaches using a greedy algorithm to compute the similarity between skeletons.

August 2011