First Pan American Congress on Computational Mechanics
PANACM 2015
April 27-29, 2015, Buenos Aires, Argentina

Parallel Genetic Algorithms for the Design of MIMO Control Systems

Paola P. Oteiza*†, Diego A. Rodriguez*†§, Nélida B. Brignole*†

*Planta Piloto de Ingeniería Química (PLAPIQUI), CCT-UAT, UNS-CONICET,
Camino La Carrindanga Km. 7, Bahía Blanca, Buenos Aires
poteiza@plapiqui.edu.ar
†Laboratorio de Investigación y Desarrollo en Computación Científica (LIDeCC), DCIC-UNS,
Av. Alem 1253, Bahía Blanca, Buenos Aires.
dybrigno@criba.edu.ar
§Facultad de Ciencias Exactas, Universidad Nacional de Salta (UNSa)
Av. Bolivia 5150, Salta, Salta.
drodriguez@plapiqui.edu.ar

ABSTRACT

In this work a metaheuristic technique for controller design was explored and its performance was assessed for a real-world case. We aimed at finding the optimal parameters in order to achieve a satisfactory control for the volume of natural gasoline in a storage tank. We have resorted to a flexible iterative technique for optimization. Genetic Algorithms (GAs) were considered because they constitute the most complete paradigm of Evolutionary Computation, i.e. they naturally meet all the fundamental ideas of this approach. By means of the implementation of parallel algorithms, both the computational time and programming effort could considerably be reduced.

The system under control is a storage tank, where liquid hydrocarbons are collected by means of pipelines coming from various sources with their own inherent dynamics that was contemplated in our design. In particular, we have addressed the transport of natural gasoline to be extracted from the gas fields located in the province of Santa Cruz (Argentina). From the storage tank, the natural gasoline should be sent with a steady flow to a processing plant. This storage tank is a MIMO (Multiple-Input-Multiple-Output) system. It consists of three inputs, which are the main flowrates originated from the gas fields known as Pico Truncado, Cañadón León and Cañadón Seco, and two control variables associated to the tank: liquid level and outflow. Unlike most of the typical multivariable control designs, the distinctive feature of this MIMO system is that it has three inputs, instead of only two.

The design of this control system consists of two stages. In the first stage [1] two SISO (Simple-Input-Simple-Output) systems were considered, but the interaction between both of them was not contemplated. In this work the second stage was developed by taking the interactions into account with MIMO controllers, the parameters also being optimized by GAs. As to the dynamics, the production from the main reservoirs (Cañadón Seco and Cañadón León) was considered. Besides, Pico Truncado was regarded as a complementary flow to the eventual decline of the other fields. In view of this scenario, the flows entering the storage system were controlled with a feedforward loop. In this way, a lack of supply to the storage tank was avoided. Therefore, in this paper the use of GAs is proposed to design and optimize a feedback-feedforward integrated control system to control the volume of natural gasoline at the storage tank, in order to guarantee the supply to the processing plant.

Not only heuristics that produce superior solutions were considered important, but also the computational speed was contemplated as a key factor. The preliminary GAs results were obtained with constraint-dependent mutations combined with various crossovers. The experimental evaluation yielded satisfactory fitness values and relatively little computational effort was required.

REFERENCES

[1] P.P. Oteiza, D.A. Rodriguez and N.B. Brignole, "Sistema De Control Para El Almacenamiento Intermedio De Gasolina Natural" *Mec. Comp.*, **XXXII**, 2503-2516 (2013).