Genetic Algorithm Based Adaptive Control of an Electromechanical MIMO System

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Abstract

An adaptive control algorithm design for an electromechanical system has been introduced. The adaptation mechanism covers the controlled system identification executed after each detection of the system dynamics behavior change and a genetic algorithm–based controller design procedure. As the moving-optimum optimization problem has a repetitive nature, the convergence rate of the genetic algorithm can be optimized using the proposed method, which exploits an archive of previous solutions.

1 ADAPTIVE CONTROL USING GA

The task was to design an adaptive control algorithm for an electro-mechanical multi-input multi-output (MIMO) system with two servomotors. Both subsystems (motors) have strong interactions and additionally, their dynamics changes with the changing mechanical load. The aim was to independently control the speed of each drive. To control this system, a four-controller structure with parameter adaptation has been proposed. The adaptation mechanism employs identification of the controlled MIMO system during its normal operation in the closed-loop using artificial neural networks (ANN). The ANN model identification follows after each detection of the controlled system dynamics change. The adaptation cycle is completed by the controller parameters computation performed by GA. In this moving-optimum problem the environment conditions repeat more or less periodically or the new conditions are similar to those, which already occurred in history. In order to timely respond to these environment changes, a sufficient convergence speed is an important requirement for the GA procedure. From this reason a new method for GA acceleration has been proposed. The method uses data, which are archived from previous solutions and which can be exploited under repeated or similar environment conditions.

2 ARCHIVE OF PAST SOLUTIONS

The principle of the proposed mechanism consists in repeating the procedure of saving the current solution and searching for past solutions after each reformulation of the optimization task. That means, that in the first phase, a standard GA finds an optimal (suboptimal) solution under the current conditions and saves the best solution into the archive. The archive has the form of a matrix, where each row is a record (string) of a solution under some environment conditions. When any new environment change occurs, such a solution is searched in the archive, which best meets the new criterion. This string (or several strings) is copied into the new population of the GA and the process continues. Another possible way is to use the best string only in the reinitialization phase of the new GA run. Anyway, the obtained results have shown, that the exploitation of the archive considerably accelerates the next GA convergence.

The described GA-based adaptation approach is robust and powerful and can be used also in many other application areas.

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