

Modeling and multi-objective optimization of a gasoline engine using neural networks and evolutionary algorithms

基于神经网络和进化算法的汽油机建模及多目标优化

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The aim of this paper is to show the comparison of emission reductions in a gasoline engine obtained by two evolutionary algorithms. A final solution is obtained from the Pareto front by applying a fuzzy method.

First, ANN models are obtained for each exhaust emission of interest, i.e., CO, HC and NOx. The inputs for each model are the engine parameters found in the electronic control unit (ECU) of the engine, which can be modified to change the operating point, and eventually to minimize the corresponding emissions.

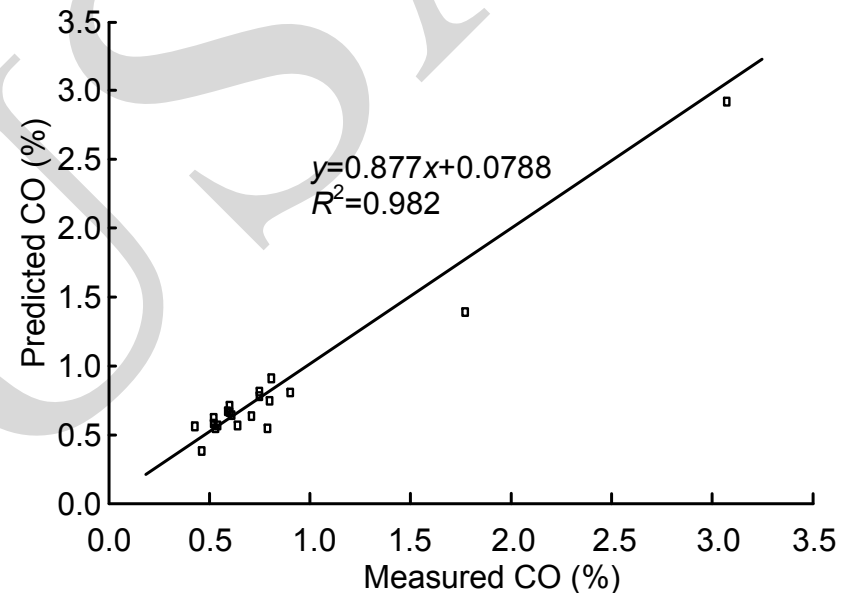


Fig. 7 Correlation between predicted and measured CO

Then, a minimization process is run using two multi-objective optimization algorithms (MOPSO and NSGA-II). The decision variables are the injected fuel mass flow (m_{fuel}), the time of the open state of an injector (t_{inj}), the ignition advance timing (θ_{ign}) and the intake manifold absolute pressure (IMAP), for 60 different values of the engine angular speed (n_{eng}) and the angle of the admission throttle valve (α_{th}).

Table 6 Details of the multi-objective optimization problem

Optimization objective: minimize CO, HC, and NO _x				
Range	m_{fuel} (lb/h)	t_{inj} (ms)	IMAP (kPa)	θ_{ign} (°)
Min	6.1	7.7	168	20
Max	37.2	14.4	202	37
Range	n_{eng} (r/min)	α_{th} (%)		
Min	1500	25		
Max	4000	100		

A fuzzy-based mechanism is used to find an acceptable solution on the Pareto front. Important improvements with respect to the nominal manufacturer engine cartographies are observed, reaching reductions of at least 9.84%, 82.44%, and 13.78% for CO, HC, and NO_x emissions respectively with NSGA-II, although with MOPSO algorithm reductions are reached at least 13.68%, 83.8%, and 7.67% for CO, HC, and NO_x emissions, respectively.

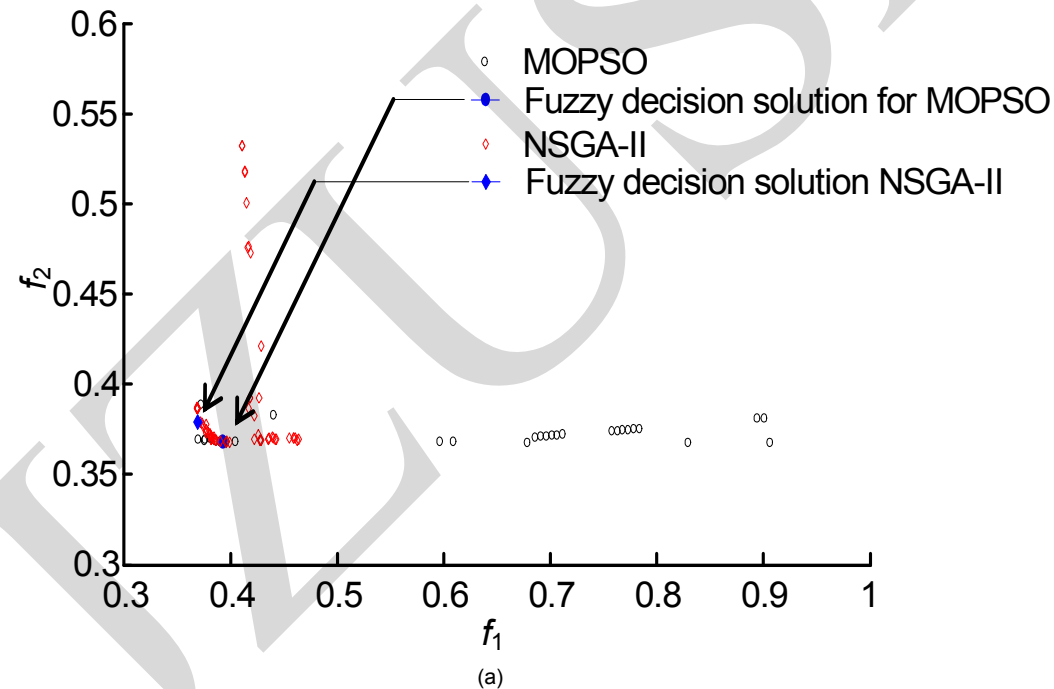


Fig. 10 Pareto fronts using MOPSO and NSGA-II methods (a) f_1 vs f_2