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INVENTORY CONTROL SYSTEM BASED ON CONTROL CHARTS TO IMPROVE SUPPLY CHAIN PERFORMANCES

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Abstract
Inventory replenishment rules have been recognized as a major cause of the bullwhip effect and inventory instability in multi-echelon supply chains. There is a trade-off between bullwhip effect and inventory stability where mitigating the bullwhip effect through order smoothing might increase inventory instability. Therefore, there is a substantial need for inventory control policies that can cope with supply chains dynamics. This paper attempts to formulate an inventory control system based on a statistical control chart approach to handle the trade-off between order variability amplification and inventory stability. The proposed replenishment system, namely IR-SPC, incorporates individual control charts to control both the inventory position and the placed orders. A simulation study has been conducted to evaluate and compare the IR-SPC with a generalized order-up-to that has order smoothing mechanism. The comparisons showed that the IR-SPC outperforms both the smoothing order-up-to policy and the Min-Max inventory policy in terms of bullwhip effect and inventory performances. 29 refs.
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Key Words: *Multi-Echelon Supply Chain, Inventory Control System, Bullwhip Effect, Inventory Variance, Control Chart, Simulation*

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EVALUATION OF COMBINED PARETO MULTIOBJECTIVE DIFFERENTIAL EVOLUTION ON TUNEABLE PROBLEMS

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Abstract
Many optimization problems in engineering involve the satisfaction of multiple objectives within the limits of certain constraints. Methods of evolutionary multi-objective algorithms (EMOAs) have been proposed and applied to solve such problems. Recently, a combined Pareto multi-objective differential evolution (CPMDE) algorithm was proposed. The algorithm combines Pareto selection procedures for multi-objective differential evolution to implement a novel selection scheme. The ability of CPMDE in solving unconstrained, constrained and real optimization problems was demonstrated and competitive results obtained from the application of CPMDE suggest that it is a good alternative for solving multi-objective optimization problems. In this work, CPMDE is further tested using tuneable multi-objective test problems and applied to solve a real world engineering design problem. Results obtained herein further corroborate the efficacy of CPMDE in multi-objective optimization. 24 refs.
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Key Words: *Multi-Objective Optimization, Constraints, Differential Evolution, Tuneable Test Beds, Evolutionary Algorithms*

Pages 288-299

PRODUCT ATTRIBUTE DESIGN USING AN AGENT-BASED SIMULATION OF AN ARTIFICIAL MARKET

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Abstract
New product development is a high-risk decision-making problem in which similar products compete with each other to expand their market shares. Brand-level diffusion predictions can help product design managers to analyse how product attribute specifications impact total market shares, which can, in turn, aid managers in choosing the designs that yield maximum profits. In this paper, we develop a product attribute design method in which an artificial market consisting of consumer agents in an interaction network is created to simulate the diffusion process of products, and a genetic algorithm is integrated with the artificial market to support the product design decision-making process. The contribution of this research is that the predicted market response to product alternatives is incorporated into the product design optimisation. Two empirical experiments were conducted on the Korean laptop computer market to demonstrate the potential of this integrated method. Preliminary experiment showed that our prediction diffusion curves had an average error of 3.04 %. In the primary experiment, five designs were recommended, and a comparison with the 31 best-selling laptop computers resulted in an average error of less than 8 % when the "Price" attribute was excluded. 25 refs.
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Key Words: *Product Attribute Design, Agent-Based Simulation, Artificial Market, Product Diffusion, Genetic Algorithm*

Pages 300-311

NUMERICAL SIMULATION OF PARTICLE MOVEMENT IN CELLULAR FLOWS UNDER THE INFLUENCE OF MAGNETIC FORCES

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Abstract
A numerical model of particle motion in fluid flow under the influence of hydrodynamic and magnetic forces is presented. The Lagrangian particle tracking algorithm was developed being capable of simulating dilute suspensions of particles in viscous flows where gravity, buoyancy, drag, pressure gradient, added mass and magnetophoretic forces are taken into account. The method is used to study the behaviour of magnetite particles in a periodic cellular flow field under the influence of a magnetic field produced by electric wires placed in cell centres. For such a flow field it is known that particles in steady state merge into individual trajectories. The influence of the magnetic field on the particle trajectories is examined and an exponential model for the time evolution of the fraction of adhered particles to the electric wires is proposed. Three particle Stokes number values are considered: 0.01, 0.1 and 1. The existence of a critical magnetic pressure coefficient was found, at which all particles end up to be adhered to the wires. The critical magnetic pressure coefficient was found to be proportional to the Stokes number. For sub-critical magnetic pressure coefficient, the particle trajectories are significantly altered by the magnetic field, both in their shape and in their number. Furthermore, in the sub-critical regime, the minimal distance of particles to the cell centres is larger for particles with smaller Stokes numbers. 18 refs.
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Key Words: *Dispersed Two Phase Flow, Lagrangian Particle Tracking, Magnetic Force, Hydrodynamic Forces, Cellular Flow*

Pages 312-322

LAMINAR FORCED CONVECTION HEAT TRANSFER CHARACTERISTICS FROM A HEATED CYLINDER IN WATER BASED NANOFLUIDS

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Abstract
Forced convection heat transfer from a heated circular cylinder to incompressible water-based nanofluids in the steady cross-flow regime has been investigated numerically. The momentum and thermal energy differential equations have been solved by the standard finite volume method on the non-uniform Cartesian grid.

The main objective of this study is to investigate the influence of the nanoparticles' volume fraction ($0\ \% \leq \varphi \leq 10\ \%$) on the heat transfer characteristics of water-based nanofluids over a wide range of base-fluid Reynolds number ($1 \leq \mathrm{Re}_{bf} \leq 20$).

Accurate numerical results are presented in the form of the local and mean Nusselt number and the heat transfer enhancement. The results indicate clearly that the heat transfer characteristics are affected by the base-fluid Reynolds number, volume fraction and the thermo-physical properties of nanoparticles. Although those nanofluids reduce the mean Nusselt number values, they enhance the heat transfer rate. 30 refs.
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Key Words: *Laminar Flow, Circular Cylinder, Nusselt Number, Heat Transfer Rate Enhancement, Numerical Modelling*

Pages 323-334

A PARALLEL OPTIMIZATION ALGORITHM FOR STEEL PLATE PICK-UP OPERATION SCHEDULING PROBLEM

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Abstract
The parallel computing is used for optimization modelling on multi-level nested genetic algorithm with superior scale to improve efficiency of the algorithm of steel plate operation scheduling problem. A parallel multi-layer genetic algorithm was designed based on the analysis of the present nested algorithm, and some key problems in parallel algorithm implementation were solved. An experimental example was illustrated. The results showed that the speedup of the proposed parallel algorithm comes up to 3.144 on a computer with quad-core processer and the total execution time is shortened greatly. The parallel nested genetic algorithm can meet the requirement for actual operation period. 14 refs.
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Key Words: *Operation Scheduling, Parallel Optimization, Parallel Genetic Algorithm, Steel Plate Pick-Up Operation*

Pages 335-347

THE INTEGRATED SCHEDULING PROBLEM IN CONTAINER TERMINAL WITH DUAL-CYCLE OPERATION

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Abstract
The paper proposes an integrated scheduling problem for dual-cycle operation in container terminal, which can be described as a 3-stage hybrid flow shop problem with multi-job families and no-buffer. The integrated scheduling problem is formulated as a mixed-integer programming model. Due to the computational intractability, a simulation-based heuristic algorithm is developed for problem solution. State transition of yard truck, inventory and quota of quay crane and yard crane are introduced into the heuristic algorithm. Computational experiments and simulation analysis are conducted to evaluate the effectiveness of the proposed heuristic algorithm. The results show that the algorithm presented is very effective for the equipment scheduling of meta-container terminal with dual-cycle operation. 18 refs.
(Received, processed and accepted by the Chinese Representative Office.)

Key Words: *Container Operation System, Dual-Cycle Operation, Scheduling, Heuristics*

Pages 348-363

A STATE ENTROPY MODEL INTEGRATED WITH BSC AND ANP FOR SUPPLIER EVALUATION AND SELECTION

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Abstract
This paper proposed a new method for supplier evaluation and selection after analysing the supplier state evolutionary process according to the entropy change process in the thermodynamics. In order to verify the feasibility of the new proposed method, we applied it to a maintenance, repair and overhaul/operation enterprise. Besides, we analysed the characteristics and problems of the maintenance, repair and overhaul/operation industry firstly, and then established an index system and calculated weights by balanced scorecard and analytic network process respectively. The results calculated by the proposed method are proved to be in accordance with the reality. 43 refs.
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Key Words: *State Entropy, Supplier Evaluation, Analytic Network Process, Balanced Scorecard*

Pages 364-376

CAPACITY COORDINATION MECHANISM FOR SUPPLY CHAIN UNDER SUPPLY-DEMAND UNCERTAINTY

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Abstract
In consideration of the supply-demand uncertainty, this paper mainly discussed the capacity coordination of product service supply chain. Facing supply uncertainty, it built a subcontractor-supplier coordination model based on penalty contracts. It was found that if the subcontractor takes punitive measures, the benefits caused by the increased subcontract demand can offset the supplier's shortage loss. As to the demand uncertainty, we constructed a coordination model consisting of subcontractors and integrated service suppliers based on the benefit sharing contract. The results found that the integrated service suppliers' order quantity and the expected joined revenue of subcontractors and integrated service suppliers will increase. Besides, considering suppliers' shared capability information, we built a product service supply chain coordination model based on penalty-benefit sharing joined contracts. The results showed that the joined contracts can decrease the uncertainty of capacity supply and soften the impact of demand uncertainty, thus raising the whole benefits of the product service supply chain, and ensuring the benefit increase of all related enterprises. 26 refs.
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Key Words: *Capacity Coordination, Supply Uncertainty, Demand Uncertainty, Contract Coordination*

Pages 377-387

SIMULATION-BASED HYBRID APPROACH TO ROBUST MULTI-ECHELON INVENTORY POLICIES FOR COMPLEX DISTRIBUTION NETWORKS

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Abstract
In today's dynamic market numerous dynamic influencing factors have seriously aggravates the difficulties of inventory planning of the complex distribution networks. This paper proposes a simulation-based hybrid approach for the optimization of the inventory policies in complex distribution networks. The initial multi-echelon inventory policies are handed over to a simulation model, which is capable of modelling complexity and uncertainties of the distribution network and simulating them under respective scenarios. Through comprehensively analysing the KPIs (logistic service level and logistic costs) of this set of multi-echelon inventory policies, their levels of robustness can be clearly ascertained. Based on the simulation results, a metaheuristic-based optimizer regenerates improved (more robust) multi-echelon inventory policies, which are once again comprehensively and precisely evaluated through simulation. This closed feedback loop forms a simulation optimization process that enables the autonomous evolution of multi-echelon inventory policies of complex distribution networks. Since the simulation results can truly reflect the performance of certain inventory policies in real market environment, the new Simulation-Based Hybrid Approach is quite useful for decision making process. 21 refs.
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Key Words: *Simulation, Metaheuristic, Evolutionary Algorithms, Inventory Policies, Distribution Network*