Pages 5-15

USING CAD AND FLOW SIMULATION FOR EDUCATIONAL PLATFORM DESIGN AND OPTIMIZATION

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Abstract
The main goal of the paper is to present how CAD and the simulation results of a virtual model were used to develop and adapt an educational platform to various manufacturing scenarios in an Industrial Logistics laboratory optimizing the performances in terms of productivity. Our paper is divided in two parts. The first part describes the design and development of an educational platform containing an AS/RS (automated storage/retrieval system) system and a RGV (Rail-Guided Vehicle). All the phases of the platform development are presented, starting with 3D modelling, and ending with the platform testing and its integration in a manufacturing cell. The second part demonstrates the platform performance diagnosis and optimization in different functional scenarios using material flow simulation. The problems that occurred (when the platform becomes part of different types of manufacturing architectures) are analysed using the simulation reports diagnosis and a new simulation validates the optimization solutions. 12 refs.
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Key Words: *Simulation, Performance Diagnosis, Industrial Logistics, AS/RS System, Witness*

Pages 16-28

A NOVEL FRAMEWORK FOR SIMULATION-BASED OPTIMISATION OF MAINTENANCE SYSTEMS

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Abstract
The maintenance function in manufacturing has been gaining growing interest and significance. Simulation based optimisation has a high potential in supporting maintenance managers to make the right decisions in complex maintenance systems. Surveys in maintenance optimisation have repeatedly reported the need of a framework that provides adequate level of details to guide both academics and practitioners in optimising maintenance systems. The purpose of the current study is to address this gap by developing a novel framework that supports decision making for maintenance in manufacturing systems. The framework is developed by synthesising research attempts to optimise maintenance by simulation, examining existing maintenance optimisation frameworks and capturing framework requirements from review papers in the area as well as publications on future maintenance applications. As a result, the framework addresses current issues in maintenance such as complexity, multi-objective optimisation and uncertainty. The framework is represented by a standard flowchart to facilitate its use. 31 refs.
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Key Words: *Simulation, Optimisation, Maintenance, Framework, Complex Systems*

Pages 29-41

HYBRID ALGORITHM BASED ON PRIORITY RULES FOR SIMULATION OF WORKSHOP PRODUCTION

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Abstract
The proposed hybrid algorithm is a combination of heuristic algorithm extended with priority rules, discrete event simulation and genetics algorithm. It takes into account 11 different priority rules and scenarios, is based on the assumption that for a realistic workshop scheduling of orders, it is necessary to consider real throughput times of the operations, otherwise the obtained scheduling of orders is not suitable for the industrial environment. The simulation result for the proposed model is the optimal sequence of selected orders for the selected time interval while taking into account three criteria: the minimum flow time of all orders, the maximum average utilization of workplaces, and the minimum waiting time of the orders. Because the mentioned criteria are usually mutually exclusive the advantage of the proposed model is that we can find the optimum with respect to all three criteria. In the paper, an example of the application of the proposed model is shown. 31 refs.
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Key Words: *Workshop Scheduling, Discrete Event Simulation, Priority Rules, Optimization of Workshop*

Pages 42-55

SIMULATION APPROACH FOR SURFACE ROUGHNESS INTERVAL PREDICTION IN FINISH TURNING

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Abstract
Existing simulation models used in predicting the surface roughness of a workpiece in finish turning are based on an ideal circular cutting tool nose profile. This leads to a single predicted roughness value for a given set of input parameters. In this paper, a simulation approach that considers the random tool nose profile micro-deviations as well as the tool chatter vibration to predict a roughness interval is proposed. The nose profiles used in the simulation were extracted from images of the real cutting tool inserts using sub-pixel edge location. The chatter vibration signal was reconstructed from the measured signals and was superimposed onto the extracted nose profile. The roughness data were computed from 24 simulated workpiece surface profiles and used to determine the 95 % roughness prediction interval. Comparison with the experimental results showed that 100 %, 96 % and 96 % of the R_t, R_a and R_q roughness values obtained experimentally fell within the predicted roughness intervals. 31 refs.
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Key Words: *Prediction Interval, Nose Profile Micro-Deviation, Surface Roughness, Turning*

Pages 56-69

SIMULATION OF THE PERFORMANCE OPTIMIZATION OF HARBIN YINGBIN INDUSTRIAL PARK IN CHINA

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Abstract
An effective performance optimization of industrial parks is urgently needed because of the importance of these parks. To develop a model to optimize the performance of industrial parks from the comprehensive perspectives of economy, society, and environment, the member assessment model was initially constructed to evaluate the comprehensive performance of enterprises. Then the assembly line balance (ALB) model and the mixed integer linear programming (MILP) method were integrated to construct a model (MILP-ALB) for evaluating the optimized comprehensive performance of an industrial park. This model was applied to Yingbin Industrial Park in Harbin, China. Simulation results indicate that the comprehensive performance of enterprises and their interactions determine the comprehensive performance of the industrial park. Results also demonstrate that the MILP-ALB model is applicable in evaluating the optimized comprehensive performance of the industrial park. Furthermore, the model can reveal the effects of the newly introduced enterprise on the optimized performance. Given these results, the model is a useful tool for performance optimization. 27 refs.
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Key Words: *Industrial Park, Comprehensive Performance Optimization, MILP Model, ALB Model, Simulation*

Pages 70-82

SIMULATION-BASED PERFORMANCE ANALYSIS OF THE ALICE MASS STORAGE SYSTEM

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Abstract
CERN – the European Organization for Nuclear Research today, in the era of big data, is one of the biggest data generators in the world. Especially interesting is transient data storage system in the ALICE experiment. With the goal to optimize its performance this paper discusses a dynamic, discrete event simulation model of disk based Storage Area Network (SAN) and its usage for the performance analyses. Storage system model is based on modular, bottom up approach and the differences between measured and simulated values vary between 1.5 % and 4 % depending on the simulated component. Once finished, simulation model was used for detailed performance analyses. Among other findings it showed that system performances can be seriously affected if the array stripe size is larger than the size of cache on individual disks in the array, which so far has been completely ignored in the literature. 31 refs.
(Received in April 2015, accepted in October 2015. This paper was with the authors 1 month for 1 revision.)

Key Words: *Big Data, Mass Storage System Optimization, Storage Area Network Simulation, Storage Area Network Optimization, Hierarchical Performance Modelling and Analysis*

Pages 83-96

A SEMANTIC-BASED SERVICE DISCOVERY FRAMEWORK FOR COLLABORATIVE ENVIRONMENTS

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Abstract
In recent years, service-oriented and ubiquitous technologies have experienced impressive development. As these services grow rapidly both in scale and type, effective and accurate service discovery methods play an increasingly important role in the search and selection of services that match consumer requirements and preferences. In order to discover the optimum service and enhance the effectiveness of discovered results, a semantic-based service discovery framework, consisting of user model, context model, service model and a service discovery process, was presented in this study. Then the personalized service ontology was introduced to adjust the service search range adaptively on the basis of the service ontology structure and user information. Furthermore, a semantic-based service discovery method was designed in the proposed framework, which enabled names, attributes and relations of services to be more accurately matched and mapped with user preferences. Finally, to evaluate the effectiveness and accuracy of this method, the simulation analysis was conducted based on service ontology, in which information on 102 separate services and 10 scenarios were extracted from actual data. The simulation results show that compared with the keywords-based method, the proposed semantic-based method shows an increase in recall rate, precision and *F*-measure. The simulation results also reveal that the proposed method improves service discovery efficiency and performs well in accuracy. Therefore, collaborative environments considered in service discovery can provide useful and effective guidance to study the service recommendation. 13 refs.
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Key Words: *Service Discovery, Recommendation, Service Ontology, Similarity, Semantic*

Pages 97-108

SIMULATION-BASED PERFORMANCE ANALYSIS OF AUTOMATED SINGLE-TRAY VERTICAL LIFT MODULE

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Abstract
In this paper a simulation analysis of an automated single-tray Vertical Lift Module (VLM) system is presented. Compared to other well-known warehouse systems, a VLM system can provide moderate throughput capacity and lower investment cost. The objective of the study is to investigate benefits of a single-tray VLM system design in terms of reducing transactions' mean cycle time, which results in increased throughput of the system. Performance of the single-tray VLM is evaluated regarding alternative design configurations and the velocity profiles.

The results show that single-tray VLM systems are effective and may serve as guideline for warehouse designers in designing a new or improving an existing automated warehouse system. 24 refs.
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Key Words: *Logistics, Automated Warehouse, Warehousing, Vertical Lift Module, Discrete Event Simulation, Performance Analysis*

Pages 109-120

INTELLIGENT CAD/CAM SYSTEM FOR PROGRAMMING OF CNC MACHINE TOOLS

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Abstract
This paper suggests the automated programming of CNC-machine tools with the help of artificial intelligence. Based on a CAD-model of the product, the system, without any help from an expert, automatically prepares a CNC program, so that the machining is safe, accurate and time-efficient. The developed CAD/CAM system uses NSGA-II multi-objective optimisation and swarm intelligence. The system consists of a prediction and evaluation module. In a prediction module artificial intelligence suggests solutions that include information about tool path, selected tools and suggested cutting parameters. The evaluation module estimates the suggested solutions by considering the geometrical, technological and time criteria, and the criterion of efficiency of machining. A simulation model was developed for searching optimal solutions. In this paper, the developed system is experimentally tested using a test case of manufacturing. The test results confirmed that with the help of this method of artificial intelligence, machine tools can be automatically programmed. 34 refs.
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Key Words: *NSGA-II, Multi-Objective Optimisation, Machine Tool, CNC Programming, CAD/CAM*

Pages 121-132

OPTIMAL TOLERANCE ALLOCATION IN A COMPLEX ASSEMBLY USING EVOLUTIONARY ALGORITHMS

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Abstract
Tolerance design is a vital factor which influences product and process development. Further, it determines the manufacturing cost, the functionality and quality of a product. It is evident that optimal tolerance normally leads to produce ample parts, better operation of mechanical systems and excellent assembling. In contrast, tight tolerance leads to increase in manufacturing cost for an assembly. An ideal relationship exists among production cost and operation, while determining the optimum tolerance. Based on this relation a new approach by implementing the Non-traditional techniques: Genetic Algorithm (GA), Elitist Non-dominated Sorting Genetic Algorithm (NSGA-II) and Differential Evolution (DE) for determining the optimum tolerance, zero percentage rejection and manufacturing cost considering the varying quality loss constants for an assembly namely overrunning clutch assembly, is discussed in this paper. From the result obtained, it is evident that, the proposed approach is best suitable for solving problems involving complex assemblies. 37 refs.
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Key Words: *Tolerance Allocation, Manufacturing Cost, Quality Loss, Evolutionary Algorithms*

Pages 133-143

INTEGRATED BATCH PLANNING OPTIMIZATION BASED ON FUZZY GENETIC AND CONSTRAINT SATISFACTION FOR STEEL PRODUCTION

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Abstract
This paper stablishes the model of the integrated batch planning process, and proposes an improved algorithm for this problem. The simulation results of a computerized scheduling system are given to prove the fitness of the model. The steel making casting production process scheduling problem is very difficult to get a good performance solution in practice. The scheduling of steelmaking casting production is a complicated problem of combinational optimization in the hybrid flow shop, which is an NP-Hard problem, and determining the polynomial time algorithm to arrive at the accurate optimal solution has proved to be a difficult task. An improved fuzzy genetic optimization and improved algorithm strategy are proposed. The results show that the method is very efficient in solving the steel casting production scheduling problem. 25 refs.
(Received, processed and accepted by the Chinese Representative Office.)

Key Words: *Integrated Batch Planning, Scheduling Problem, Fuzzy Genetic*

Pages 144-156

MODELLING OF MAGNETORHEOLOGICAL DAMPER FOR INTELLIGENT BIONIC LEG AND SIMULATION OF KNEE JOINT MOVEMENT CONTROL

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Abstract
To compensate for missing functions of lower extremity amputees, this paper proposes a model of an intelligent bionic leg semi-actively controlled by a magnetorheological damper (MRD). A mechanical structure of the leg is designed, and with the help of Bouc-Wen model, a MRD forward dynamics model is constructed for simulation. On the basis of data obtained from simulations, the MRD inverse dynamics model is constructed by BP neural network. An integrated control platform is constructed for the intelligent bionic leg, on which the simulation for knee joint control is conducted. Results of the research show that the MRD forward dynamics model can precisely express relationships among damping force, velocity, and displacement, while the inverse forward dynamics model can accurately predict MRD control currents, thus obtaining precise trajectory tracking effects of knee joint movement. 20 refs.
(Received, processed and accepted by the Chinese Representative Office.)

Key Words: *Intelligent Bionic Leg, Magnetorheological Damper, Forward Dynamics Model, Inverse Dynamics Model, RBF Neural Network*

Pages 157-169

MODELLING AND SIMULATION OF A MULTI-RESOURCE FLEXIBLE JOB-SHOP SCHEDULING

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Abstract
Flexible job-shop scheduling problem (FJSP) in the field of production scheduling presents a quite difficult combinatorial optimization problem. Machines are mostly considered to be the only resource in many research projects dealing with FJSP. In actual production, there are many other factors which influence production scheduling, such as transportation, storage and detection. If machines are considered to be the only resource, the problem may not be in accord with the actual production. Thus, in order to make FJSP more in line with the real production situation, machines, warehouses, vehicles and detection equipment are all considered to be the scheduled resources simultaneously due to the shortage of flexible job shop scheduling problem in resources. A new mathematical model for a multi-resource flexible job-shop scheduling problem (MRFJSP) is proposed. The constraints of the model are presented. The makespan is the main target which will be minimized. A genetic algorithm which includes elitist strategy is proposed to solve the MRFJSP. Due to the complexity of MRFJSP, each key module of the genetic algorithm is redesigned. Finally, the model and algorithm are proved through an application case. 19 refs.
(Received, processed and accepted by the Chinese Representative Office.)

Key Words: *Multi-Resource, Scheduling, Genetic Algorithm*

Pages 170-180

EFFECTS OF SPIRAL LINE FOR PICK ARRANGEMENT ON BOOM TYPE ROADHEADER CUTTING LOAD

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Abstract
The effects of the spiral line for pick arrangement on the cutting load of a boom type roadheader's cutting head were investigated. For this purpose, cutting heads with equal and unequal pitch angle and various numbers of spiral lines were designed for the same cutting head body. The cutting head with unequal pitch angle of spiral lines was specifically designed to avoid tool-holder overlap at the top section without adjustments and reduce the manufacturing difficulties. The cutting process of different cutting heads were simulated by finite element method using ANSYS/LS-DYNA and the time history curve of the traversing force, vertical force, axial force, and resultant force on the cutting head were obtained. The results indicate that the load stability of the cutting head with unequal pitch angle was worse than the equal pitch angle cutting head. For cutting heads with various numbers of spiral lines, the head with 3 spiral lines shows the best performance, considering the force values and fluctuations of the cutting head. The analysis provides a reliable basis for optimization of the design of boom type roadheader cutting heads. 28 refs.
(Received, processed and accepted by the Chinese Representative Office.)

Key Words: *Cutting Head, Pick Arrangement, Spiral Line, Cutting Head Design, Cutting Load, Boom Type Roadheader*

Pages 181-193

A NEW MODEL FOR EVALUATING THE VOLUME OF LAPTOP SPARE PARTS DEPENDING ON USERS' INTENTIONS RELATED TO LAPTOP USE TIME

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Abstract
This paper is a continuing studying about the volume of laptop spare parts, and it takes into account the users' repair intentions. We found that when a laptop is no longer working, whether it will be repaired is determined by the user's intention. The user's intention is related to the number of times that his laptop fails and to its use time, i.e., how long the laptop has been used. Therefore, this paper focuses on the volume of laptop spare parts calculation equation. First, we assume the failure process of laptop parts is a Poisson process, and the failure probability of laptop spare parts can calculate at different times. We deduce the transition probability formula of users' repair intention related to laptop use time. Finally, the equation to calculate the volume of spare parts is presented in this paper and is verified by simulation. The simulation results agree with the theoretical values. From the simulation curve, we know that the volume of spare parts will decrease sharply when the laptop use time is long. After having used a laptop for five years, a user is less likely to have a broken laptop repaired. Therefore, laptop factories could reduce the inventories of spare parts. 30 refs.
(Received, processed and accepted by the Chinese Representative Office.)

Key Words: *Laptop Spare Parts, Users' Repair Intention, Simulation*
