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COMPUTER VISION-BASED APPROACH TO END MILL TOOL MONITORING

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Abstract
The paper is concerned about the system of automatic detecting of wear and damages of the end mill tool by the use of computer vision. By using the algorithms developed for image segmentation and by an innovative approach to extraction of features describing individual end mill tool tooth the information representing significant features of the individual tool tooth is effectively gained from the captured image. The proposed approach to feature extraction is robust and independent of the scale and rotation of the end mill tool in the image. The features vectors have been classified by two approaches, i.e., *k*-nearest neighbour algorithm and artificial neural network. Both approaches have been tested by the test base of tool images and the results mutually compared. The classification has been validated by 10-fold cross-validation method. The best precision of classification (92.63 %) has been reached by the use of artificial neural network. Simulation results have confirmed that the proposed approach can improve monitoring of tool wear and damages and, consequently, the effectiveness and reliability of CNC milling machine tool. 27 refs.
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Key Words: *Manufacturing System, Computer Vision, Machine Vision, k-Nearest Neighbours, End Mill Tool, Neural Network*

Pages 584-595

CHANGE MANAGEMENT WITH THE AID OF A GENERIC MODEL FOR RESTRUCTURING BUSINESS PROCESSES

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Abstract
In the last few decades, the Slovenian business environment has experienced a number of transitions, market, political and financial changes. Companies, which failed to incorporate these changes into their strategies, quickly fell into difficulties or went into liquidation. Managing change is of key importance if companies or organisations want to remain competitive. As a means of support companies can employ various approaches, techniques, tools and models; these, however, are not always adapted to the needs – deriving from the strategy and the environment – or the type of the company, especially if these are small or medium-sized enterprises. This article presents the concept of a generic model for managing changes. Based on simulation, this model will support the management of small and medium-sized enterprises in detecting problems, defining solutions and implementing necessary changes in business processes. With the developed model a simulation of changes in balance sheet data for sales and the profit achieved was carried out, the goal of increasing sales defined and the limits set. The model offered seven opportunities which have all been commented on appropriately. By utilising this model, a static company changes into a dynamic one capable of quick restructuring whenever necessary. 19 refs.
(Received in August 2014, accepted in May 2015. This paper was with the authors 4 months for 2 revisions.)

Key Words: *Change Management Model, Business Processes, Life Cycle, Pathological Problems, Simulation*

Pages 596-608

AN OPEN SOURCE TOOL FOR AUTOMATED INPUT DATA IN SIMULATION

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Abstract
Discrete Event Simulation (DES) is one of the most effective tools for planning, designing and improving material flows in production. One of the main weaknesses of operating DES is the exertion needed and costs spent on collecting and handling the input data from different organisation's data resources. To tackle the problem of the time consuming input data process for DES projects an Open Source (OS) tool, called Knowledge Extraction (KE) tool was developed. The tool reads data from several organisations' resources; analyses it and outputs it in a format that is applicable to be used by a simulation tool, all conducted in one automated process. The primary, readable to simulation software, output format follows the Core Manufacturing Simulation Data (CMSD). This paper presents the KE tool and a test implementation, as a first step towards the validation of the tool in a real case study in the medical industry. 27 refs.
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Key Words: *Input Data Management, Discrete Event Simulation, Open Source, Core Manufacturing Simulation Data, Automation*

Pages 609-620

DYNAMIC DEFORMATIONS IN COORDINATE MEASURING ARMS USING VIRTUAL SIMULATION

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Abstract
This paper presents a study for assessing the dynamic structural deformations of one of the most modern, and portable, measurement equipment: the Coordinate Measuring Arms (CMAs or AACMMs). The study of the measurement errors derived from the use of these instruments is still controversial due to a certain lack of traceability and reliability in measurements due to the influence of the human factor acting on a complex 3D structure (with 6 or 7 degrees-of-freedom). When contact measurements are taken into account, the human factor variable originates non-uniform contact forces, lack of stability, different velocities and accelerations, among unpredictable probing trajectories. All these factors lead to conclude that in every manual measurement involving a CMA there is a structural dynamic deformation caused by the approach movement before probing a contact point as well as by the force exerted during probing. In order to determine the amplitude of this deformation and its distribution along the CMA structure a new methodology has been developed. Both depend on the followed trajectory and on the probing force amplitude and orientation. This work presents the methodology and steps required for the construction of the virtual simulation model. The method employs 3D modelling of all elements of the CMA structure, Finite Element Analysis (FEA) software and multibody simulation techniques with flexible bodies. This set of software tools is nowadays capable of creating dynamic virtual models for the dynamic analysis of complex mechanisms (machines, vehicles…) in optimization tasks. The application of these tools supposes a novel approach to the study of the CMA metrological behaviour. 25 refs.
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Key Words: *Coordinate Measuring Arms, Dynamic Deformations, Dynamic Simulation*

Pages 621-632

OPTIMISING FORKLIFT ACTIVITIES IN WIDE-AISLE REFERENCE WAREHOUSE

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Abstract
Nowadays the great attention has to be paid to warehouse. Theoretical analysis shows the need to optimise their activities. This encourages the search of more advanced solutions. Aiming to determine possible improvements, the operations of forklifts are examined in warehouses, and detail solutions are presented.

For empirical study author created a simulation model and tested different scenarios. First of all, author examined the new routing method and suggested programming algorithm for forklift route optimization. In the first part of the study possible improvements for put-away activity are analysed, in the second part – improvements for replenishment activity are overviewed. Simulation results showed that the reduction of forklift travel distance is equal from 11.1 % to 35.6 %. Finally, the study ends with detail suggestions: author presented new routing method and forklift routing algorithm. Further, the theoretical results have to be tested in practise. 22 refs.
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Key Words: *Warehouse, Forklifts, Routing, Simulation, Performance Analysis*

Pages 633-646

CONNECTIONISM STRATEGY FOR INDUSTRIAL ACCIDENT-ORIENTED EMERGENCY DECISION-MAKING: A SIMULATION STUDY BASED ON PCS MODEL

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Abstract
Connectionism strategy is widely used by the policymaker to implement the emergency rescue activities in industrial accidents, exploring its mechanism is helpful to deeply understand the mechanism of behavioural change of policymakers during emergency decision-making procedure. In this study, the emergency process and influential factors as well as three types of emergency disposal schemes, when the connectionism strategy was adopted for rescue activities in coal mining accidents, were qualitatively analysed and concluded. Then, an improved simulation model was proposed based on Parallel Constraint Satisfaction (PCS) model. Lastly an algorithm written in MATLAB was employed to model and explore the influential mechanism of the negative emotion and the concern of policymakers as well as the mode of decision-making tasks on decision time and decision confidence. Results demonstrate that, the higher the policymakers' negative emotion, the shorter the decision time and the higher level of decision confidence they have. Under different modes of decision tasks, the more difficult it is to identify the superiority and inferiority of different disposal schemes, the more decision time the policymakers need and the lower level of decision confidence they have, the decision confidence is more sensitive to the mode of decision-making task, meanwhile the negative emotion and the concern of policymakers have different effects on decision time and decision confidence. Compared with the concern on cues, policymakers' decision confidence is much higher when they focus more on schemes. The study reveals the mechanism of connectionism strategy adopted for emergency rescue activities in industrial accidents, which has a profound significance for optimizing emergency decision support systems for industrial accident management and enhancing the quality of emergency decision-making. 29 refs.
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Key Words: *Industrial Accident, Emergency Management, Coal-mine Accident, Connectionism Strategy, Parallel Constraint Satisfaction (PCS), Decision-making Simulation*

Pages 647-657

MULTI-MODEL STABILITY CONTROL METHOD OF UNDERACTUATED BIPED ROBOTS BASED ON IMBALANCE DEGREES

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Abstract
In this paper, a stability control strategy for underactuated biped robots is proposed based on imbalance degree. The dynamic models of single-leg support of underactuated biped robots are firstly illustrated. Based on the external disturbance force strength of the system, the motion process of an underactuated biped robot is partitioned into three stages according to the imbalance degree. In different stages, corresponding dynamic models, tracking, gesture and gait switching control are adopted. Analysis of simulation result shows that the proposed underactuated gait control method is stable, practicable in engineering, and satisfies the real-time requirement. 19 refs.
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Key Words: *Underactuated Biped Robots, Varying Gait, Imbalance Degree, Multi-Model Control*

Pages 658-668

STUDY ON FAILURE PROCESS OF TAILING DAMS BASED ON PARTICLE FLOW THEORIES

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Abstract
Based on a tailing dam project, tailing sands are simulated as discrete materials in this paper. Taking the distribution rule of tailing sands into account, the discrete element software PFC2D is adopted to examine the stability and instability process of the dam according to fundamental particle flow principles. The PFC2D model is established according to the deposition rule of tailing sands in the tailing dam then the function of strength reduction is proposed based on the principle of strength reduction to simulate the flooding condition as well as the factor of safety at the stable state and the displacement at the instability process under the particular condition. In addition, comparison is made with the limit equilibrium method and the obtained difference in factor of safety is discussed. The obtained factor of safety for the stability of dam slope from PFC2D analysis is higher than expectation mainly because the micro-parameters in PFC2D affect many macro-parameters simultaneously and the relation between micro-parameters and macro-parameters are nonlinear, which well fits engineering practice. 16 refs.
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Key Words: *Tailing Dam, Particle Flow, PFC2D, Stability Analysis, Discrete Element, Numerical Simulation*

Pages 669-682

SIMULATION-AIDED DETERMINATION OF AN EFFICIENCY FIELD AS A BASIS FOR MAXIMUM EFFICIENCY-CONTROLLER DESIGN

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Abstract
In the field of hydraulic drive technology various power supply systems are used within different power unit set-ups. The both of two mostly used drive concepts in modern electrohydraulic systems, a variable displacement pump driven by constant speed electric motor and fixed displacement pump driven by a variable speed electric motor, have some disadvantages, especially regarding the increasing demand for maximum efficiency of the entire power unit without lowering the high dynamics. The combination of a variable pump and speed-controlled electric motor, offers the option of setting two parameters of the drive, the rotational speed of the motor and the pump flow-rate.

Such a combination allows all power unit components to operate within the areas of their maximum efficiencies, the so-called maximum efficiency drive. A prerequisite for designing suitable controllers that would ensure the operations of individual components within the areas of maximum efficiency, regardless of the current operating point, is certainly knowledge about the efficiency area of the entire power unit. This paper presents a procedure for determining areas of efficiency, first on the basis of simulation and detailed models of each component, and later verification of the model using an experiment. 16 refs.
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Key Words: *Hydraulic, Power Unit, Control Concepts, Efficiency Field, Simulation Results*

Pages 683-696

MODELLING, SIMULATION AND OPTIMIZATION OF SMALL-SCALE CCHP ENERGY SYSTEMS

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Abstract
The article defines and discusses techno-economic models of CCHP system based on a power system with an internal combustion engine or a gas turbine with electric power of 0,2–1 MW including an absorption or vapour-compression refrigeration unit. The thermodynamic, ecological and economical features of the CCHP system under different load situations are analysed in relation to the basic model of energy generation with boiler and vapour-compression refrigeration unit. Based on the data of the equipment manufacturer, functional dependency curves of individual components are created in dependency to the load, which enables the construction of a system model composed of a power system (internal combustion engine or a gas turbine), single-stage or two-stage absorption refrigeration unit and boiler. A program solution has been developed applying the object-oriented programming language Modelica that enables the insight into the behaviour and techno-economic validity of usage of the analysed systems in transformable operating conditions. The article examines various energetic models, defining for the influential parameters (electric energy and fuel prices, investment costs and the level of heat recovery) the value of total energy efficiency, the return period on investment costs and the environmental impact concerns. 32 refs.
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Key Words: *Small-Scale CCHP, Trigeneration, Optimization, Energy Efficiency, Modelica, SimulationX*

Pages 697-709

DYNAMIC OPTIMIZATION MODEL FOR GARMENT DUAL-CHANNEL SUPPLY CHAIN NETWORK: A SIMULATION STUDY

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Abstract
This paper aims to explore the optimization tactics of a dual-channel production and distribution network based on pre-sale mode to address the current situation of overstocked inventories in the apparel industry and considering the effect of changing production-distribution modes on apparel sales which results from the difference of order decoupling point. The research indicates that in the highly homogeneous apparel market, the pre-sale mode in which the products are made-to-order can utilize the highly efficient feedback of online pre-sales to provide guidance for traditional distribution channel by making accurate demand forecasts in a certain environment. This could help to resolve the problem of overstocked inventories by providing relative reference for the apparel industry in its subsequent operations. The mode of the production-distribution network after optimization is able to make reference to the real operations of pre-sale mode in the apparel industry. 18 refs.
(Received, processed and accepted by the Chinese Representative Office.)

Key Words: *Dual-Channel, Pre-Sale Mode, Supply Chain Network, Dynamic Optimization*

Pages 710-718

SIMULATING SCHEDULE OPTIMIZATION PROBLEM IN STEELMAKING CONTINUOUS CASTING PROCESS

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Abstract
This paper establishes the models of the steelmaking continuous casting (SCC) process, and proposed the improved algorithms for this problem. The simulation results of a computerized scheduling system are also given to prove the model. The SCC process scheduling problem is very difficult to get a good performance solution in practice. The scheduling of the SCC process requires that each cast plan is processed on time, and the charges should be processed continuously for the same caster in the same cast, as well as the waiting time of the charges cannot be conflicted mutually in the same converters. We propose a quantum-behaved particle swarm optimization (QPSO) and improved algorithm strategy. The results show that the QPSO is very efficient for solving the SCC production scheduling problem, especially for large scale problem. 25 refs.
(Received, processed and accepted by the Chinese Representative Office.)

Key Words: *SCC, Scheduling Problem, Quantum-Behaved Particle Swarm Optimization*

Pages 719-731

RESCHEDULING METHODS FOR MANUFACTURING FIRMS APPLYING MAKE-TO-ORDER STRATEGY

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Abstract
To combat the problem of frequent production plan change in an environment where manufacturing systems are constantly varying, an improved hybrid rescheduling strategy is proposed. Disturbance factors are classified according to their origin and influence, and their disturbance degree is determined using a fuzzy-neural network. On the basis of this, an adaptive rescheduling process for manufacturing systems has been constructed and an improved hybrid rescheduling strategy is proposed. Finally, the effectiveness of this improved strategy is illustrated by a case study of practical manufacturing. The results show that this strategy can effectively reduce rescheduling times and maintain the stability of manufacturing systems. 21 refs.
(Received, processed and accepted by the Chinese Representative Office.)

Key Words: *Manufacturing Systems, Disturbance Degree, Rescheduling, Fuzzy-Neural Network*

Pages 732-743

A NEW MULTI-BODY DYNAMIC MODEL FOR SEAFLOOR MINER AND ITS TRAFFICABILITY EVALUATION

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Abstract
In this paper, the particular mechanical interaction relationships between a seafloor tracked miner and the sediment are obtained through laboratory-simulated experiments. Underwater sediments exhibit entirely different shear properties compared to land surface soils. An innovative user-written subroutine for characterizing the mechanical models of various soil types is compiled and linked to the RecurDyn simulation environment and then validated against an available commercial program and with laboratory tests. A new three-dimensional multi-body dynamic simulation model of the miner is developed in RecurDyn by integrating the developed mechanical model of the seafloor sediment. Simulations are conducted to measure the miner's geometric trafficability and locomotion performance. Additionally, a mathematical model to evaluate the miner's tractive trafficability in relation to its slip ratio and its primary design parameters is established, and the results demonstrate that there is an optimum slip ratio that produces a maximum traction force for the miner. This research provides a valuable and effective simulation modelling method for trafficability, locomotion predictions, design optimization and motion control of tracked-operated vehicles under various terrain conditions. 18 refs.
(Received, processed and accepted by the Chinese Representative Office.)

Key Words: *Seafloor Tracked Miner, Track-Sediment Interaction Mechanics, 3D Multi-Body Dynamic Model, Simulation Analysis, Trafficability Evaluation*

Pages 744-755

MODELLING THE IMPACTS OF RESOURCE SHARING ON SUPPLY CHAIN EFFICIENCY

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Abstract
This study investigates the impacts of resource sharing on the supply chain efficiency. Due to the increased emphasis on efficiency, modern supply chain processes are no longer labour-intensive. Supply chain management should particularly consider resource sharing. The queuing and AnyLogic approaches are developed in this paper to model and simulate complex supply chain operations. First, based on the queuing theory, this paper conducts a mathematical analysis on the resource sharing mode's impact on supply chain efficiency; then, it performs a simulation for the resource sharing mode's impact on supply chain efficiency. Then, in a case from the express industry, this paper quantitatively analyses the resource sharing mode's impact on the average service length of orders, the average service time of orders, the loss rate of orders and the utilization of resources. Finally, through simulation, this study shows that the resource sharing mode is superior to the resources exclusive mode in all of the above aspects. For example, the service length of the resources exclusive mode is much longer than the total service length of the resource sharing mode. However, the service time of the resources exclusive mode is nearly equal to the total service time of the resource sharing mode; the resource sharing mode's loss rate is approximately 90 % lower than the loss rate of the resources exclusive mode. 21 refs.
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Key Words: *Resource Sharing Mode, Queuing, Modelling, Simulation, AnyLogic*
