larity parameter is approximately constant. The falling velocity of droplet increases a little by viscosity ratio increase, but circularity parameter is decreased rapidly. The falling droplet shape goes from sphere to ellipse after producing vortex loops from its tail, and it leads to circulating region growth at the rear of the droplet. The velocity field makes droplet surface horizontally by growth of vortex sizes.

Key Words: Phase field model, incompressible droplet, viscosity ratio, density ratio, least square method.

Dept. of Mechanical Engineering
Sharif University of Technology
A. Ghasemi
alighasemi_me@yahoo.com
R. Seifi
rahmanseifi@yahoo.com
Dept. of Mechanical Engineering
University of Bu Ali Sina

Sharif Mechanical Engineering Journal
Volume 33, Issue 2, Page 133-140, Original Article

- Received 6August 2016; received in revised form 15 October 2016; accepted 29 October 2016.

Abstract

Many engineering components are subjected to cyclic loading which is the main cause for most of engineering failures. When a cyclic loading is repeated, fatigue must bring into account for any life estimation study. Fatigue results in failure of the engineering components in a stress level well below the yield stress of the material. Life extension techniques can delay the initiation or propagation of the crack in the engineering structures. Most of these techniques induce compressive residual stresses which can enhance the component fatigue life. As the crack usually starts from the surface, the induction of compressive residual stresses on the surface of the components can greatly influence the component life cycle. There are many surface modification techniques practicing in different industries. Shot peening is one of the most well-known surface treatment methods that is employed to enhance the fatigue life.

In the current paper, severe shot peening has been applied to samples made of Aluminum A356. This alloy has been used where high strength, good weldability, ability of permanent die casting and corrosion resistance are required. A356 is an aerospace aluminum alloy and has a wide application in other industries, such as automobile and military. Fatigue crack growth and life curves of as-received and shot peened samples have been found both numerically and experimentally. Finite element analyses of the shot peening process are still under development by many researchers. The exact coverage percentage is difficult to achieve, and it requires simulation of a random peening process. This manuscript also describes how to achieve the correct coverage. The experiments were designed very carefully to evaluate the effects of the shot peening process. Very good agreements were observed between results. They showed life extension for high cycle fatigue up to three times. Having the finite element results in hand, the experimental achievement was explained.

Key Words: Life extension, fatigue, residual stresses, Al A356, shot peening.

NUMERICAL SIMULATION OF DENSITY AND VISCOSITY RATIO CHARACTERISTICS EFFECT ON DYNAMIC OF FALLING INCOMPRESSIBLE SPHERICAL DROPLET

M. Mahmoodi(corresponding author)
mehdymahmoody@gmail.com
Dept. of Mechanical Engineering
Babol University of Technology
R. Shadmani
shadmani@gmail.com
Dept. of Maritime Engineering
Amirkabir University of Technology
M. Ebrahimi
ebrahimi@iust.ac.ir
Dept. of Mechanical Engineering
Iran University of Science & Technology

Sharif Mechanical Engineering Journal
Volume 33, Issue 2, Page 141-147, Research Note

- Received 4 June 2016; received in revised form 1 August 2016; accepted 21 August 2016.

Abstract

In this study, numerical simulation of falling incompressible, spherical droplet of a fluid under gravity in other peripheral fluid is done. Phase field model and least square method are used for solving the two dimensional incompressible Cahn-Hilliard and Navier-Stokes equations in so little time step duration for different densities and viscosities between phases. The main performance of the least squares method is the minimization of the residual functional in a least squares manner of parameters. Instead of level-set, large eddy simulation or volume of fluid methods, the phase field models have been successfully implemented to simulate the flow of two or more immiscible fluids whose their densities and viscosities are not the same. The studied geometry includes a spatial domain as a vertical channel [0.2]X[0.08] that its boundaries have no slip and no penetration conditions and a stationary droplet with 0.005 radius starts falling by gravitational force. The droplet center of mass at the initial time is (0.04, 0.15). The effects of density and viscosity ratios on incompressible droplet dynamics are quantitatively studied. Density and viscosity ratios are defined to generalize the numerical solution by creating the relation between some properties of two different fluids. The chemical potential parameter in Cahn-Hilliard equation depends on the kinematic fluid pressure. The velocity field around droplet and its effect on droplet shape are investigated in this paper. The falling velocity of droplet decreases by density ratio increase, but circu-

rial. In this paper, a new and powerful method is presented that reconstructs the microstructure using only one cut-section. The method is based upon correlation functions and phase recovery algorithm. The effective properties of a random heterogeneous material are strongly correlated with a particular formalism called n-point statistics. At first, using the available cut-section, two-dimensional two-point correlation functions are determined. Then, three-dimensional, two-point correlation functions are approximated using 2D ones. Indeed, using the phase recovery algorithm, based on the approximated correlation functions, the three-dimensional microstructure is reconstructed. Besides the isotropic microstructures, this procedure can be used for reconstruction of transversely isotropic microstructures using only one cut-section. Thermal conductivity for the original and reconstructed microstructures is calculated and compared with each other; it is shown that the proposed method reconstructs the original microstructure with a small error rate. An effective reconstruction procedure enables one to generate close to target structures at will, and a subsequent analysis can be performed on the reconstructed microstructure to obtain approximate macroscopic properties (e.g., mechanical, transport, and electromagnetic properties) of the heterogeneous media.

Key Words: Three-dimensional reconstruction; two-point correlation functions; phase recovery algorithm; heterogeneous material.

EXPERIMENTAL INVESTIGATION OF FATIGUE LIFE IN CRACKED ALUMINUM PLATES REPAIRED BY COMPOSITE PATCHES

Sh. Yousefzadeh(corresponding author)
shy@iau-aligudarz.ac.ir
Dept. of Mechanical Engineering
Islamic Azad University, Aligudarz
M.M. Doustdar
mdostdar@ihu.ac.ir
Faculty of Engineering
Ghadr Research center, Imam Hossein University

Sharif Mechanical Engineering Journal
Volume 33, Issue 2, Page 123-132, Original Article

- Received 18 June 2016; received in revised form 2 August 2016; accepted 22 August 2016.

Abstract

Existence and growth of cracks in structures is an unavoidable matter, and presentation of economical repair methods is useful in this situation. Applications of repaired structures by composite patches are expanding. One of the most significant uses of this method is repairing cracked components and parts of aerospace industries. This type of patch includes many advantages such as high strength, resistance against corrosion and humidity, low weight and acceptable fatigue life. Patch repair causes the stress reduction around the crack and also the transition of stress from the cracked plate to the patch. Finally this type of repair decreases or totally stops the crack growth and increases the fatigue life of parts. In this study, the experimental investigation of crack growth and fatigue life in cracked Aluminum plates repaired by composite patches has been considered. Edge-cracked aluminum plates repaired with one-side composite patches are investigated. Due to avoidance of the disadvantages of mechanical joints such as; stress concentration, low strength against fatigue, the risk of failure in the main body, and so on, the adhesive has been used to join the parts. In addition, the effects of several parameters, such as the prime cracks angle in three levels 0^0, 30^0, and 45^0, patch's width in three levels 25, 30, and 35mm and the layer's layout in three levels on fatigue life have been investigated. The results indicate that by the increase in crack angle from 0 to 45^0, the fatigue life of parts under fatigue loads increases; and in several path layouts, there is not any difference in fatigue life. It is noticeable that increase in the patch's width, does not have any remarkable influence on the fatigue life and even may cause some decrease in lifetime.

Key Words: Cracked plate, repair, composite patch, crack growth, fatigue life.

LIFE EXTENSION OF AL A356 BY SEVERE SHOT PEENING: AN EXPERIMENTAL AND NUMERICAL STUDY

A.H. Mahmoudi(corresponding author)
a.h.mahmoudi@gmail.com
M. Niknam
majidniknam68@yahoo.com
Dept. of Mechanical Engineering
University of Bu Ali Sina
G.H. Farrahi
farrahi@sharif.edu

AIFANTIS THEORY AND RITZ METHOD

S. Ziae
ziaee@yu.ac.ir
Dept. of Mechanical Engineering
Yasouj University

Sharif Mechanical Engineering Journal
Volume 33, Issue 2, Page 103-113, Original Article

- Received 25 May 2016; received in revised form 11 September 2016; accepted 27 November 2016.

Abstract

The nano-resonator sensors are designed to detect atoms or molecules more precisely and robustly. One of the techniques used to design nano-sensors is vibration-based method. In this method, the detection principle is based on the differentiable shift in resonant frequencies in nano-resonator due to foreign atoms or molecules attached to the surface of the nano-resonators. Carbon-based nano-structures are common nano-materials used for design of nano-sensors due to their high modulus of elasticity and extremely low mass. Nowadays, boron nitride nano-tubes which have similar structures to the carbon nano-tubes are considered as nano-resonators.

The present study aims to investigate the ability of bi-layered nano-sheets made of graphene or boron-nitride or a monolayer graphene and a monolayer boron-nitride to detect foreign atoms or molecules in comparison with a monolayer nano-sheet. Also, the free vibration of two-layered nano-sheets formed by a monolayer graphene and a monolayer boron nitride nano-sheet with different boundary conditions are studied. The fundamental frequencies of this hybrid two-layered system are compared with those of bi-layered graphene and boron nitride nano-sheets as well. To this end, Aifantis's theory is incorporated into the classical plate theory to obtain a non-classical plate theory which is suitable to study the mechanical behavior of carbon- and/or boron-nitride-based nano-structures. Because of the importance of the inter-layer van der waals force on mechanical behavior of multi-layer nano-sheets, the nonlinear model of inter-layered interaction between graphene and boron-nitride nano-sheets and between boron-nitride layers is estimated based on Lenard-Jones 6-12 potential at first, although the linear part of inter-layered interaction model is used in linear free vibration study.

The results show that bi-layered boron-nitride nano-sheets are more suitable for detecting foreign mass rather than bi-layered graphene sheets or hybrid two-layer system, although the sensitivity of a monolayer boron-nitride nano-sheet with the same surface area to foreign mass is more than the bi-layered one. On the other hand, between the bi-layered boron-nitride and the monolayer boron-nitride nano-sheets, which have the same mass, the bi-layered boron-nitride is more sensitive to foreign mass.

Key Words: Mass detection nano-sensors; two-layered graphene boron nitride nanosheet, non-classical plate theory .

THREE-DIMENSIONAL RECONSTRUCTION OF HETEROGENEOUS MICROSTRUCTURES BASED ON ONE CUT-SECTION USING TWO-POINT CORRELATION FUNCTIONS AND PHASE RECOVERY ALGORITHM

A. Hasanabadi(corresponding author)
ali.hasanabadi@gmail.com
M. Baniassadi
m.baniassadi@ut.ac.ir
K. Abrinia
cabrinia@ut.ac.ir
Dept. of Mechanical Engineering
University of Tehran

Sharif Mechanical Engineering Journal
Volume 33, Issue 2, Page 115-121, Original Article

- Received 23 May 2016; received in revised form 17 September 2016; accepted 25 September 2016.

Abstract

Three-dimensional reconstruction of microstructure and evaluation of the various properties (such as mechanical, thermal, etc.) using limited two-dimensional cut-sections are intriguing subjects in microstructure optimal design. There are many practical cases, including material science, biology and medicine, and petroleum engineering for which only 2D images are available for analysis instead of 3D media. Furthermore, direct reconstruction of heterogeneous microstructures using stitching digitized serial section images is not well-suited to routine engineering applications, because providing the acquired images by FIB-SEM, X-ray computed tomography (micro CT), scanning laser confocal microscopy, and other imaging methods are expensive due to their complicated technology, lack of skilled operators and many other technical issues. Thus, three-dimensional reconstruction of such a heterogeneous microstructure is highly useful in performing homogenization, characterization, and finding correlations between microstructural attributions and effective properties of a mate-

addition, by comparing the results of ductile fracture criteria and FLD criterion with experimental results, the Argon ductile fracture criteria were chosen as the most appropriate criteria to predict fracture. Also, the effects of parameters were studied as sheet thickness, bending radius, and bending angle on fracture with argon as the selected criterion. The investigation results showed that by increasing the sheet thickness, bending angle increases the risk of fracture defects in the product; by increasing bending radius, the risk of fracture defects in the product decreases.

Key Words: Flexible roll forming, ductile fracture criteria, finite element method (FEM), forming limit diagram (FLD).

DESIGN AND SIMULATION OF A NOVEL MOTILE SPERM SEPARATION MICROFLUIDIC SYSTEM BY USE OF ELECTROPHORESIS

M. Shiri
msb.shiri@gmail.com
M. Moghimi Zand(corresponding author)
mahdimoghimi@ut.ac.ir
School of Mechanical Engineering
University of Tehran

Sharif Mechanical Engineering Journal
Volume 33, Issue 2, Page 93-101, Original Article

- Received 17 May 2014; received in revised form 19 November 2014; accepted 8 December 2014.

Abstract

Different studies show that at least half of the couples referring for infertility investigation and treatment have a causative male factor. Male factor infertility can be caused by a variety of defects, e.g., abnormal sperm amount, morphology abnormality, or low functionality. In all cases where the sperm cannot reach the ovum, Iin Vitro Fertilization (IVF) technique can be used for fertility. Separation of motile sperms from non-motile ones is essential in some infertility treatments such as intracytoplasmic sperm injection (ICSI) and in vitro fertilization. Motility is one of the most important parameters in sperm quality, the effective and safe operations are more desirable in such treatments. The ideal sperm separation technique should be easy, low-cost, separate many sperms as possible, not damage the sperms, not cause physiological transformation, eliminate dead sperms and also other cells, allow for analyzing larger volumes of ejaculates, reduce the risk of reactive oxygen species and not having toxins for spermatozoa. In addition, after the separation step, spermatozoa must be viable and be able to fertilize the egg. Sperm morphology is directly related to the successful process. A system that selects the best sperms for fertilization can help to increase the rate of birth. In addition, sperm separation is a basic step in the IVF process. Several methods for motile sperm separation have been reported, including : Sperm washing, Sperm migration, Sperm sedimentation, Filtration, Density gradient centrifugation, Sperm surface charge for sperm selection(electrophoresis & zeta), Magnetic-activated cell sorting (MACS), Hyaluronic acid sperm binding, Raman spectroscopy, Confocal light absorption and scattering microscopy (CLASS), and Selection based on live sperm morphology. Sperm migration and movement from one point to another, is one of the sperm separation methods. Migration method, as a method to separate motile sperms, is used as an ideal experimental sperm selection method. One of the emerging systems used for motile sperm separation is sperm separation microfluidic system. among methods of motile sperm selection, the ones which use micro channels go beyond others in simplicity, user-friendliness, and similarity to the physiological environment. Among methods of motile sperm selection, the ones which use micro channels go beyond others in simplicity, user-friendliness, and similarity to the physiological environment. Seo et al. (2007) designed a motile sperm sorting microfluidic system (MSMS) consisting four channels and three reservoirs. The flow in channels is created by hydrostatic pressure of columns at the liquid reservoirs. In this system, a reverse stream is flowing and only motile sperms are able to swim against the flow. In this paper, we will simulate and develop the MSMS micro fluidic device previously reported by Seo. After validation, with Seo's results, we optimize the size of micro channels. The results will be useful in sperm sorting applications. In addition, in this research, by the use of the optimized system and electrophoresis based concepts, microfluidic system, consisting of a electrostatic field and optimized TRMS system, is designed for separation and selection motile sperms.

Key Words: Sperm, motile sperm, sperm separation, microfluidic, micro injection.

FREE VIBRATION OF TWO-LAYERED GRAPHENE BORON NITRIDE NANOSHEETS VIA

MINIMUM DESCENT VELOCITY CONSTRAINT FOR A PASSIVE FLYING VEHICLE

A. Kosari(corresponding author)
kosari_a@ut.ac.ir
H. Rahimi Kondelaji
rahimi_h@ut.ac.ir
Dept. of Aerospace
Faculty of new Science and Technology
University of Tehran

Sharif Mechanical Engineering Journal
Volume 33, Issue 2, Page 75-82, Original Article

- Received 19 April 2016; received in revised form 16 July 2016; accepted 1 August 2016.

Abstract

Designing automatic come back system has long been of interest to researchers and scientists worldwide because of the strategic importance of this technology. But, there are not significant resources because most of such activities and studies are often in isolated and semi-military places. A trajectory with minimum acceleration rate, the energy loss, and high precision with high reliability, the selection and implementation guidance law is required which is obtained by evaluating the mission system, support system, and also challenged environmental conditions. Hereof, guidance laws with suitable trajectory can play important and effective roles as a software in increasing reliability of system and fulfilling the objectives of the control system designer. Several strategies have been proposed to guide the direction of flight systems, which each of them has its strengths and weaknesses. One of the strengths of guidance solutions, is the satisfaction of controlling the vector of the final speed for which Kappa guidance law is one of them. Kappa guidance law is an analytical solution with minimum energy performance index based on the calculation of the acceleration required to satisfy the boundary conditions of the aerial vehicles. In this paper, generalizing kappa guidance law in order to design a come-back trajectory with minimum landing velocity constraint for an aerial passive vehicles has been derived. Designed trajectory has been improved against "kappa guidance law with constant navigation coefficients". This means that "acceleration rate" and "final velocity in vertical plane" are reduced to minimum. Evaluation and comparison of the results, through the case studies are carried out, confirms recovery of acceleration time history of payload and final velocity vector control in order to increase reliability of landing sub-system for come-back aerial passive vehicles.

Key Words: Parafoil, come-back, generalized kappa guidance law, trajectory shaping.

INVESTIGATION OF FRACTURE ON FLEXIBLE ROLL FORMING PROCESS USING DUCTILE FRACTURE CRITERIA AND FLD CRITERION

Y. Dadgar Asl
y.dadgar@srttu.edu
M.M. Sheikhi(corresponding author)
m.sheikhi@srttu.edu
A. Pourkamali Anaraki
ali_pourkamali@srttu.edu
V. Panahizadeh Rahimloo
v.panahizadeh@srttu.edu
M. Hosseinpour Gollo
m.hoseinpour@srttu.edu
Dept. of Mechanical Engineering
Shahid Rajaee Teacher Training University

Sharif Mechanical Engineering Journal
Volume 33, Issue 2, Page 83-92, Original Article

- Received 25 April 2016; received in revised form 18 June 2016; accepted 19 July 2016.

Abstract

Using cold roll forming process can only produce profiles with constant cross-sections.
While industries, such as automotive and construction, require profiles with variable cross sections.
High costs and dimensional limitation of these products by production methods with limited flexibility, such as incremental forming, deep drawing, and hydroforming, led to the idea of using roll-forming process to produce these components discussed. That is the famous the process of forming parts with variable cross-sections or flexible roll forming process.
This process has some defects like other forming processes that are causing unexpected forms. The main defects of this process are web warping, the deviation from the desired edge position, edge wrinkling, fracture at bending edges, longitudinal deflection. One of the main defects in this process is the fracture phenomenon. The fracture is observed on the bending edges at transition zone in which sheet thickness is largely compared to the bending radius. In this research, the fracture phenomenon was investigated on flexible roll forming process of channel section using ductile fracture criteria and FLD criterion. For this purpose, finite element simulation of the process was done using Abaqus software.
The fracture defect in this process was investigated using six ductile fracture criteria and FLD criterion. Then, experimental tests were performed using flexible roll forming machine made in Shahid Rajaee Teacher Training University. By comparing simulation results with experimental results, numerical results were validated. In

Sharif Mechanical Engineering Journal
Volume 33, Issue 2, Page 53-61, Original Article

- Received 8 February 2016; received in revised form 2 November 2016; accepted 5 December 2016.

Abstract
One of the effective solutions for controlling unwanted vibrations in rotating machinery is increasing the damping of the system by means of Squeeze Film Damper (SFD). In spite of the effectiveness of this equipment in controlling the vibrations of rotating machinery, we confront some limitations due to strong inherent nonlinearity of this equipment. For example, we can mention nonlinear behavior such as occurrence of various types of bifurcations, nonsynchronous vibration, chaotic motions, and jump phenomena. In this paper, the effect of system parameters, namely the unbalance parameter U , bearing parameter(B_b) , gravity parameter W, and rotating speed parameter Ω, are investigated on stability and bifurcation of a rigid rotor on squeeze film damper with centering springs and with consideration of occurrence of cavitation in fluid film by means of Floquet Transition Matrix Method. Numerical results in the form of journal center orbit and Poincare map showed the wrecking role of the unbalance parameter U in nonlinear behavior of the system and occurrence of Saddle-node and Period-Doubling Bifurcations and jump between Period-1 and Period-2 orbits in rotor response.

Key Words: Stability, bifurcation, squeeze film damper, rigid rotor, cavitation.

TRAJECTORY OPTIMIZATION OF FLEXIBLE REDUNDANT ROBOT MANIPULATORS BY SEPARATION OF ELASTIC VIBRATION

S.M. Faritus
mr_faritus@yahoo.com
H. Homaei(corresponding author)
hadi-h@eng.sku.ac.ir
Dept. of Mechanical Engineering
University of Shahrekord
Sh. Hadian Jazi
s.shadian@eng.ui.ac.ir
Dept. of Mechanical Engineering
University of Isfahan

Sharif Mechanical Engineering Journal
Volume 33, Issue 2, Page 63-73, Original Article

- Received 1 March 2016; received in revised form 16 July 2016; accepted 26 July 2016.

Abstract
In this article, trajectory optimization of robot manipulators with additional degrees of freedom is studied. In the suggested method, all possible answers are obtained based on rigid conditions and redundancy of robot. Then, by using open-loop optimal control approach, the trajectory which minimizes the objective function will be selected. Due to flexibility, the dimensions of system are unlimited. So, the assumed mode method is used for discretization. By calculating kinetic and potential energy of system and based on Lagrange formulation, dynamic equations of motion are extracted. Given that global optimization is more accurate and efficient in comparison with local optimization, global optimization is used in this research. The objective function is defined as an integral index and will be minimized in the entire path. The objective function and constraints of optimization problem will be selected based on conditions of point-to-point motion or the specified trajectory between two fixed points. In two states, reduction of elastic vibrations of flexible members is considered as one of the main goals of issue. Dynamic equations of system are constraints of optimization problem in point-to-point motion. For condition of motion in the specified trajectory, kinematic equations are added to dynamic constraints. Also, unequal constraints are applied for bounding the velocity and torque magnitudes. By selecting the state and control signal vector which are obtained from assuming rigid motion of robot, the objective function and constraints will be changed to the standard form of an optimization problem. To solve the equations, Pontryagin's minimum principle is used. By using this principle, the equations of the classic form will be changed to a set of first order of differential equations, and finally, to a two-point boundary value problem. Given that the suggested method for point-to-point motion and movement in the specified trajectory is provided; therefore, two examples in simulation are considered for each. Results indicate accuracy and efficiency of the suggested method.

Key Words: Trajectory optimization, flexible manipulators, redundancy.

GENERALIZING KAPPA GUIDANCE LAW IN ORDER TO IMPROVE COME-BACK TRAJECTORY WITH

one translational DOF (3R1T), two rotational DOFs and two translational DOFs (2R2T), and three translational DOFs and one rotational DOF (3T1R) are synthesized. These mechanisms belong to a group of complex mechanisms which have closed chains in the structure of their limbs. The parallelogram loop is considered to synthesizes these complex mechanisms which helps to achieved mechanisms with lower motion decoupling. After synthesizing and obtaining the appropriate degrees of freedom and motion patterns, the mechanism with less kinematic complexities is selected, and then analyzed via the screw theory. Using the screw theory, without complex derivative of inverse kinematic problems, Jacobian mechanism can be obtained. In this analysis, the degrees of freedom and motion patterns of each mechanism are tested and the Jacobian matrix related to each one is obtained. Using the screw theory, Jacobian matrix of all mechanisms are is obtained. The results indicate that the mechanisms have the appropriate degrees of freedom and motion patterns, and thus, the theory of linear transformations works properly. Moreover, the Jacobian matrices for these mechanisms have acceptable motion decoupling which implies the non-complexity in the velocity equations of these mechanisms.

Key Words: Parallel mechanism, theory of linear transformation, screw theory, type synthesis, 4-DOF.

NUMERICAL SIMULATION AND REDUCED ORDER MODELING OF MASS TRANSFER DUE TO NATURAL CONVECTION BASED ON COUPLING BETWEEN TEMPERATURE AND CONTAMINANT CONCENTRATION MODAL COEFFICIENTS

M.K. Moayyedi
mk.moayyedi@qom.ac.ir
Dept. of Mechanical Engineering
University of Qom

Sharif Mechanical Engineering Journal
Volume 33, Issue 2, Page 43-52, Original Article

- Received 20 December 2015; received in revised form 14 September 2016; accepted 24 September 2016.

Abstract
In this study, a numerical approach and a reduced order model based on POD method are developed for simulation of the fluid flow and mass transfer. The flow field is under the effects of temperature gradients associated with contaminant transport. For this purpose, unsteady incompressible Navier-Stokes equations with terms of effects of buoyancy forces, unsteady heat transfer, and concentrations transport equations were solved simultaneously using numerical method. In order to discreatize the spatial terms, the second-order central difference method was used and the time integration was performed using Runge-Kutta fourth-order approach. The required snapshots for reconstruction of dynamical system were calculated using the numerical simulation data. Firstly, the CFD model was incorporated for simulation of a classic fluid mechanics problem, such as cavity flow, for validating its accuracy. Then, the developed computer code was applied for simulation of natural convection and mass transfer in a bounded domain under specified boundary conditions. In order to construct the reduced order model, based on the concept of dynamical system and projection approach, momentum and concentration transport equations were projected along POD modes. Moreover, for modeling the dynamics of flow field, velocity field and concentration transport dynamical system equations were solved for related modal coefficients variations. For simulation of heat transfer, temperature field modes were computed according to the modal coefficients of concentration field. The special achievement of this research would be reduction in the number of equations required to simulate the dynamic of the flow field. Based on POD modes energy level results in a higher level of captured kinetic energy of flow field when using a smaller number of modes. This means that by the described method a reduced order model can be obtained. The proposed model has the ability to simulate the flow and contaminant transport with higher speed of computations. The results of the reduced model were compared with the data obtained from numerical model and the accuracy and the ability of the developed model have been validated.

Key Words: Reduced order model, numerical simulation, natural convection, pollutant transport, mass transfer, dynamical system.

EFFECT OF RIGID ROTOR PARAMETERS WITH SQUEEZE FILM DAMPER ON INSTABILITY AND BIFURCATION

H. Heidari(corresponding author)
hr.heidari@malayeru.ac.ir
M. Ashkooh
ashkooh@rocketmail.com
Dept. of Mechanical Engineering
Malayer University

force is supplied to the DNS solver. Simulations were conducted with different number of particles, different Stokes numbers, and different amounts of slippage. Results show that the increase of the slip on the particles surface causes the decrease of the preferential concentration. By using Q criterion, the vortices are detected and behaviors of particles near these vortices are studied. Results show that by decreasing Trostel number and drag force, particles run away more quickly from the vortices.

Key Words: Direct numerical simulation, particle-laden flow, ciportosi suoenegomohturbulent flow, mixed stick-slip boundari condition.

UAV 3D ROBUST GUIDANCE LAW DESIGN BY FUZZY SLIDING MODE APPROACH

E. Sadeghi
esadeghi1368@gmail.com
J. Karimi(corresponding author)
karimi_j@mut.ac.ir
S.H. Sadati
hsadati@aut.ac.com
Dept. of Aerospace Engineering
MalekAshtar University of Technology

Sharif Mechanical Engineering Journal
Volume 33, Issue 2, Page 13-25, Original Article

- Received 25 November 2015; received in revised form 1 August 2016; accepted 13 August 2016.

Abstract

One of the main concerns in the field of promoting autonomy level of Unmanned Air Vehicles (UAVs) is guidance system which is designed to enable UAVs to fulfill their missions, especially through uncertain atmospheric conditions. The UAV should be able to complete the mission in a robust manner. Therefore, the current study is to provide a robust guidance system for UAV's. The designed guidance law should perform the mission, defined by a set of waypoints, in presence of wind and turbulence as efficiently as possible. In those parts of the path with small radii of curvature or when the UAV flies within the wind and turbulence, the classic guidance laws such as Pure Pursuit and Proportional Navigation undergo severe losses in their performance. In order to flight through a series of waypoints, while considering the UAV nonlinear six degrees of freedom dynamic model, a new robust guidance law is designed, based on the Pure Pursuit Guidance law and sliding mode control approach. Then, in order to increase the efficiency of the Pure Pursuit Sliding Mode Guidance and to reduce the undesired phenomenon of chattering, the desired guidance law is combined with a fuzzy control approach. Then, dynamic inversion is used for attitude control. The performance analysis of the newly developed guidance law, Pure Pursuit Fuzzy Sliding Mode Guidance, is evaluated through a series of scenarios without turbulence and wind and with turbulence and wind effects. The six degrees of freedom simulations reveal the superior performance of the proposed approach in comparison with the pure pursuit guidance law.

Key Words: Robust guidance, pure pursuit guidance, sliding mode control, fuzzy system, dynamic inversion, guidance and control system.

TYPE SYNTHESIS AND ANALYSIS OF A NEW SET OF 4-DOF PARALLEL ROBOTS USING LINEAR TRANSFORMATION AND SCREW THEORY

E. Rostami
esmaeil.rostami@ut.ac.ir
M. Tale Masouleh(corresponding author)
m.t.masouleh@ut.ac.ir
School of Electrical and Computer Engineering
University of Tehran

Sharif Mechanical Engineering Journal
Volume 33, Issue 2, Page 27-41, Original Article

- Received 13 December 2015; received in revised form 20 August 2016; accepted 6 September 2016.

Abstract

In this paper, by using the theory of linear transformations, we investigate the type synthesis of 4-DOF parallel mechanisms performing different motion patterns are investigated. Most of the applications in various fields require limited movement and less than 6 degrees of freedom. The parallel mechanism with 4 degrees of freedom has many applications in different areas, such as industry and, medicine. Thus, the type synthesis of these mechanisms are is of paramount importance. This theory, which is one of the motion criteria, is applied to determine the degrees of freedom, and then synthesize the limbs of mechanisms. Unlike the classical theories of motion, in the case of parallel mechanisms and mechanisms with closed chains, this approach leads to promising and remarkable results. In this paper, 4-DOF parallel mechanisms performing three rotational DOFs and

Abstracts of Papers in English

DIRECT NUMERICAL SIMULATION OF TURBULENT PARTICLE-LADEN FLOW WITH MIXED STICK-SLIP BOUNDARY CONDITION

Z. Alinejad
z.alinejad.mec@gmail.com
A. Moosaie(corresponding author)
moosaie@yu.ac.ir
Gh. Zendehbudi
zendehbudi@yu.ac.ir
Dept. of Mechanical Engineering
Yasouj University

Sharif Mechanical Engineering Journal
Volume 33, Issue 2, Page 3-12, Original Article

- Received 8 November 2015; received in revised form 16 July 2016; accepted 1 August 2016.

Abstract

In this paper, a homogeneous isotropic turbulent flow inside a box with periodic boundary conditions laden with heavy spherical particles is investigated. The mixed stick-slip boundary condition is applied onto the particles surface. In all previous studies, the problem have been solved by considering no-slip boundary condition on the particles, but this assumption is not always acceptable, e.g., in two-phase liquid-liquid and liquid-gas suspensions. For example, assuming no-slip boundary condition on the surface of liquid particles is not realistic, because, the background flow induces a flow inside the liquid drops, and thus, there is a non-zero velocity at the interface. This effect can be modeled by assuming the slip boundary condition. Furthermore, due to the evaporation of liquid particles suspended in a gas, there is a mass transfer at the interface, which could be modeled as a boundary slip, again. Also, with the progress of technology, hydrophobic materials are being used in various areas. These surfaces cause an apparent slip at the boundary. Hence, the study of mixed stick-slip boundary condition is of great fundamental as well as applied importance, because the effect of creeping flow boundary condition on the dynamics of the particles can be observed. The background turbulent flow field is computed using the direct numerical simulation (DNS) technique. In order to sustain the turbulence state, a linear forcing scheme is employed. The particle dynamics is governed by the Maxey-Riley equation. The drag force acting on the particle is obtained by solving creeping flow around a spherical particle with slip boundary condition. The so-obtained analytical formula for the drag