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**3-5, 2014
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2014 International Conference on Mechanical Engineering and Automation

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Preface

It is my honor to welcome all of you to Beijing, China to participate in the 2014 International Conference on Mechanical Engineering and Automation (ICMEA2014) which will be held during January 3 to 5, 2014. The ICMEA2014 will provide an excellent international academic forum for sharing knowledge and results in theory, methodology and applications of Mechanical Engineering and Automation.

The ICMEA2014 is organized by Advanced Information Science Research Center (AISRC) and is co-sponsored by Chongqing University, Changsha University of Science & Technology, Huazong University of Science and Technology and China Three Gorges University.

This ICMEA2014 proceedings tends to collect the up-to-date, comprehensive and worldwide state-of-art knowledge on mechanical engineering and automation, including control theory and application, mechanic manufacturing system and automation, and Computer Science and applications. All of accepted papers were subjected to strict peer-reviewing by 2-4 expert referees. The papers have been selected for this volume because of quality and the relevance to the conference. We hope this book will not only provide the readers a broad overview of the latest research results, but also provide the readers a valuable summary and reference in these fields.

ICMEA2014 organizing committee would like to express our sincere appreciations to all authors for their contributions to this book. We would like to extend our thanks to all the referees for their constructive comments on all papers; especially, we would like to thank to organizing committee for their hard working.

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Beijing University of Technology

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Oil Flow in Two Axial Groove Journal Bearing

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Keywords: Hydrodynamic lubrication, journal bearing, oil flow rate.

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Abstract. Results are presented of a study of oil flow rate in hydrodynamically lubricated axial groove plain journal bearing. The prediction of oil flow rate under steady load and a variation of viscosity across the film thickness is solved by Reynolds equation. Constant viscosity theory leads us to expect feed pressure and hydrodynamic induced flow rate to increase with eccentricity up to a peak value and then decrease for eccentricity ratio above about 0.75. Thus it is expected that a rise of load will result in increased or induced flow rate according to the operating eccentricity ratio. The theoretical results show, for the shorter bearing ($L/D = 0.3$), that due to the viscosity variation through the film thickness, the velocity induced flow rate is significantly less than that predicted on the basis of constant viscosity. The reduction of velocity-induced flow rate increases with a speed, the difference is in the order of 17% at high speed from the low viscous theory.

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Introduction

The basic design procedure for the prediction of journal bearing performance (shown in Fig. 1) involves the ability to predict the operating temperature of the bearing. Johnson [1,2] has shown that for high speed bearings over 50 mm diameter, convection via the oil flow through the bearing represents the primary flow of heat from the bearing. Thus oil flow rate is the key factor determining the working temperature of large bearings.

Originally, Wicock and Kowalick [3] predicted the oil flow through a journal bearing on the basis of adding together the hydro-dynamically induced flow and the hydrostatic flow, and subsequently this method has been used by ESDU S4031 design procedure [4]. There is a lack of poor agreement between actual flow rates in journal bearings and those predicted on [5].

In practice, the journal temperature lies between the maximum and minimum bearing surface temperature. Considering the convective flow term, in the film inlet region the journal temperature is generally higher than the bearing temperature. Through the film thickness, the viscosity increase from the journal to the bearing surface and the velocity gradient decreases (as shown in Fig. 2a).

If we compare this with the constant viscosity case there will exist a velocity induced flow rate. In the outlet film region (where $dy/dx = 0$), the journal temperature is lower than the bearing surface temperature and the velocity gradient increases as the viscosity of lubricant film decreases (as shown in Fig. 2b). Comparing with the constant viscosity case there will exist an increased flow rate.

Thus, in comparison with the constant viscosity case, through the film thickness viscosity variation is likely to lead to lower flow rate at the 'inlet' end of the film and, therefore induced side flow from the bearing.

This study of oil flow in journal bearings arose from observations that the measured flow rate is commonly lower than that calculated on the assumption of a complete film and constant viscosity. The need for a more comprehensive analysis of oil flow rate in journal bearings should take account of the variation of viscosity through the film thickness.

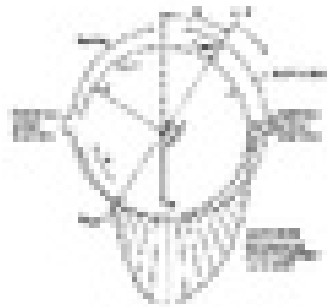


Fig. 1. Journal bearing



Fig. 2. Velocity profile

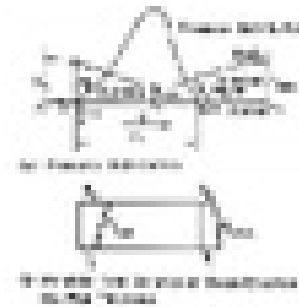


Fig. 3. Velocity variation across the film.

Theoretical Study

The velocity profile across the film thickness, is shown in Fig. 3. Velocity varies according to,

$$u = -u_0 \left[1 + \left(C \frac{z}{h} \right) \right] \tag{1}$$

The modified Reynolds equation becomes,

$$\frac{d}{dx} \left[K_0 h^3 \frac{d\phi}{dx} \right] + K_1 \frac{d}{dx} \left[h^3 \frac{d\phi}{dx} \right] = -C u_0 \frac{d}{dx} [K_0 h] \tag{2}$$

where: For parabolic variation of viscosity, K_0 and K_1 are given by,

$$K_0 = \frac{1}{12\eta} \left[-1 + \frac{2}{\sqrt{C}} \arctan \sqrt{C} + \frac{\ln(1+C)}{\arctan \sqrt{C}} \frac{1}{2\sqrt{C}} (h(1+C)) \right] \text{ and } K_1 = \frac{1}{\arctan \sqrt{C}} \frac{1}{2\sqrt{C}} (h(1+C))$$

The finite difference of Eq. 2 becomes,

$$\frac{d^2 P}{dx^2} + \frac{d}{dx} \frac{dP}{dx} + \frac{1}{\beta} \left[\gamma \frac{d^2 P}{dx^2} + \frac{d}{dx} \frac{dP}{dx} \right] = -\frac{d^2 u_0}{dx^2} = -\phi \tag{3}$$

Substituting the approximations into the Reynolds Eq. 3 gives a general relationship,

$$A P_{i+1,j} + B P_{i,j} + C P_{i-1,j} + D P_{i,j+1} + E P_{i,j-1} = F \tag{4}$$

Two bearing and journals are used in this investigation and the data is shown in Table 1 and Fig. 4.

Table 1. Bearing dimensions [mm]

Bearing	Supply geometry	d	h_0	C&M	d_1
A	2 axial grooves	76.25	30.517	0.001-0.000	76.17
B	2 axial grooves	76.25	30.517	0.001-0.000	76.17

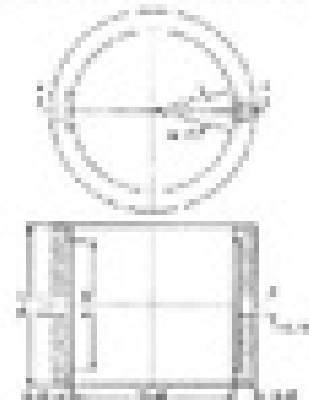


Fig. 4. Bearing and groove geometry

The lubricant temperature distribution around the bearing is adapted from experimental data which is shown in Fig. 3.

1

The Analysis of Journal Bearing

The lubricant was assumed to supplied at ambient pressure via a slit with thin groove in the upper half of the journal. The Reynolds equation was solved using the Gauss-Seidel iterative method with over relaxation factor.

1

The boundary conditions required were at the bearing edges and at the lubricant supply line. The lubricant was assumed to cavitate at ambient pressure. Thus, $P_{cavitation} = P_{ambient} = 0$.

For use with the Reynolds equation and full-film film applied, the following boundary conditions adapted were,

- a) $P = 0$ at $\theta = 0$.
- b) $P = 0$ at $\theta = 360 - \phi$, and $P = 0$ at $\theta = 360 - \phi$.
- c) $P = \frac{dP}{d\theta} = \frac{dP}{d\theta} = 0$ at $\theta = \theta_1 = 180$.
- d) $P = 0$ at $x = \pm 1/2$.

2

The solution of the type representative by Eq. 4 resulted in as many equations as grid points and the solution of a system of simultaneous linear equations in the pressure variable was required.

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The iterations were continue until the following convergence criterion was satisfied,

$$\left| \frac{P_{i,j} - P_{i,j}^{old}}{P_{i,j}} \right| \leq \epsilon \left| \frac{P_{i,j}}{P_{i,j}} \right|$$

A computer program flow chart which models the bearing behaviour is shown in Fig. 4. The dimensionless pressure P was given by,

$$P = \left[\frac{P h^3_{min}}{\mu_0 U L} \right] \tag{5}$$

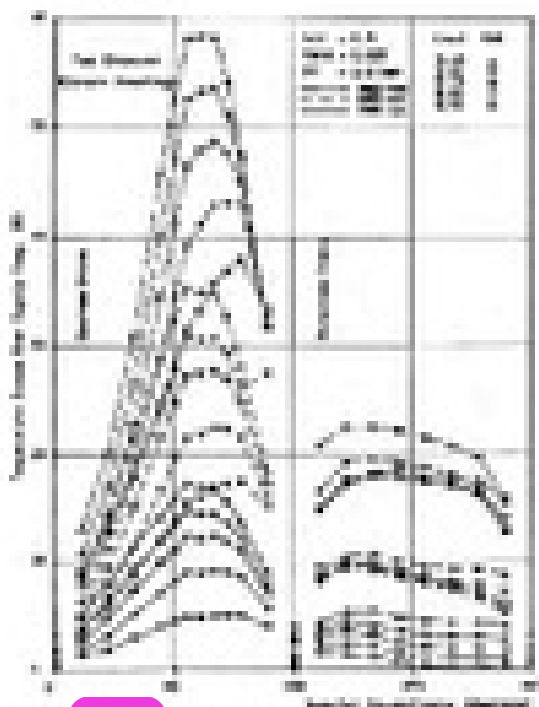


Fig. 3. Typical bearing temperature distribution.

2

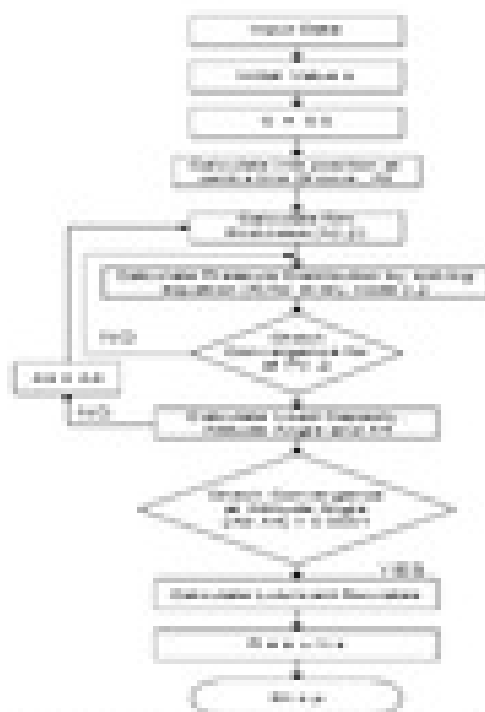


Fig. 4. Computer program flow chart

The load capacity was determined by integration of the pressure distribution around the bearing. For the co-ordinate system represented in Fig. 2, the components of the resultant film pressure force along and perpendicular to the line of centres are given by,

$$W_1^* = -2\pi \int_{-1}^{+1} \int_{-1}^{+1} P \cos \theta dX dZ \quad \text{and} \quad W_2^* = +2\pi \int_{-1}^{+1} \int_{-1}^{+1} P \sin \theta dX dZ \quad (5)$$

The attitude angle was then determined from,

$$\theta = \tan^{-1} (W_2^* / W_1^*) \quad (7)$$

Lubricant Flow Rates

The computer program calculated the dimensionless flow rate from the inlet of the bearing (Q^*) and the flow rate into the cavitation region (Q^{*c}). The condition of the full-film lubrication at the inlet region in journal bearing can be seen in Fig. 3.



Fig. 7. Orthogonal and resultant load

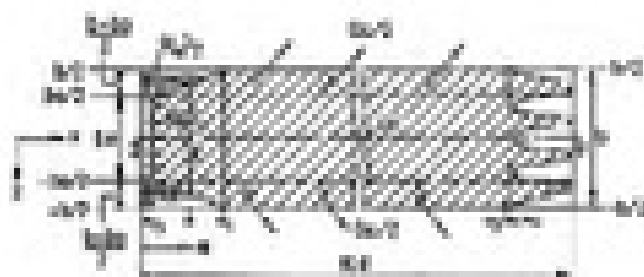


Fig. 8. Fluid film region in journal bearing

In dimensionless form, the circumferential flow rate across a bearing of width (2z) was given by,

$$Q^* = \int_{-1}^{+1} \left[K_1 \frac{dP}{d\theta} + \frac{\pi}{2} K_2 N \right] dZ \quad (8)$$

The axial flow rate across the section of circumferential length (2a) was determined from,

$$Q^* = \frac{1}{2} \left(\frac{d}{b} \right)^2 \int_{-1}^{+1} \left[K_1 N^2 \frac{dP}{dZ} \right] dZ \quad (9)$$

The flow rates were made dimensionless according to,

$$Q^* = \frac{Q}{cR\omega b} \quad (10)$$

Results and Discussion

The non-dimensional feed flow factor [5] and the non-dimensional side flow rate (two-viscosity theory) for two axial grooves journal bearing are shown in Fig. 9 and 10. Constant viscosity theory for journal bearings leads us to expect feed pressure induced flow rate and hydrodynamic induced flow rate to increase with eccentricity ratio to a peak value and then to decrease for eccentricity ratio above about 0.75.

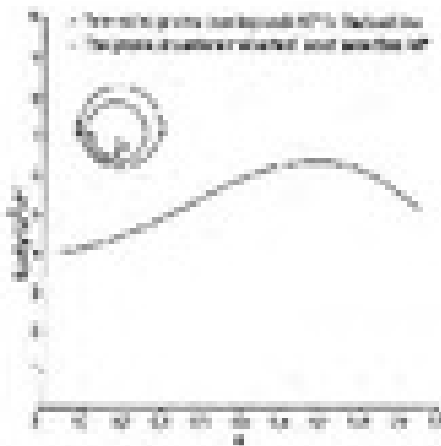


Fig. 9. Non-dimensional load flow factor (from Martin and Lee data [5])

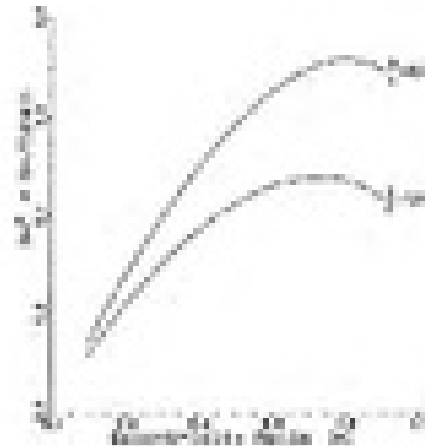


Fig. 10. Non-dimensional side flow rate (iso-viscous theory)

It can be expected that increase of load will result in increased or reduced flow rate according to the operating eccentricity ratio value.

The results of the investigation for the influence of the variation of viscosity through the film thickness on the velocity-induced flow rate are given for comparison with the iso-viscous solution. Comparisons of these data are shown plotted in Fig. 11 and 12.

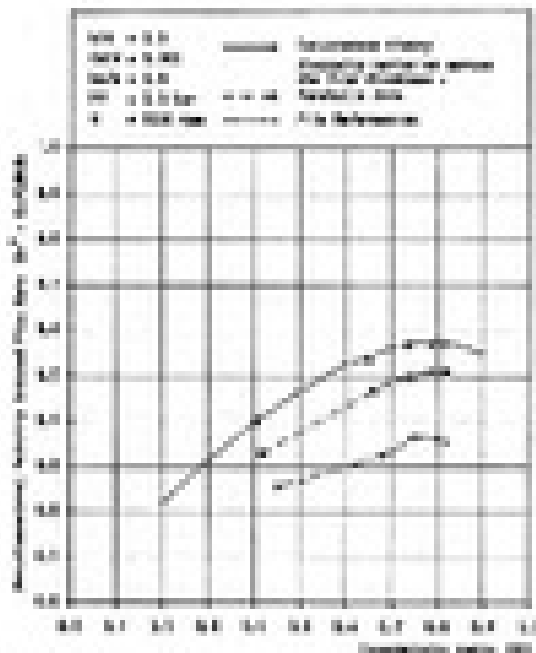


Fig. 11. Non-dimensional velocity induced flow rate for $N = 5000$ (rpm)

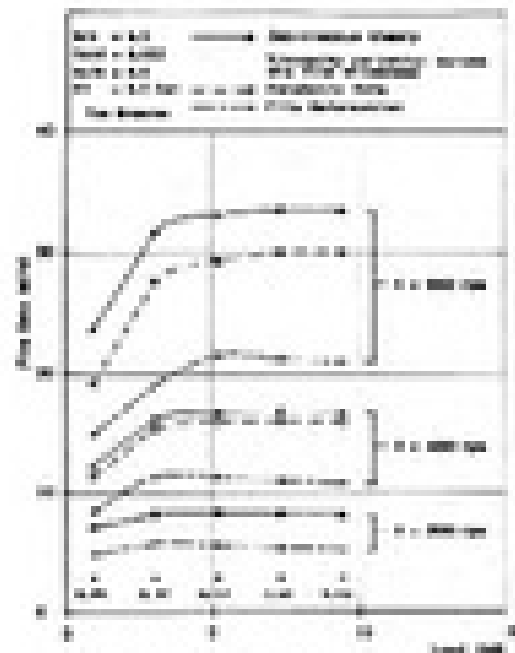


Fig. 12. Velocity induced flow rate

It is evident that due to the viscosity variation through the film thickness, the velocity-induced flow rate is significantly less than that predicted on the basis of constant viscosity.

The reduction of velocity-induced flow rate increases with speed, the difference is of the order of 17% at high speed from the iso-viscous theory. This result is consistent with what would be expected. First, through the film thickness, the viscosity of lubricant increases at the film inlet and decreases at the film outlet from journal surface to the bearing surface, therefore the oil side flow rate from the bearing would be reduced and the velocity-induced flow rate would be reduced too.

Conclusions and Suggestions

The conclusions of such study can be summarized as follows:

- 1) For a given speed, it is to be expected the magnitude of load will result in increased or reduced flow rate according to the operating eccentricity ratio value.
- 2) In engines, there is negligible difference between the results obtained from a lower form and higher form of variation of viscosity through the film thickness. It is the magnitude of the manner of the variation that is important.
- 3) The effects of viscosity variation through the film thickness on the velocity-induced flow rate is significant and the reduction of the flow rate has been ascertained using this numerical model.
- 4) The influence on the discrepancy of oil flow rates of viscosity variation model, incorporated in the numerical model is greater at high speed than at low speed. As a result, a better prediction is provided by this numerical model at high speed than the case of low speed.

Suggestion for Future Work

It has been shown that there is a significant effect of variation of viscosity through the film thickness upon the velocity-induced flow rate. From this findings, the suggestions for the future work would be to study the precise manner and the magnitude of the delayed film with film information in inlet region of journal bearing.

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2014 机械工程与自动化国际学术会议

10

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Session 1: Control Engineering and Applications

An Overview on the Ball and Plate Control System

Kyongwon Han, Yantao Tian, Huida Duan1, Jinsong Li, Yinghui Zhang and Zhenchao Zhu.....1

Abstract. Ball and plate system has the under-actuated characteristic, friction between ball and flat plate, strong nonlinearity and etc., so it is known as a benchmark to identify the stability and accuracy of control strategies like the ball and beam system in control engineering field. In this paper, the various control strategies applied to ball and plate system up to this time are analyzed synthetically, and the important control engineering problems are proposed which should be solved in the field of ball and plate control system for improving the stability and accuracy of control.

Design and Manipulation of High Concentration Reflected Photovoltaic Module

Cheng-Yi Hsu, Yu-Chin Chou and Yuli Lin.....2

Abstract. In this study, a 3x3 array module of high concentration reflected photovoltaic (HCRPV) has been designed. The optimal condition is also calculated by simulation method. First, a 10cmx10cm single module is designed which is named as model A structure. The focal length of first and secondary mirror, the slope angle and the length of light guide were the main parameters to be optimized. It was found the model A-5 structure has the best performance. The light collection efficiency can be reached to about 97.1%. For 3x3 array module as named as model B structure, the light collective efficiency can be reached to about 96.9%. Aluminum HCRPV module was then fabricated according to the optimal simulated conditions. When the HCRPV module of model A-5 structure was coated with silver material, the voltage on the multi-junction solar cell was measured to be 2.68V, the current was measured to be 0.63A, as the solar energy of illumination is 300 W/m². According to measurement, the power of this designed structure is calculated to be about 1.7W.

Multifunctional Cabinet Interior Environment Monitoring System

Jia Zhang, Xiang Li, Gonghuang Yang and Mingkung Ma.....3

Abstract. Local overheating in the cabinet is a hot problem. Multifunctional cabinet interior environment monitoring system based on MSP430 chip as the main body controls all sensors which supervises real-time data in the cabinet. System can be widely used in Banks, customs, and other large-scale real-time data exchange of the post office room, its good man-machine interactive operation provides convenient to the customer. System for the modular design, can be designed according to user requirements, thus has broad market prospects.

An Alternative Numerical Method for the Inversion of Laplace Transforms

Yanhong Liu, Hongwei Yu and Guanghui Qing.....4

Abstract. Based on the initial-value theorem and the final-value theorem by combining the Subbotin's method with different integration steps, an alternative numerical method for the inversion of Laplace transform was developed. The accuracy of the method presented was tested by a lot of individual functions whose analytical Laplace transforms were known. The numerical results show that the present method can give excellent accuracy on a wide range of continuous functions for either a short or a long-time inversion. For a short-time inversion the method can provide a better approximation to the analytical solution of the exponential functions. For a long-time inversion the results of the present method are relatively reliable and the accuracy is sufficient for engineering application.

Research on Marketing Personnel Training Mode in Chinese Liquor Industry

Jiabin Wang.....5

Abstract. Traditional mode of Marketing personnel training, based on macro personnel training, can not meet the needs of the demand from different enterprises in the industry for marketing personnel, which results in the structural contradictions between the supply and the demand in marketing personnel. In order to solve this problem, a deep research has been made into the liquor business, a full discussion and research has also been launched the marketing personnel

quality and ability requirements, and moreover brand-new marketing personnel training mode has been explored and summarized. This training model is the challenge to the traditional personnel training mode, and it can be further utilized as a good exploration and attempt into the form and direction of running an educational practice in university.

7 Subway Platform Layer Fire Evacuation Simulation
 Cheng Qi, Bolu Yong and Ren Yuan.....6

6 Abstract. Nowadays urban subway transport system has transformed its role from auxiliary facilities of urban traffic into a key component in people's lives. Most urban subway stations are underground, and in relatively enclosed spaces, so subway emergency evacuations are difficult. This paper studied social force model and simulated the evacuation of the subway platform fire. This paper designed two plans for the station, and compared the results of the plans. At last the paper also gives some suggestions.

Research and Application of Case-based Reasoning Theory
 Wendong Li, Dongying Wu, Shengli Liu, Da Xiao.....7

Abstract. Case-based reasoning (CBR) is an important research area of artificial intelligence, being a rapidly developed reasoning technique in recent years, has been widely used in various fields. This paper outline the origin and development of case-based reasoning theory, detail to analyze its reasoning process, and the key point of implementation of this theory, present classical application of CBR. At the end of paper, we predict the possible Research Directions and development of case-based reasoning in the future.

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Research of Stop-schedule Plan on Urban Rail Traffic
 Yuan Ren, Yongbo Lv, Hailing Gu and Jiao Wang.....8

Abstract: This paper quantitatively analyzes the formulation of stop-schedule plan, establishes a linear programming model targeting on optimal operating costs and travel time. Beijing metro line 6 is taken as an example to demonstrate it, then three kinds of feasible schemes are put forward, and these schemes are evaluated by AHP - membership function clustering. At last, the best one of the stop-schedule plan is obtained to verify the feasibility and rationality of this research.

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New Delay-dependent Criteria to Robust $L_2 - L_\infty$ Filter Design for Stochastic Systems with Time-varying Delays and Parameter Uncertainties
 Wenqin Wang, Shouming Zhong and Feng Liu.....12

Abstract. This study investigates the new delay-dependent criteria to robust $L_2 - L_\infty$ filter design for stochastic systems with time-varying delays and parameter uncertainties. Based on the Lyapunov-Krasovskii functional method, sufficient condition are obtained to ensure the systems are mean-square robustly asymptotically stable. Then the $L_2 - L_\infty$ filters are in terms of linear matrix inequalities (LMIs) which can be easily checked in practice. Finally, a example is given to illustrate the effectiveness and advantages of the proposed results.

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A Wavelet Collocation Precise Integration Method for Piezo-electric Laminated Rectangular Plates Four Sides Clamped

6 Jing-hui QING, Liang GUO and Chun-cao ZHANG.....10

Abstract. By using Quasi-Shannon wavelet, we develop a wavelet collocation method for the Hamilton canonical equation of piezoelectrics, and get the Hamilton canonical equation which discrete in plane and continuous along its thickness. Then we solve the partial differential equation according to the precise integration method. The approximate solution which is expressed by Quasi-Shannon wavelet satisfies the clamped boundary conditions of the plate easily. Numerical results show that the approach is correct and therefore provides a new algorithm for the static problem of piezoelectric laminated rectangular plates.

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virtual machines (VMs) on the same physical machine. The virtual machine monitor (VMM) treats I/O bound VMs and CPU bound VMs equally which results in the high scheduling latency for I/O bound applications. To mitigate the drawbacks while retain the high CPU throughput for CPU bound applications, we proposed a Non-uniform Time-slice Load Balancing scheduling scheme to leverage the multi-core to support I/O and CPU mixed applications. NTLB migrates I/O bound and CPU bound VMs to different run queues. One class of queues specified with short time-slice is dedicated for I/O bound VMs and the other class specified with long time-slice is dedicated for CPU bound VMs. NTLB takes the characteristic of applications into consideration when make global load balancing to improve the I/O responsiveness of I/O bound VMs. The experimental results show that NTLB improves the *netperf* TCP transaction rate by 33% and also reduces the connection time and the reply time of Apache web server.

Based Multi-point Infrared Probe Railway Hotbox Detection Algorithm

Ying Wang, Zhengrong Wu, Ying Liu and Zhesi Wang.....37

Abstract. Railway safety is the basic requirement of the normal operation. The factor that threatens the safety of railway is the equipment factors besides human factors. Moreover, excessively heated axle and sifter shafts accidents are the inertial accidents of vehicles. They are also the great hidden danger which threatens the safety of railway transportation. The paper mainly does the analysis and researches for the algorithm of the railway's hotbox detection. First of all, it introduced the overall architecture of the system according to the requirement of the railway hotbox detection system. Then it did the analysis of the hotbox detection model, which is based on the four-point liner array infrared probe, at the basement of hotbox detection principles, and pointed out the computer's key technologies when PC deals with this detection model which are the hotbox feature value extraction and decision-making of hotbox level. This paper mainly elaborates the batch estimated information fusion algorithm which is applied to the calculation of hotbox feature value, and hotbox level decision algorithm's implementation which is based on the fuzzy neural network. Finally, it gives the simulation affects of the railway hotbox detection algorithm.

Oil Flow in Two Axial Groove Journal Bearing

Hasan Bazzi, Irsyad Yan.....38

Abstract. Results are presented of a study of oil flow rates in hydrodynamically lubricated axial groove plain journal bearings. The prediction of oil flow rates under steady load and a variation of viscosity across the film thickness is solved by Reynolds equation. Constant viscosity theory leads us to expect feed pressure and hydrodynamic induced flow rate to increase with eccentricity ratio to a peak value and then decrease for eccentricity ratio above about 0.75. Thus it is expected that increase of load will result in increased or reduced flow rate according to the operating eccentricity ratio value. The theoretical results show, for the shorter bearing ($h/d = 0.5$), that due to the viscosity variation through the film thickness, the velocity induced flow rate is significantly less than that predicted on the basis of constant viscosity. The reduction of velocity-induced flow rate increases with speed, the difference is in the order of 17% at high speed from the iso-viscous theory.

Fuzzy Sliding Mode Based Ship Rudder/Fin Joint System Control

Yaochen Han, Ronglin Ma.....39

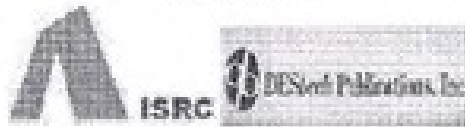
Abstract. For achieving good stabilization effect while keeping course angle, a rudder and fin joint controller is designed based on fuzzy sliding mode theory. Exponential approach law is applied in the sliding mode control for a class of multi input and multi output(MIMO) system combining with fuzzy logic for alleviating chattering. Applying the designed controller to rudder and fin joint stabilization system. White noise is employed to drive a typical second order transfer function to simulate wave disturbance. Matlab/Simulink toolbox is used and the simulation results show that average roll angle is about $\pm 1.5^\circ$ while keeping course by using the designed fuzzy sliding mode controller.

Performance Comparison of Two DR Observation Models in GPS/DR Tightly Coupled Algorithm

Bo Zhang, Liu Qin, Shujian Li.....40

Abstract. Twotightlycoupled vehicle-mountednavigation algorithm models based on GPS and low

2014 International Conference on Advanced Education and Management
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INVITATION LETTER

Dear

Paper ID: ICMEA-MATA 117

Paper Title: Oil Flow in Two Axial Groove Journal Bearing

Thank you for submitting your paper to 2014 International Conference on Advanced Education and Management [ICAEM2014]. As a result of the reviews and revisions, we are pleased to inform you that the paper above has been formally accepted for publication on ICAEM2014 conference proceedings. On behalf of the organizing committee, I am pleased to invite you to attend 2014 International conference on Economics and Management [ICAEM 2014] (<http://www.icaem2014.org>), which will be held on Jan.03-Jan.05, 2014 Beijing, China. 2014 International Conference on Advanced Education and Management [ICAEM2014] is to offer scholars, professionals, academics and graduate students to present, share, and discuss their studies from various perspectives in the aspects of Education and Management. We are looking forward to see you on Jan.03-Jan.05, 2014 Beijing, China.

Wish every success in your life.

Yours sincerely,

ICAEM2014 Organizing Committees



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**2014 International Conference on
Mechanical Engineering and Automation
[ICMEA 2014]**

**Jan.03-Jan.05, 2014
Beijing, China**

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ORAL PRESENTATION

Paper ID: ICMEA-MATA 117

Title: Oil Flow in Two Axial Groove Journal Bearing

Authors: Hasan Basri

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**Has given the oral presentation on 2014 International
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